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Awareness, Knowledge and Risk Perception of Chronic Diseases among University Students in Nigeria: Implications for Early Detection Strategies

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Abstract *The prevalence of chronic diseases is rising among younger individuals, yet there is a notable deficiency in both awareness and preventive strategies within various low- and middle-income countries. Gaining insights into young adults' awareness, knowledge, and perceptions is crucial for developing effective intervention programs. This study aimed to assess young adults' awareness, understanding, and perceptions of chronic diseases among students in tertiary institutions in Nigeria. A cross-sectional survey was conducted among 500 undergraduate students selected from Ambrose Alli University in Nigeria, with a total student population of 27,388. Data collection used a structured, self-administered questionnaire to assess awareness, knowledge of risk factors and symptoms, and perceptions of risk and severity. Data were analyzed using SPSS. Many participants demonstrated a general understanding of chronic conditions such as hypertension and diabetes. The average level of knowledge was 3.98 (SD = 1.36), with a possible range of 0 to 9. Nonetheless, respondents showed insufficient knowledge of early signs, symptoms, and related risk factors. Many respondents believed that these illnesses primarily affect older people, which contributed to a reduced sense of personal risk. Furthermore, misconceptions surrounding the onset and prevention of these diseases were observed. Although young adults show significant awareness of chronic diseases, important gaps remain in their knowledge and perceptions of risk. Therefore, targeted health education programs are essential to reduce behaviours that could hinder early detection and prevention of these conditions.*

Keywords *Awareness, Chronic Diseases, Knowledge, Nigeria, Perception, Young Adults.*

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Introduction

Chronic diseases are long-term conditions that typically develop over several years. These diseases, also known as non-communicable diseases (NCDs), cannot be transmitted from one person to another. They are often influenced by genetic and environmental factors, as well as personal behaviours and attitudes. Examples include cardiovascular diseases, diabetes, cancer, and chronic respiratory illnesses [1].

In Nigeria, especially regarding trends, the situation is characterised by the rise in the number of hypertension cases as well as the number of obese students in tertiary institutions. This is driven by unhealthy eating habits and low physical activity rates, as well as alcohol abuse, which complicates matters even more [3]. However, early-stage diagnosis rates remain low, partly because university healthcare centres lack necessary medical equipment, regular check-ups are uncommon, and students are often unaware of their health status. Nigeria is a low- to middle-income country, whose prevalence of diabetes, hypertension, and cardiovascular disorders is steadily rising. In this framework, university students constitute a valuable population for studying awareness and knowledge of diabetes [4]. University students are generally young adults in a transitional life stage, during which lifelong habits and health behaviours are established.

A study conducted among students at Nigerian universities indicates that although there is some general knowledge of diabetes, significant gaps remain in understanding its pathogenesis, risk factors, and prevention. A survey conducted among undergraduates across different tertiary institutions revealed that 85% of participants were aware that diabetes is a chronic disease, but more than half had limited knowledge of diabetes self-management [5]. This means that simple awareness is not the same as understanding the disease mechanisms or the methods of its successful management. Another study in Osun State found that 75.9% of undergraduates understood diabetes, but only 40.4% could define it accurately, and many could not suggest viable prevention measures [16]. These results suggest that in-depth disease knowledge may not translate into optimal health behaviours or reduced vulnerability.

A large cross-sectional study among Nigerian university students demonstrated that although most could identify specific risk factors for CVD, especially psychological stress, very few believed they were personally at risk of the condition [6]. This reflects a general trend in health behaviour research, in which people may have only basic knowledge of a disease yet cannot internalise it in a way that changes their health decisions. That is, knowledge is at the intellectual level but does not always lead to preventive health behaviour or to perceived vulnerability [2].

Perceived personal risk is low when awareness is present for some conditions, such as CVDs. There is also research showing that although many students are aware of CVD risk factors in classroom settings, they fail to translate this awareness into their health status [6]. This lack of perceived personal vulnerability may reduce motivation to follow preventive strategies such as exercise and a healthy diet.

Although previous studies have assessed awareness of chronic diseases, few have simultaneously examined awareness, knowledge and risk perceptions among young adults within tertiary institutions using an integrated network. This study provides a comprehensive analysis of these factors and highlights their implications for early detection strategies in resource-limited settings.

Methodology

Setting of the Study

Ambrose Alli University (AAU) is among the top universities in Nigeria for its notable contributions to national educational

frameworks, with a total of 27,388 students [24]. AAU is located in Ekpoma, Edo State, in a local government area and a Semi-Urban Community, and it currently serves a wide range of youth from diverse socio-economic backgrounds, with a focus on public health research. This diversity enhances student representation across academic disciplines, enriching insights into variations in health awareness.

Sample Size Determination

To perform the quantitative evaluation, a targeted sample of 300 to 500 undergraduate students was selected based on recommendations from cross-sectional studies primarily focused on large populations. Moreover, Cochran's formula was used at the 95% confidence level to determine the minimum sample size, with a 5% margin of error. To identify incomplete or non-potential responses during data collection, the sample size was increased beyond the minimum threshold to ensure adequate generalizability and power [8,9]. A sample size of 500 was calculated using Cochran's formula.

Sample Size Determination

Sample size was determined based on Yamane's (1967) formula for finite populations as:

Sample Size Calculation

Formula used for sample size calculation:

$N = N / [1 + N(e^2)]$

Where:

N = required sample size

N = total population (27,388 students)

E = margin of error (0.05 at 95% confidence level

Substituting the values:

$N = 27,388 / [1 + 27,388(0.05^2)]$

This formula gave us a minimum sample size of about 394 people. To account for potential nonresponse and incomplete questionnaire responses, we added an additional 20% to the sample, bringing the total to 473 respondents. Nevertheless, 500 questionnaires were used to improve response reliability and ensure sufficient representation of our population.

Sampling Technique for Sample Selection

A multistage sampling method was used to recruit participants from AAU in three key states, and the study was conducted over a one-week period. In the first stage, faculty members were randomly selected across disciplines. In the second stage, a random department section was performed between the selected faculties. Moreover, in stage three, participant selection was conducted using systematic protocols based on an eligibility criterion, ensuring that diverse academic backgrounds were accurately represented. Through this approach, the risk of sampling bias was reduced, and a comprehensive representation of the sample across diverse academic contexts was achieved.

The reliability test of the two perceived-susceptibility items (probably the reversed-scored susceptibility item and the worry about consequences item) yielded a negative Cronbach's alpha of −0.113, based on only two items. A negative alpha indicates very low response consistency across the scale, unacceptable internal consistency, and failure to meet the basic assumptions of the Cronbach alpha reliability model [7].

This research was conducted to evaluate the item content and ensure that the two items measure conceptually distinct constructs. The results show measures of perceived susceptibility (personal vulnerability to the chronic disease) and perceived severity (worry about the consequences of a diagnosis). Negative Cronbach's alpha in two-item scales is especially widespread when one of the items is reverse-coded or when constructs diverge, and it does not necessarily imply low-quality data but rather a mis-specified measurement model [10]. Consequently, the items were analysed as single-item measures, a widespread

and justifiable approach in an HBM-grounded study when multi-item scales lack sufficient internal consistency or when constructs are theoretically distinct [11].

Inclusion Criteria:

1. Undergraduate students at Ambrose Alli University.
2. Ages ranging from 18–30 years.
3. Willingness to provide informed consent.

Exclusion Criteria:

1. Postgraduate students.
2. Undergraduates outside the specified age range.
3. Individuals declining participation.

Data Analysis and Processing

The data collected through the self-administered structured questionnaires were processed and analysed in version 26 of the Statistical Package of the Social Sciences (SPSS). This software is well regarded in public health research for its reliability and ability to process large volumes of data [12].

Data Processing

Every completed questionnaire was checked for completeness and consistency before the data were entered into SPSS. All questionnaire questions were assigned numerical codes according to a predefined coding scheme. The errors were identified during data cleaning; missing values and outliers were handled using appropriate statistical tools, i.e., by excluding cases or imputing missing data, depending on the type of missingness. This ensured that the dataset was validated before analysis [15].

The sample size for this research was calculated using Yamane's (1967) formula tailored for finite populations [23]. With a total student population of 27,388 and a desired margin of error of 5%, the initial sample size was determined to be 394. To mitigate issues with non-responses and incomplete questionnaires, an additional 20% was added, bringing the revised sample size to 473. Ultimately, 500 questionnaires were distributed to enhance response reliability and ensure the study population was adequately represented.

Results

The study sample consisted of 500 undergraduate students. 88% (n = 440) of the respondents reported having undergone at least one form of health screening. On the other hand, only 12% (n = 60) of the respondents had never been screened. In this test, screening uptake refers to having undergone any preventive health check/test with the intent of detecting chronic disease risk factors early [2]. Examples of preventive health checks/tests may include (but are not limited to) blood sugar, blood pressure, cholesterol, and other relevant health assessments. The largest groups in the most common age (peaks) are shown in Figure 1.

- Age 26: 41 respondents (8.2%) is the *highest / modal age*
- Age 22: 39 (7.8%)
- Age 31: 38 (7.6%)
- Age 21: 36 (7.2%)
- Age 23: 35 (7.0%)

So, while respondents are spread across ages, the mid-20s, especially 22–26, is the strongest cluster.

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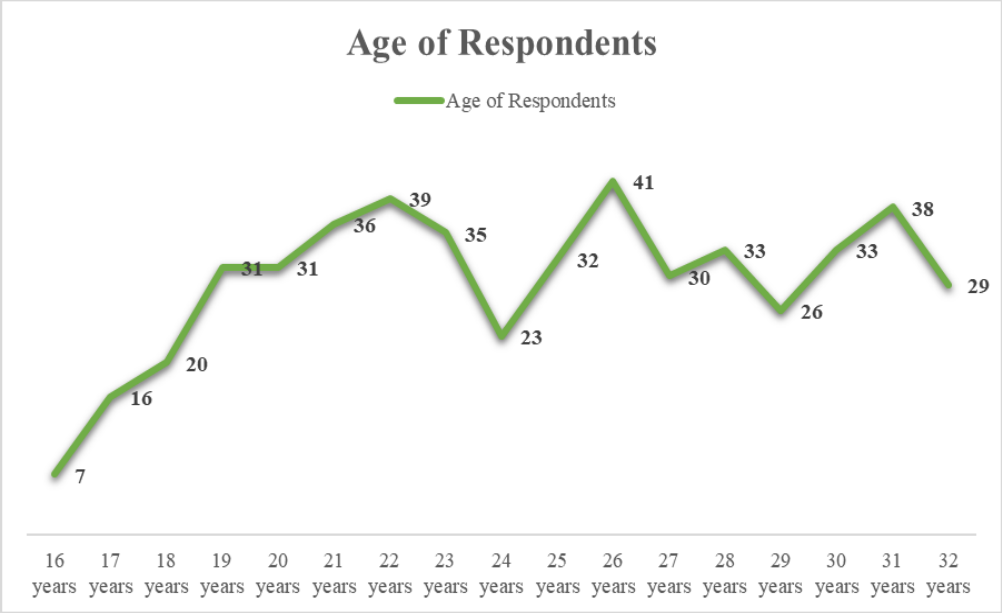


Figure 1. Age of Respondents

Since the mean age of the sample is approximately 24.8 years (SD = 4.5), it is confirmed that the sample predominantly comprises young adults, who are in their late teens to late twenties. The age of participants aligns perfectly with the study's target population, i.e., adults in their late teens to late twenties.

Looking at participants' educational levels further confirms that the age range aligns with the target population of university undergraduates and reflects a life stage in which establishing healthy behaviours (such as screening practices) is very important, as noted by Claire et al. [22].

In broader way, the gender distribution in sample seems to be fairly balanced because 48.2% (n = 241) of the participants were males while the remaining 51.8% (n = 259) of them were females—as shown in Table 1 portrayed that out of 500 respondents, 241 were male, who constituted 48.2% of the total sample and 259 were female, who constituted 51.8% of the total sample.

Table 1. Gender of Participants

Sex	Frequency	Percent	Valid Percent	Cumulative Percent
Male	241	48.2	48.2	48.2
Female	259	51.8	51.8	100.0
Total	500	100.0	100.0	

Figure 2 shows a broad representation across fields of study, suggesting that the findings on health knowledge and screening behaviour are not limited to a particular academic background. It also reduces the risk of bias that might occur if, say, mostly health science students (who might have higher health awareness) were surveyed.

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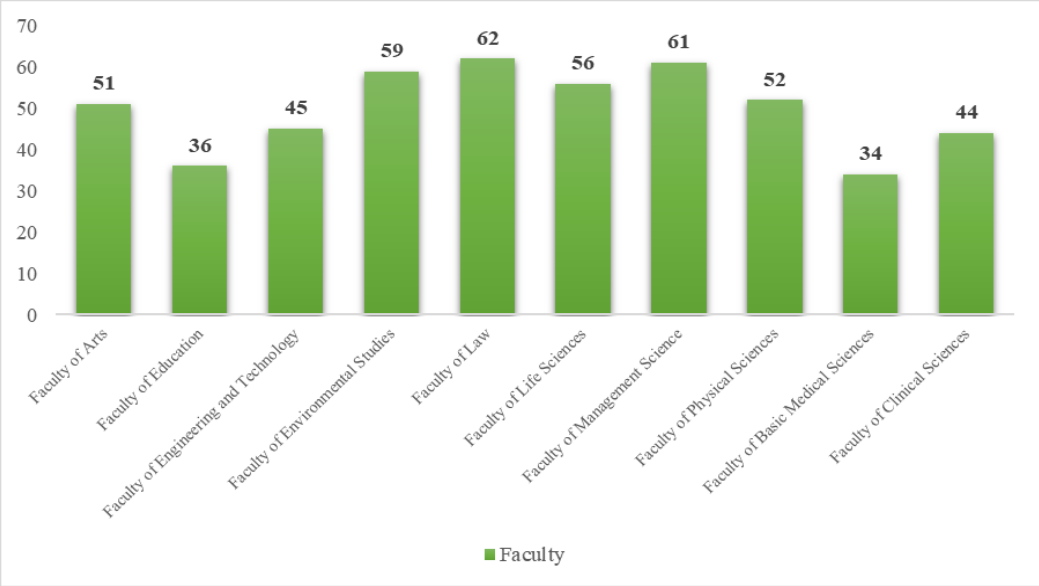


Figure 2. Faculty of Study

Knowledge Level – Knowledge of Chronic Disease Risk Factors

Table 2 showed that the respondents' knowledge of the risk factors for chronic diseases and the importance of early diagnosis was quite moderate. The average level of knowledge was 3.98 (SD = 1.36), with a possible range of 0 to 9. This implies that knowledge levels are generally low to moderate. Therefore, only a small number of students understand chronic disease prevention moderately, and almost no students scored in the high range of knowledge. The importance of this result lies in a knowledge gap among university students regarding health-related issues, and the outcomes are not new, as past research in Nigeria has shown that students are aware of health-related diseases.

Table 2. Descriptive Statistics

Descriptive Statistics	N	Minimum	Maximum	Mean	Std. Deviation
Knowledge score	500	.00	8.00	3.9760	1.35614
Valid N (listwise)	500				

The findings of the chi-square test in Table 3 (Pearson chi2 = 1.627, df = 2, p = 0.443) suggest that the relationship between knowledge level (poor, fair, or good) and screening uptake (ever screened vs never screened) is not statistically significant among the 500 undergraduate respondents. The test value (p = 0.443) is not significant at the conventional significance level (0.05), so we cannot reject the null hypothesis of independence. There is consistency in the non-significance of the likelihood ratio (1.448, p = 0.485) and linear-by-linear relation (1.108, p = 0.293). Although the expected value was less than 5 (the smallest, 1.68), which was expected given 1 cell (16.7), this violation is insignificant in a very large population (N = 500). However, it does not undermine the test's overall reliability under such circumstances, as the chi-square test is robust with large sample sizes (Turhan, 2020). The cross-tabulation demonstrates that screening uptake is high across all knowledge categories (89.5% in poor, 87.5% in fair, 78.6% in good) and therefore supports the idea that knowledge level is not a significant predictor of screening behaviour in this demographic [14].

Table 3. Chi-square Results: Knowledge Level and Uptake of Screening Services

Chi-Square Tests	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.627[a]	2	0.443
Likelihood Ratio	1.448	2	0.485
Linear-by-Linear Association	1.108	1	0.293
N of Valid Cases	500		

The cross-tabulation in Table 4 of perceived susceptibility (reversed-scored Likert item d1 R, where 1 = strongly disagree/low perceived risk and 5 = strongly agree/high perceived risk) versus screening uptake (screened any: 0 = never screened, 1 = ever screened) demonstrates that screening participation is always high at all levels of perceived susceptibility. Only 84.9% (n = 90) of those who reported the lowest perceived risk (score 1.00) had been screened, compared with 15.1% (n = 16) who were not screened. This trend continues with intermediate levels 88.7% uptake at the score (n = 102/115), 92.9% uptake at the score (n = 91/98), 83.2% uptake at the score (n = 79/95), and even stronger with the highest perceived risk (score 5.00, n = 86) with 90.7% (n = 78) reported screening [13, 19].

The uptake is 88 (440/500), and the never-screened group (n = 60, 12) is relatively evenly distributed across levels of susceptibility (there is no evident focus at either end, low or high risk). The Pearson chi-square test yields a p-value of 0.206, indicating that perceived susceptibility and screening behaviour are not statistically significantly related. The confidence of the chi-square assumption of reliable inference is 10.32, and it was established that the insignificance was not a result of small cell counts [21].

The outcomes of the research in this instance are drastic and intuitive. The theoretical model, embodied in the Health Belief Model (HBM), holds that a higher degree of perceived susceptibility to developing a chronic illness, such as hypertension or diabetes, is a powerful predictor of preventive behaviour, including screening. The data, however, indicate that uptake is consistently high, regardless of whether students strongly agreed that they were at risk within the next decade.

Table 4. Perceived Susceptibility vs Screened Uptake

(Perceived susceptibility (reversed) * screened any Crosstabulation)

Perceived susceptibility (reversed)	Statistic	.00	1.00	Total
1.00	Count	16	90	106
	% within Perceived susceptibility (reversed)	15.1%	84.9%	100.0%
	% within screened_any	26.7%	20.5%	21.2%
2.00	Count	13	102	115
	% within Perceived susceptibility (reversed)	11.3%	88.7%	100.0%
	% within screened_any	21.7%	23.2%	23.0%
3.00	Count	7	91	98
	% within Perceived susceptibility (reversed)	7.1%	92.9%	100.0%
	% within screened_any	11.7%	20.7%	19.6%
4.00	Count	16	79	95
	% within Perceived susceptibility (reversed)	16.8%	83.2%	100.0%
	% within screened_any	26.7%	18.0%	19.0%

5.00	Count	8	78	86
	% within Perceived susceptibility (reversed)	9.3%	90.7%	100.0%
	% within screened_any	13.3%	17.7%	17.2%
Total	Count	60	440	500

The chi-square test values (Pearson $\chi 2 = 5.905$, df = 4, p = 0.206) in Table 5 indicate that there is no statistically significant relationship between perceived susceptibility (reversed-scored 5-point Likert item, 1 = low perceived risk to 5 = high perceived risk) and screening uptake (ever screened vs. never screened) among the 500 undergraduates. This non-significant result is supported by the likelihood ratio (6.008, p = 0.199) and the linear-by-linear association (0.327, p = 0.567). Most importantly, zero cells (0.0%) had anticipated values under 5. The lowest anticipated value was 10.32, which met the chi-square test requirements perfectly, and the p-value could be trusted [13, 19].

Table 5. Chi-Square Perceived Susceptibility vs Screened Uptake

Test	Value	df	Asymptotic Significance (2-sided)
Chi-Square Tests			
Pearson Chi-Square	5.905[a]	4	.206
Likelihood Ratio	6.008	4	.199
Linear-by-Linear Association	.327	1	.567
N of Valid Cases	500		

Discussion

Knowledge of risk factors for chronic diseases was low to moderate, with most students classified as fair and only a few demonstrating a good level of knowledge. However, screening uptake was high across all levels of knowledge. The lack of a significant relationship indicates that knowledge is not the motivating factor for preventive health behaviour in this case. This challenges the traditional belief that greater awareness will lead more people to participate in screening.

In addition, there was no significant impact of perceived susceptibility and perceived severity, important constructs of the Health Belief Model, on screening uptake. Students who perceived themselves as low risk or were less concerned about the severity of the chronic disease had an equal likelihood of having the screening performed as those who were perceived to be at higher risk or more concerned. This implies that individual attitudes towards risk and perceived disease severity are not particularly influential in shaping behaviour among this group. These results help emphasise the fact that the superficial knowledge is not always the same as in-depth knowledge - a trend which seems to be relevant in our sample as well. Research studies have demonstrated that knowledge can be enhanced to enhance attendance to preventive and early detection interventions. The article on health literacy by Nutbeam highlights that increased awareness and knowledge of disease risks are more likely to promote preventive behaviours (such as screening) [20]. Put differently, the more students learn about the dangers of chronic diseases and the benefits of early detection, the more willing they tend to be to perform screening and other preventive health actions [16]. A possible obstacle to informed health decision-making is evident in the largely positive to poor levels of knowledge observed in this sample. However, as the results show, despite these knowledge constraints, screening adoption rates were high, which may

indicate that other factors prompt students to undergo screening.

The findings are explained using the Health Belief Model (HBM): greater knowledge of risk factors, symptoms, and screening benefits is associated with greater perceived benefits and cues to action, which, in turn, lead to increased screening. Nevertheless, the near-homogeneous high uptake (ranging from 78.6% in good knowledge to 89.5% in poor knowledge) does not support this expectation. It is inconsistent with much of the Nigerian literature, which often associates low-to-moderate knowledge with delayed or absent preventive behaviours among young adults [17, 18].

The results implied that the tertiary setting is not inherently knowledge-seeking but can be driven by external structural facilitators, such as regular campus health promotions, free or low-cost university clinic services, mandatory medical examinations at registration, or even health-seeking norms normalised by peers, which override individual cognitive deficits. This observation aligns with the Social Ecological Model (SEM), embedded in the conceptual framework, which emphasises institutional and environmental factors rather than exclusively individual-determined ones. The low mean knowledge score (3.98 out of 9) also supports the existence of a literacy gap. However, it does not play a decisive role in stopping action, suggesting that knowledge-only interventions (e.g., health education workshops) might have a small incremental effect on uptake in such institutional settings [13].

Moreover, the inferential analysis showed that the variables obtained using the Health Belief Model, i.e., knowledge, perceived susceptibility, and perceived severity, did not have significant predictive power for screening behaviour. Equally, barriers that are commonly cited, such as cost, insufficient time, insufficient information, and perceived need, have no significant effect on uptake. The findings are consistent with studies in other low- and middle-income countries, suggesting that inadequate risk perception among young adults is a global challenge rather than a context-specific issue.

The findings also have important implications for public health policy in Nigeria. Integrating routine screening programs into tertiary institutions and leveraging digital platforms for awareness campaigns could significantly improve early detection among young adults.

Conclusion

This study highlights that awareness of chronic diseases is relatively high among young adults in Nigerian tertiary institutions; however, significant gaps remain in knowledge and perceptions. Misconceptions and low perceived susceptibility negatively impact behaviour and early detection

Recommendations

The following recommendations are invaluable for improving awareness, knowledge, and Risk Perception of Chronic Diseases among University Students in Nigeria.

1. Incorporation of chronic disease education in academic curriculum.
2. Encourage routine screening among young adults.
3. Implementation of targeted health education programs in a tertiary institution.
4. Awareness promotion and campaigns regarding the early onset of chronic diseases.
5. Accurate health care information dissemination with the use of digital platforms.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgement

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Author Contributions

Taiwo Akhigbe conceived the presented idea. planned and carried out the data collection, analysed the data and generated the manuscript. Osede Ignis Iribhogbe, review the titles and supervise the manuscript development.

Ethical Approval

Ethical approval was obtained from the Ambrose Alli University Research Review Board. Participation was voluntary, and informed consent was obtained. Confidentiality and anonymity were strictly maintained.

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Data Availability

The data for this study are available on direct request from the authors

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Determinants of Health Insurance Non-Enrollment in Guinea: Supply Availability, Awareness and Institutional Trust in the Context of Universal Health Coverage

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Abstract *Health insurance coverage remains very limited in Guinea, slowing progress toward Universal Health Coverage (UHC). This study estimated health insurance coverage among Guinean adults and examined the influence of availability, awareness, affordability, and institutional trust on non-enrollment. Methods: Data from the 2024 Afrobarometer Round 10 survey in Guinea (n=1,200; valid insurance status n=1,198) were analyzed using survey weights. Logistic regression identified factors associated with insurance coverage, while multinomial logistic regression, Multiple Correspondence Analysis, and exploratory spatial analysis examined reasons for non-enrollment and regional differences. Results: Only 10.3% of adults reported having health insurance. Among uninsured respondents, the most common reasons for non-enrollment were lack of awareness of existing schemes (30.6%) and absence of available schemes in the area (26.6%). Other barriers included complex enrollment procedures (15.7%), inability to afford membership (7.8%), and distrust of schemes (7.8%). High trust in the Ministry of Health was significantly associated with greater odds of insurance coverage (OR=1.94; 95% CI: 1.26–2.99). Coverage varied substantially across regions, ranging from 2.2% in Faranah to 33.9% in Mamou. Conclusions: Health insurance coverage in Guinea remains very low. Expanding scheme availability, improving public awareness, simplifying enrollment, and strengthening trust in health institutions are essential to accelerate progress toward UHC.*

Keywords *Afrobarometer, Guinea, Health Insurance, Institutional Trust, Universal Health Coverage.*

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Introduction

Universal Health Coverage (UHC), defined as access to needed health services without financial hardship, is a central part of Sustainable Development Goal 3 [1, 2]. Health insurance can pool financial risk and reduce catastrophic direct health spending [3, 4]. In sub Saharan Africa, community-based insurance and mutual health organizations are often promoted as a route toward UHC, particularly where formal employment covers only a small share of the population [5, 6].

Guinea faces severe constraints in this area. Despite commitments to universal healthcare access, the country remains among the lowest in West Africa for health insurance coverage and public health expenditure per capita [7]. The health system is marked by high direct payment by households, fragmented service delivery, recurrent drug shortages, and geographic gaps in service availability [8]. These conditions interact with poverty, limited health information, and weak institutional trust, which together reduce enrollment in health insurance.

Evidence from Guinea and comparable low-income settings suggests that lack of insurance coverage reflects several mechanisms [4, 9, 10]. Some people live in areas where no scheme is available. Others may not know that a scheme exists or may not understand how it works. A third group may know about insurance but distrust the institutions that manage it, because of past experiences, perceived mismanagement, or broader skepticism toward public institutions [11, 12]. These mechanisms need to be separated because they call for different responses.

This study used nationally representative data from Afrobarometer Round 10 (Guinea, 2024) to estimate the prevalence of health insurance coverage, describe the profile of uninsured adults, examine reported reasons for having no coverage, assess the role of institutional trust, and map regional differences. It provides one of the first national quantitative analyses of health insurance coverage in Guinea based on a large survey instrument.

Methods

Study Design and Data Source

We conducted a cross-sectional analysis of the Afrobarometer Round 10 survey in Guinea in 2024 [13]. Afrobarometer is an independent, non-partisan research network that conducts nationally representative surveys across Africa on citizens' experiences of governance and public services. In Guinea, the sample included 1200 adults aged 18 years and above, selected through a stratified multistage cluster design with allocation across administrative regions and urban/rural strata.

Variables

Primary outcome: Current health insurance coverage was assessed from the survey item asking whether respondents had medical coverage or insurance that would cover expenses in case of illness or injury. Respondents answering, "don't know" (n = 2) were excluded from coverage estimates and models.

Reason for no coverage: Uninsured respondents were asked for the main reason they did not have coverage. Responses were grouped as no scheme available, unaware of schemes, distrust of schemes, enrollment too complex, cannot afford, and other reasons.

Type of coverage: Among insured respondents, coverage type was classified as private insurance, public sector scheme, national government insurance, community-based insurance or mutuelle, or other.

Institutional trust: Trust in the Ministry of Health was measured on a four point scale, from no trust to a lot of trust. Responses of "somewhat" or "a lot" were coded as high trust.

Concern about healthcare access: Concern about being unable to obtain needed healthcare was measured on a four-point scale.

Respondents reporting "a lot" were classified as very concerned.

Government responsibility: Agreement that the government should ensure healthcare access was measured on a five-point scale. Respondents who agreed or strongly agreed were classified as supporting government responsibility for access. Don't know responses were treated as missing.

Socioeconomic and geographic covariates: The Lived Poverty Index (LPI) was constructed as the means of five deprivation items covering food, water, cooking fuel, cash income, and medical care. The score was grouped as none, low, moderate, or high. Refused and don't know responses in the component items were treated as missing before the index was computed. Residence, sex, age group, presence of a health facility in the enumeration area, and administrative region were included as covariates.

Statistical Analysis

All analyses incorporated survey weights to account for the sampling design, using the *survey* package in R [14, 15]. Weighted proportions and their standard errors were computed for descriptive statistics.

A weighted binary logistic regression modeled the probability of having health insurance as a function of poverty category, residence, sex, age group, health facility availability, institutional trust, concern about healthcare access, and belief in government responsibility. Complete case analysis was used for this model. Results are presented as odds ratios (OR) with 95% confidence intervals.

Among uninsured respondents with a valid reason response, multinomial logistic regression modeled the main reason for having no coverage, using "No scheme available" as the reference category. Results are presented as relative risk ratios (RRR).

Multiple Correspondence Analysis (MCA) was conducted among uninsured respondents to explore how reasons for no coverage grouped with trust, concern about access, poverty category, and residence type. MCA was performed using the *FactoMineR* package [16]; the first two dimensions are presented as a biplot.

An exploratory spatial analysis projected weighted regional coverage rates onto an official administrative boundary map (OCHA Guinea) using the *sf* package [17]. Global Moran's I [18] was computed from a queen contiguity spatial weights matrix to assess spatial autocorrelation. Given the small number of regions, spatial results were interpreted as descriptive [19, 20].

Ethical Considerations

Afrobarometer data are publicly available, anonymized, and collected after informed consent from participants. No further ethical approval was required for this secondary analysis.

Results

Sample Characteristics

The full sample included 1200 adults; coverage estimates used 1198 respondents after excluding 2 respondents with missing information on insurance status. The mean age was 43.6 years (SD: 16.5); 50% were male and 35.6% lived in urban areas. Lived poverty was high: 51% had high LPI scores, while 2.1% reported no deprivation. A health facility was present in the enumeration area for 61.2% of respondents. High trust in the Ministry of Health was reported by 52.1%; 58.3% were very concerned about healthcare access, and 86.5% agreed or strongly agreed that government should ensure access to healthcare (Table 1).

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Table 1. Sample Characteristics and Valid Denominators

Characteristic	n	Weighted % (95% CI) or Mean (SD)
Sex		
Male	600	50 (47.1 to 52.9)
Female	600	50 (47.1 to 52.9)
Age (years)		**43.6 (SD: 16.5)**
18 to 24	151	12.6 (10.6 to 14.5)
25 to 34	252	21.1 (18.7 to 23.5)
35 to 49	350	29.2 (26.5 to 31.8)
50+	447	37.2 (34.3 to 40)
Residence		
Urban	440	35.6 (32.8 to 38.4)
Rural	760	64.4 (61.6 to 67.2)
Lived Poverty Index		
None	25	2.1 (1.3 to 3)
Low	220	18.6 (16.3 to 20.9)
Moderate	342	28.3 (25.7 to 31)
High	609	51 (48 to 53.9)
Health facility in area		
Yes	744	61.2 (58.3 to 64.1)
No	456	38.8 (35.9 to 41.7)
Health insurance coverage		
Covered	125	10.3 (8.5 to 12)
Not covered	1073	89.7 (88 to 91.5)
High trust in Ministry of Health		
Yes	614	52.1 (49.1 to 55)
No	568	47.9 (45 to 50.9)
Very concerned about healthcare access		
Yes	706	58.3 (55.4 to 61.2)
No	494	41.7 (38.8 to 44.6)
Govt should ensure healthcare access		
Agree/Strongly agree	1039	86.5 (84.4 to 88.5)
Other	159	13.5 (11.5 to 15.6)

n: unweighted count. % and 95% CI estimated with survey weights. Age: weighted mean (SD). Coverage status is estimated among valid responses (n = 1198); LPI categories exclude invalid component responses.

Health Insurance Coverage

Only 10.3% of Guinean adults (n = 125) reported any health insurance coverage. This corresponds to 89.7% without coverage (n = 1073). Among insured respondents, community based insurance (mutuelles) was the most common type (38.6%), followed by private insurance (28.5%).

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Reasons for Having No Coverage

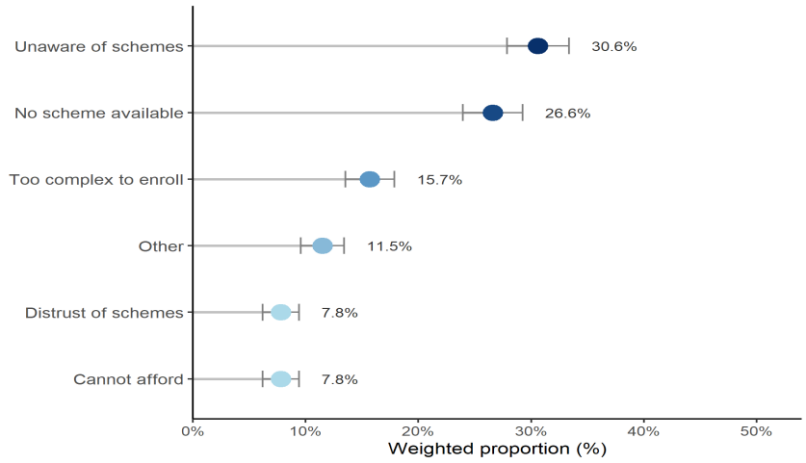


Figure 1. Distribution of Reported Primary Reasons for having no Health Insurance among Uninsured Adults, Guinea 2024 (Weighted Proportions). Error Bars represent 95% Confidence Intervals. Points are Colored by Proportion Magnitude

Among the 1073 uninsured respondents with a valid reason response, Figure 1 shows the reported reasons for having no coverage. Lack of awareness of existing schemes was the most frequent reason (30.6%), followed closely by absence of any scheme in the respondents' area (26.6%). Difficulty navigating enrollment was reported by 15.7%, inability to afford by 7.8%, and distrust of schemes by 7.8%.

These results suggest that information and availability barriers account for much of the lack of coverage. Financial constraints and distrust affect smaller, but still distinct, groups of uninsured adults.

Coverage Rate by Administrative Region

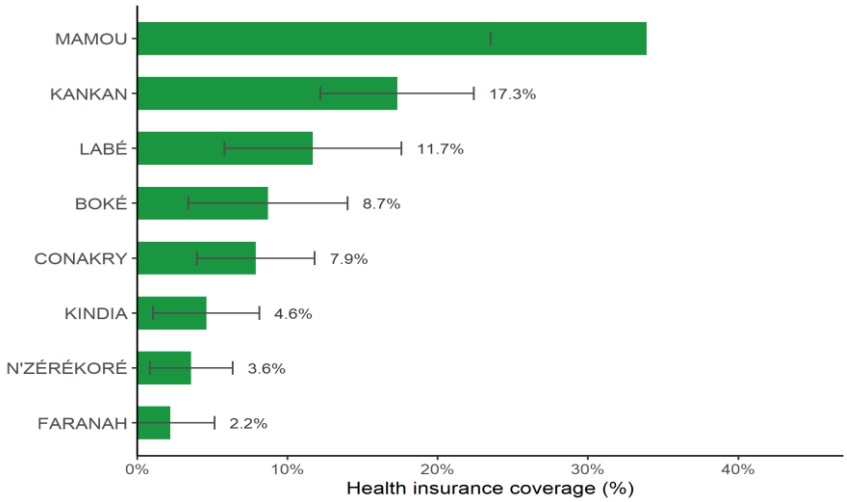


Figure 2. Weighted Health Insurance Coverage Rate by Administrative Region, Guinea 2024. Error Bars represent 95% Confidence Intervals

Coverage rates varied across Guinea's eight administrative regions (Figure 2). MAMOU had the highest coverage rate (33.9%), while FARANAH had the lowest (2.2%).

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Determinants of Health Insurance Coverage

Table 2. Adjusted odds ratios for health insurance coverage, Guinea 2024 (weighted logistic regression; complete case n = 1175)

Predictor	OR	95% CI	p value
Poverty: Low (ref = None)	0.27	0.08 to 0.86	= 0.03
Poverty: Moderate	0.31	0.1 to 0.96	= 0.04
Poverty: High	0.36	0.12 to 1.08	= 0.07
Urban residence (ref = Rural)	1.07	0.7 to 1.66	= 0.75
Male sex (ref = Female)	0.50	0.33 to 0.76	= 0.001
Age 25 to 34 (ref = 18 to 24)	1.08	0.51 to 2.25	= 0.84
Age 35 to 49	1.31	0.66 to 2.61	= 0.44
Age 50+	1.74	0.9 to 3.37	= 0.1
Health facility in area	0.70	0.46 to 1.05	= 0.08
High trust in Min. Health	1.94	1.26 to 2.99	= 0.003
Very concerned re: access	0.67	0.45 to 0.99	= 0.05
Gov should ensure healthcare	1.40	0.75 to 2.63	= 0.29

Table 2 shows the weighted logistic regression results. High trust in the Ministry of Health was the strongest predictor of insurance coverage (OR = 1.94; 95% CI: 1.26 to 2.99; p = 0.003). Urban residence was not significantly associated with health insurance coverage (OR = 1.07; 95% CI: 0.70 to 1.66; p = 0.75). High lived poverty was associated with lower odds of coverage compared with no deprivation (OR = 0.36; 95% CI: 0.12 to 1.08; p = 0.07). The presence of a health facility in the enumeration area showed a non-significant tendency toward lower odds of insurance coverage (OR = 0.70; 95% CI: 0.46 to 1.05; p = 0.08). Figure 3 presents these adjusted odds ratios and their 95% confidence intervals graphically.

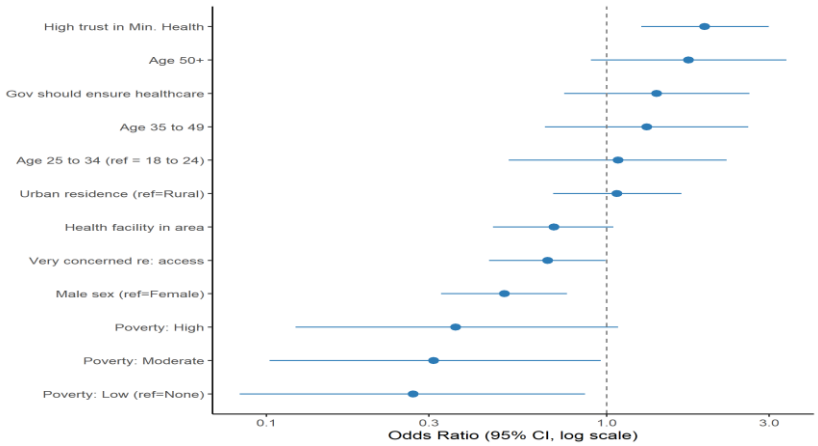


Figure 3. Adjusted odds ratios (95% CI) for health insurance coverage, Guinea 2024. OR > 1 indicates increased odds of coverage. Reference categories: Poverty = None, Age = 18 to 24, Residence = Rural, Sex = Female

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Multinomial Analysis of Reasons for No Coverage

Table 3. Relative Risk Ratios (RRR) from Multinomial Logistic Regression of the Main reason for Having no Health Insurance, Guinea 2024. Reference Category: No scheme Available in Area

Reason vs No scheme available	Predictor	RRR	95% CI	Sig.
Unaware of schemes	Poverty: Low	0.44	0.08 to 2.43	
	Poverty: Moderate	0.51	0.09 to 2.81	
	Poverty: High	0.54	0.1 to 2.93	
	Urban	1.41	0.98 to 2.03	
	Male	1.00	0.72 to 1.4	
	Age 25 to 34	0.82	0.46 to 1.46	
	Age 35 to 49	0.99	0.57 to 1.72	
	Age 50+	1.09	0.63 to 1.88	
Unaware of schemes	High trust (MoH)	1.58	1.13 to 2.21	**
Distrust of schemes	Poverty: Low	0.10	0.01 to 0.76	*
	Poverty: Moderate	0.26	0.04 to 1.83	
	Poverty: High	0.32	0.05 to 2.17	
	Urban	4.93	2.86 to 8.51	***
	Male	2.11	1.23 to 3.62	**
	Age 25 to 34	0.73	0.29 to 1.84	
	Age 35 to 49	0.97	0.41 to 2.31	
	Age 50+	1.09	0.47 to 2.53	
	High trust (MoH)	1.03	0.6 to 1.76	
Too complex to enroll	Poverty: Low	1.23	0.11 to 13.3	
	Poverty: Moderate	0.95	0.09 to 10.29	
	Poverty: High	1.03	0.1 to 10.95	
	Urban	1.33	0.86 to 2.04	
	Male	1.03	0.69 to 1.54	
	Age 25 to 34	0.60	0.31 to 1.15	
	Age 35 to 49	0.75	0.4 to 1.39	
	Age 50+	0.65	0.35 to 1.21	
	High trust (MoH)	1.36	0.91 to 2.03	
Cannot afford	Poverty: Low	0.21	0.02 to 1.71	
	Poverty: Moderate	0.44	0.06 to 3.52	
	Poverty: High	0.27	0.03 to 2.15	
	Urban	1.39	0.79 to 2.42	
	Male	1.73	1.02 to 2.94	*
	Age 25 to 34	0.86	0.36 to 2.08	
	Age 35 to 49	0.65	0.27 to 1.56	
	Age 50+	0.97	0.43 to 2.22	
	High trust (MoH)	1.49	0.89 to 2.51	
Other	Poverty: Low	0.08	0.01 to 0.47	**
	Poverty: Moderate	0.20	0.04 to 1.04	

	Poverty: High	0.16	0.03 to 0.84	*
	Urban	3.16	1.98 to 5.03	***
	Male	1.21	0.77 to 1.91	
	Age 25 to 34	1.27	0.56 to 2.9	
	Age 35 to 49	1.15	0.51 to 2.59	
	Age 50+	1.56	0.71 to 3.43	
	High trust (MoH)	1.33	0.84 to 2.1	

The multinomial model (Table 3) compared each reported reason with the absence of an available scheme. Urban residents had a higher relative risk of reporting lack of awareness rather than lack of supply (RRR = 1.41; CI: 0.98 to 2.03). This suggests that lack of supply is more concentrated in rural areas, while lack of awareness is also present in urban settings. Institutional trust was not significantly associated with reporting distrust of schemes rather than lack of scheme availability (RRR = 1.03; 95% CI: 0.60 to 1.76).

Spatial Analysis

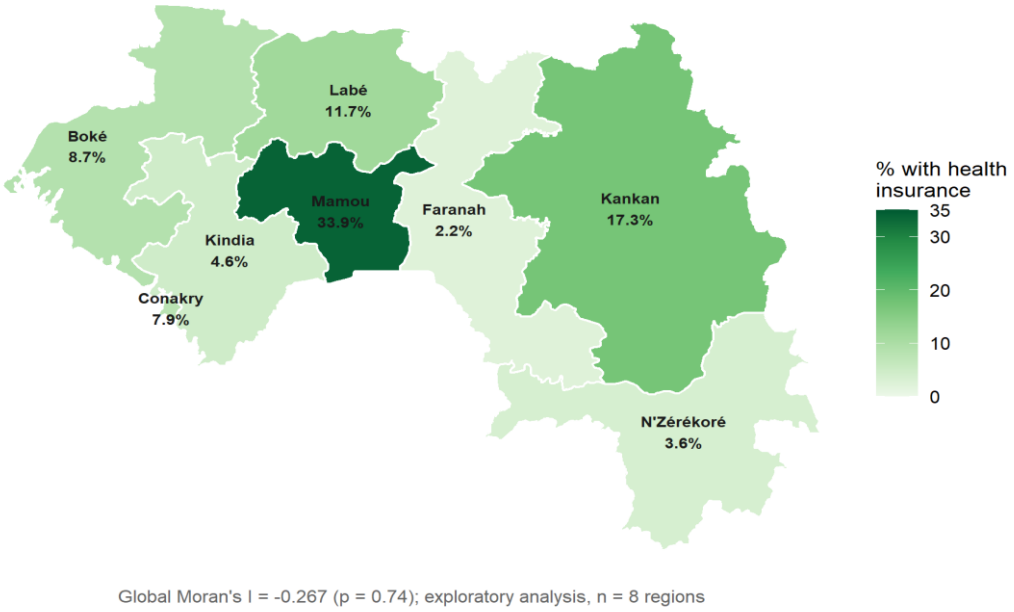


Figure 4. Regional Distribution of Health Insurance Coverage Rate (%) in Guinea, 2024 (Weighted Estimates).
Data Source: Afrobarometer Round 10

The choropleth map (Figure 4) shows geographic variation in coverage, with higher rates in Conakry and nearby regions. The global Moran's I for coverage was negative (I = -0.267; p = 0.74), indicating no evidence of positive spatial clustering. The result was not statistically significant and should be interpreted cautiously.

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Profiles Among Uninsured Adults

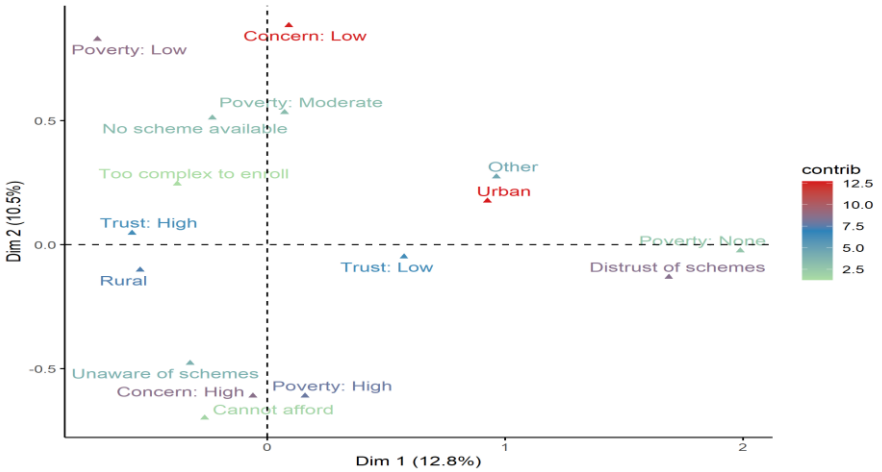


Figure 5. Multiple Correspondence Analysis (MCA) Biplot among Uninsured Adults, Guinea 2024. Active Variables: Main Reason for No Coverage, Institutional Trust, Concern about Access, Poverty Category, and Residence type. Dots represent Variable Categories; Proximity Indicates Co-occurrence

The MCA biplot (Figure 5) illustrates how reported barriers group together. Dimension 1 contrasts absence of schemes, rural setting, and high poverty with lack of awareness and urban setting. Dimension 2 separates distrust from inability to afford coverage. The pattern supports the distinction between availability, information, and trust as separate mechanisms behind lack of insurance.

Discussion

Principal's Findings

This study found that only 10.3% of Guinean adults reported any health insurance coverage. This low level is consistent with Guinea's limited progress toward UHC [3, 7]. The results suggest that the problem is not explained by affordability alone. Availability, information, and trust all matters.

The most frequent reasons for having no coverage were lack of awareness (30.6%) and lack of an available scheme (26.6%). Together, these reasons account for more than half of uninsured respondents. This means that many adults may be reached through a combination of scheme expansion and clearer communication. Similar findings have been reported in other West African settings, where lack of information reduces enrollment even when affordability is not the only barrier [6, 9].

Institutional trust was the strongest positive predictor of insurance coverage in the multivariable model (OR = 1.94; 95% CI: 1.26 to 2.99). This finding is consistent with evidence showing that trust in health authorities influences voluntary enrollment in insurance schemes linked to government or public institutions [11, 12]. Distrust was the main reason for having no coverage in 7.8% of uninsured respondents. This is a smaller group, but it is unlikely to respond to information campaigns alone.

Although the point estimate suggested slightly higher odds of coverage among urban residents, the association was not statistically significant (OR = 1.07; 95% CI: 0.70 to 1.66). This is likely to reflect the concentration of schemes in Conakry and other urban centers. The spatial analysis revealed substantial regional variation, with Mamou recording the highest coverage rate and Faranah the lowest. The multinomial model also suggested that urban residents were more likely to report lack of awareness than lack of supply, whereas lack of supply was more prominent in rural areas.

A trend toward lower insurance coverage was observed among respondents experiencing high levels of poverty (OR = 0.36; 95% CI: 0.12 to 1.08), although the association did not reach conventional statistical significance (p = 0.07) [4, 10]. However, inability to afford ranked fourth among reported reasons for having no coverage (7.8%). For many uninsured adults, enrollment may not yet be perceived as a real option, either because no scheme is available or because existing schemes are not known.

Policy Implications

The findings point to three practical policy directions. First, insurance schemes, including community based mutuelles, need to expand into rural prefectures where many respondents report that no scheme exists. Second, communication efforts should explain what schemes are available, who can join, and what benefits are covered. This is especially relevant in urban and peri urban areas where schemes may exist but remain poorly known. Third, trust should be treated as part of implementation. Transparent management, clear rules, accountability for scheme managers, and community involvement may help convert interest into enrollment.

Strengths and Limitations

The main strength of this study is the use of a nationally representative sample with a standardized questionnaire, allowing inference across all administrative regions. Afrobarometer design also makes future comparisons with other countries possible.

The study also has limitations. Its cross-sectional design does not allow causal interpretation. Reasons for having no coverage were based on respondent report and one survey item, which may simplify more complex decisions. The survey did not independently verify which insurance schemes operated in each region, so lack of supply was measured through respondents' perceptions. The spatial analysis was exploratory because only eight administrative regions were available. Finally, the small number of insured respondents (n = 125) limits precision for analyses within the insured group.

Conclusions

Health insurance coverage in Guinea remains very low at 10.3%. The main barriers are lack of available schemes, limited awareness, affordability, and institutional distrust. Progress toward UHC will require more than asking households to enroll. Schemes need to be available, understandable, affordable, and trusted.

List of Abbreviations

- **CBHI**: Community-Based Health Insurance
- **CI**: Confidence interval
- **LPI**: Lived Poverty Index
- **MCA**: Multiple Correspondence Analysis
- **OR**: Odds ratio
- **RRR**: Relative risk ratio
- **UHC**: Universal Health Coverage
- **WHO**: World Health Organization

Ethical Approval

This study was based on secondary analysis of publicly available Afrobarometer Round 10 data for Guinea. The original survey was conducted in accordance with ethical standards and informed consent was obtained from all participants prior to data collection. The dataset used for this study was fully anonymized and contained no personally identifiable information. Therefore, according to applicable guidelines for secondary analysis of publicly available anonymized data, additional ethical approval was not required for this study.

Data Availability

The Afrobarometer Round 10 dataset for Guinea is publicly available at https://www.afrobarometer.org. R analysis code will be made available upon reasonable request.

Competing Interests

The authors declare no competing interests.

Funding

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Authors' Contributions

AK (Ansoumane Kourouma) conceptualized the study, conducted all analyses, and drafted the manuscript.

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The Integrated Community Health Systems Institutionalization Framework (ICHS-IF): A Strategic Model for Strengthening Primary Health Care and Universal Health Coverage in South Sudan

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Abstract *Community health systems are central to achieving Universal Health Coverage (UHC), particularly in fragile and conflict-affected settings. In South Sudan, fragmented community-based programmes, parallel implementation structures, weak governance, and inconsistent financing have constrained the sustainability and effectiveness of community health services. To address these challenges, the Ministry of Health developed a Community-Based Networks (CBNs) Integration Strategy within the Revised Boma Health Initiative (2024–2028). This study presents a strategic framework for institutionalising CBNs within South Sudan's national community health system to strengthen Primary Health Care (PHC), improve service integration, and advance UHC. A qualitative Health Policy and Systems Research approach was applied through review and thematic analysis of national policies, strategic frameworks, programme reports, technical working group documents, stakeholder consultation reports, and relevant international literature. The analysis identified fragmented governance, parallel community structures, inconsistent supervision, inadequate financing, and weak accountability as major barriers to effective community health service delivery. In response, the study proposes the Integrated Community Health Systems Institutionalization Framework (ICHS-IF), which integrates governance and leadership, service delivery, community health workforce development, sustainable financing, digital health information systems, community accountability and participation, and multisectoral coordination within a unified institutional model. Institutionalizing CBNs within existing government systems offers a practical and potentially scalable approach for strengthening resilient community health systems. The ICHS-IF provides an evidence-informed framework for South Sudan and other fragile and resource-constrained settings seeking to strengthen PHC, improve health system resilience, and accelerate progress toward UHC.*

Keywords *Boma Health Initiative, Community Health Systems, Community-Based Networks, Health Systems Strengthening, Institutionalisation, Primary Health Care, South Sudan, Universal Health Coverage.*

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Introduction

Universal Health Coverage (UHC) remains a global health priority under Sustainable Development Goal (SDG) 3, aiming to ensure that all people have access to quality health services without financial hardship [1, 2]. Achieving UHC requires strong Primary Health Care (PHC) systems that are accessible, equitable, people-centred, and resilient, particularly in fragile and conflict-affected settings where weak governance, health workforce shortages, recurrent disease outbreaks, insecurity, climate-related shocks, and limited domestic financing continue to constrain access to essential health services [3-8].

Community health systems are increasingly recognised as a cornerstone of PHC because they extend essential services to underserved populations while promoting disease prevention, health promotion, surveillance, community engagement, and accountability [9-12]. Community Health Workers (CHWs) and other Community-Based Networks (CBNs) strengthen the link between households and health facilities, improve service utilisation, and support emergency preparedness and response [13-16]. However, in many low- and middle-income countries, community health programmes remain fragmented, donor-dependent, and implemented through parallel structures that weaken coordination, government ownership, and long-term sustainability [17-19].

South Sudan faces similar challenges. Years of conflict, humanitarian crises, population displacement, recurrent disease outbreaks, flooding, and limited health infrastructure have weakened the national health system and constrained access to essential PHC, particularly in rural and hard-to-reach communities [20-25]. Although numerous CBNs have been established by government institutions and development partners, many have operated independently, resulting in duplicated roles, inconsistent supervision, fragmented reporting systems, and variable incentive mechanisms.

To address these challenges, the Ministry of Health introduced the Revised Boma Health Initiative (2024–2028), which prioritises stronger governance, integrated service delivery, institutionalisation, accountability, sustainable financing, and improved coordination across the community health system. Building on these reforms, this study proposes the Integrated Community Health Systems Institutionalization Framework (ICHS-IF) as a practical model for integrating multiple CBNs within a unified national community health system.

The framework addresses an important gap in the literature, which has largely focused on individual CHW programmes and disease-specific interventions rather than the institutional integration of diverse community-based structures within national health systems. By presenting an evidence-informed governance framework, this study provides practical guidance for South Sudan and other fragile and resource-constrained settings seeking to strengthen PHC, improve health system resilience, and accelerate progress toward UHC.

Background and Literature Review

Community Health Systems and Universal Health Coverage

Community health systems are fundamental to Primary Health Care (PHC) and Universal Health Coverage (UHC), particularly in low- and middle-income countries where shortages of skilled health workers constrain access to essential health services [3, 9]. The Declaration of Astana reaffirmed PHC as the foundation for achieving UHC through integrated, people-centred services, community participation, and multisectoral collaboration [4]. Community Health Workers (CHWs) and other Community-Based Networks (CBNs) extend preventive,

promotive, and selected curative services to underserved populations while strengthening disease surveillance, health promotion, referral systems, and community engagement [10-16].

Despite these contributions, many community health programmes remain fragmented because they have evolved through disease-specific and donor-funded initiatives operating outside routine government systems. Such fragmentation often results in duplicated responsibilities, inconsistent supervision, parallel reporting systems, and weak government ownership, thereby reducing efficiency and long-term sustainability [17-19].

Community Health in Fragile Settings: The South Sudan Context

Fragile and conflict-affected settings face persistent challenges, including insecurity, population displacement, disease outbreaks, weak governance, limited infrastructure, and inadequate health financing, all of which undermine equitable access to PHC [5-8]. South Sudan exemplifies these challenges, with recurrent humanitarian emergencies and health workforce shortages disproportionately affecting rural and hard-to-reach communities [20-25].

To improve access to community-based PHC, the Ministry of Health introduced the Boma Health Initiative (BHI) as the national community health strategy. The BHI established Boma Health Workers (BHWs) as the frontline community health workforce responsible for delivering integrated promotive, preventive, and selected curative services while linking households with health facilities. However, implementation has revealed persistent challenges, including fragmented governance, inconsistent supervision, parallel reporting systems, inadequate financing, and limited coordination among multiple CBNs.

Institutionalising Community-Based Networks

Institutionalisation refers to integrating governance, financing, workforce management, service delivery, information systems, and accountability mechanisms into routine government functions to ensure sustainability beyond externally funded projects [26-30]. Evidence indicates that institutionalised community health systems can strengthen government leadership, improve coordination among partners, harmonise implementation, and enhance workforce performance [26-30].

Recognising these benefits, the Ministry of Health developed the CBNs Integration Strategy to harmonise existing community structures within the BHI. Rather than creating additional volunteer cadres, the strategy promotes coordinated governance, standardised training, integrated supervision, harmonised reporting, sustainable financing, and stronger accountability through existing Ministry of Health structures.

Knowledge Gap and Study Rationale

Although considerable evidence supports strengthening community health systems, relatively few studies describe how multiple CBNs can be systematically institutionalised within a single national health system, particularly in fragile and humanitarian settings. Most published research focuses on individual CHW programmes or disease-specific interventions, with limited attention to governance integration, organisational reform, financing, accountability, and long-term institutional sustainability [17, 26-29].

This study addresses this gap by proposing the Integrated Community Health Systems Institutionalization Framework (ICHS-IF), an evidence-informed framework developed from South Sudan's policy reforms and implementation experience. The framework provides practical guidance for integrating CBNs within national health systems while

strengthening governance, service delivery, workforce development, financing, digital health information systems, community participation, and multisectoral coordination. Although informed by South Sudan's experience, the ICHS-IF is intended to support community health system reforms in other fragile and resource-constrained settings.

Materials and Methods

Study Design

This study employed a qualitative Health Policy and Systems Research (HPSR) design to examine the institutional integration of Community-Based Networks (CBNs) within South Sudan's national community health system. The HPSR approach was selected because it is appropriate for analysing health policies, governance arrangements, organisational reforms, and institutional change within complex health systems [19, 26].

Study Setting

The study focused on South Sudan, a fragile and conflict-affected setting characterised by recurrent humanitarian crises, disease outbreaks, flooding, population displacement, limited health infrastructure, and health workforce shortages. These challenges have contributed to fragmented community health programmes and constrained access to quality Primary Health Care (PHC), particularly among rural and underserved populations [20-25].

The analysis focused on the Ministry of Health's Boma Health Initiative (BHI) and the Community-Based Networks Integration Strategy as key national reforms intended to strengthen and harmonize community health systems.

Data Sources

Data were obtained through a review of national health policies, strategic plans, technical reports, programme implementation reports, stakeholder consultation reports, and peer-reviewed literature relevant to community health systems, PHC, health systems strengthening, and Universal Health Coverage (UHC). The use of multiple documentary sources enabled triangulation of evidence across policy, programme, and research perspectives.

Data Collection and Analysis

Documents were purposively selected based on their direct relevance to community health governance, institutional reform, health systems strengthening, and CBN integration in South Sudan. The review prioritised national policy and strategy documents, programme and implementation reports, stakeholder consultation materials, and peer-reviewed literature capable of informing the institutional dimensions of CBN integration. Data were analysed using thematic content analysis. Emerging themes were identified through iterative review and synthesised using a health systems strengthening perspective to identify institutional barriers, enabling factors, and priority areas for integrating CBNs within the national community health system [3, 9, 29].

Trustworthiness

Rigour was strengthened through triangulation of multiple documentary sources, systematic review of relevant evidence, and iterative thematic analysis. Credibility was enhanced by comparing findings across policy documents, programme reports, stakeholder consultations, and peer-reviewed literature. Dependability and confirmability were supported through a transparent analytical process, while transferability was enhanced by describing the institutional and health system context in which the framework was developed.

Ethical Considerations

The study was based exclusively on publicly available policy documents, programme reports, and published literature and did not involve human participants or

identifiable personal data. Therefore, ethical approval and informed consent were not required. The study adhered to principles of scientific integrity, transparency, and appropriate citation of information sources.

Development of the Integrated Community Health Systems Institutionalization Framework (ICHS-IF)

The ICHS-IF was developed through thematic synthesis of the reviewed evidence, incorporating lessons from South Sudan's community health reforms and internationally recognised health systems strengthening principles. The framework comprises seven interrelated institutional domains:

1. Governance and leadership;
2. Integrated service delivery;
3. Community accountability and participation;
4. Sustainable financing;
5. Community health workforce development;
6. Digital health information systems; and
7. Multisectoral partnerships and coordination.

Together, these seven domains provide a practical framework for institutionalising CBNs within national health systems to strengthen PHC, improve health system resilience, and advance UHC. Monitoring, evaluation, learning, and adaptation operate as cross-cutting functions that support continuous improvement across the seven domains.

Results

Institutional Context for Community-based Networks Integration

The review found that community health services in South Sudan have historically been delivered through multiple Community-Based Networks (CBNs) established by government institutions, development partners, faith-based organisations, civil society organisations, and humanitarian agencies. While these networks have expanded access to community-level services, their independent implementation has contributed to fragmented governance, duplicated responsibilities, inconsistent supervision, parallel reporting systems, and unsustainable financing. These challenges have constrained coordination, accountability, and the efficiency of community health service delivery.

The Ministry of Health has responded through the Boma Health Initiative (BHI) and the CBNs Integration Strategy, which seek to institutionalise these networks within a unified, government-led community health system. This transition provides the institutional basis for harmonising governance, workforce management, service delivery, reporting, financing, supervision, and community accountability.

Strategic Pathway for Institutional Integration

Figure 1 presents the conceptual pathway for integrating CBNs into South Sudan's national community health system. It illustrates the transition from fragmented and parallel community-based structures to an integrated, government-led system characterised by harmonised governance and policies, standardised capacity development, coordinated supervision, integrated reporting systems, sustainable financing and incentives, and strengthened community engagement and accountability.

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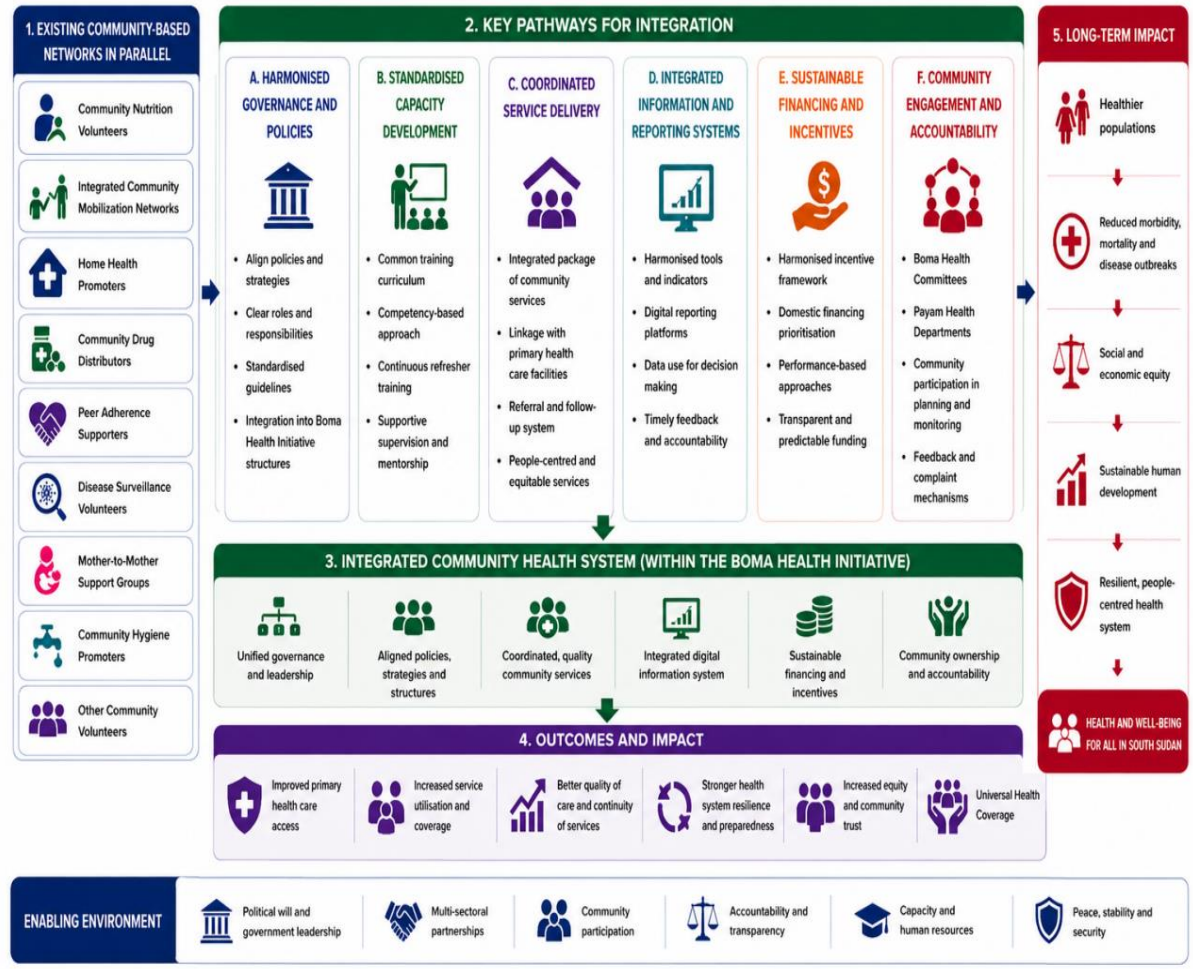


Figure 1. Conceptual Pathway for Integrating Community-Based Networks into South Sudan's National Community Health System

Source: *Developed by the author based on the Ministry of Health community health reforms and relevant international community health systems literature.*

Interpretation: Figure 1 illustrates the transition from fragmented and parallel CBNs toward an integrated national community health system. The pathway demonstrates how harmonised governance, workforce development, supervision, reporting, financing, and community accountability can strengthen service integration and contribute to improved PHC, health system resilience, and progress toward UHC.

Integrated Community Health Systems Institutionalization Framework (ICHS-IF)

The principal output of this study is the Integrated Community Health Systems Institutionalization Framework (ICHS-IF) presented in Figure 2. The framework identifies seven interdependent domains required for sustainable institutionalisation: governance and leadership; integrated service delivery; community accountability and participation; sustainable financing; community health workforce development; digital health information systems; and multisectoral partnerships and coordination. Together, these domains provide an integrated institutional model for strengthening coordination, accountability, service quality, resilience, and long-term sustainability.

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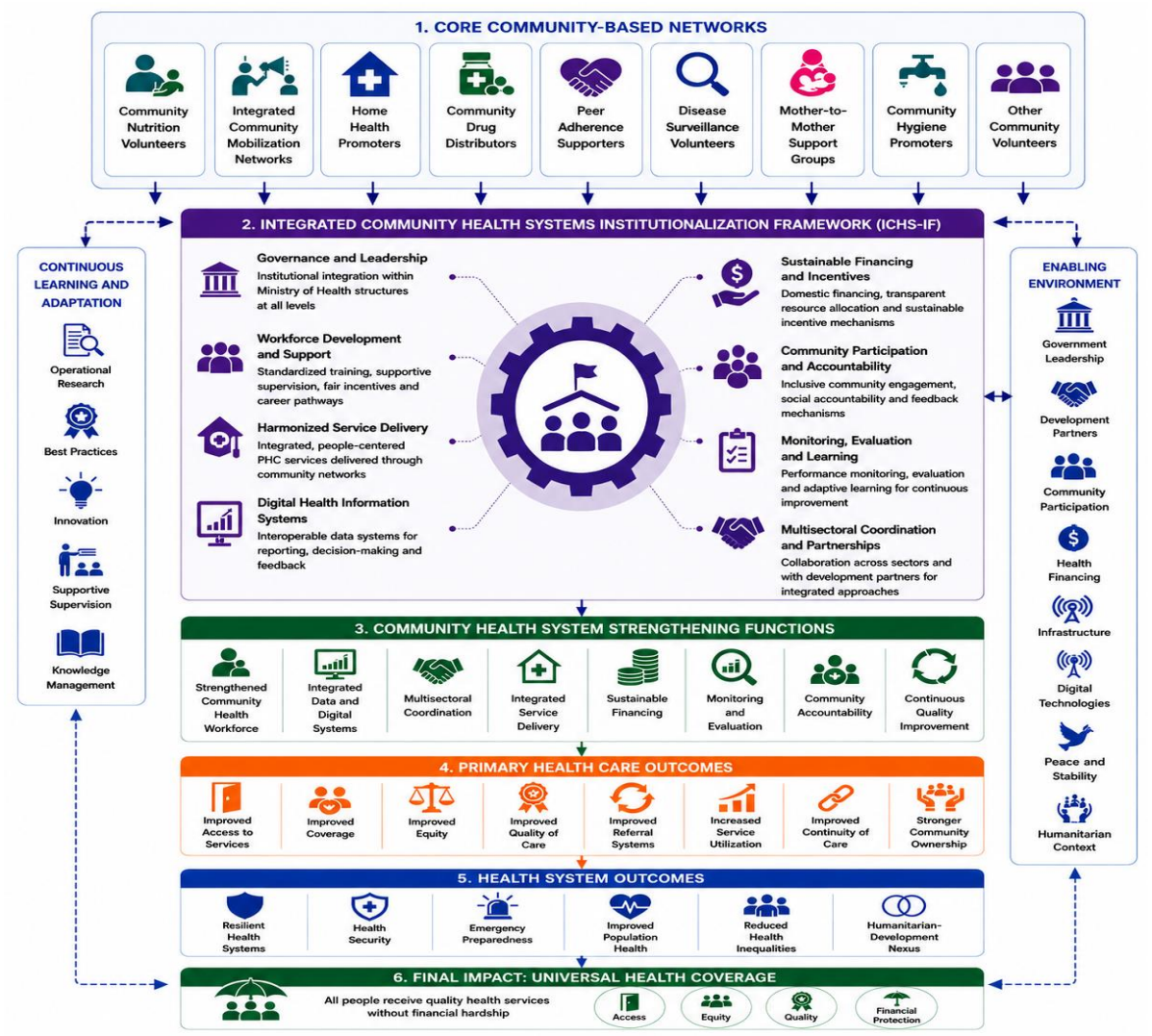


Figure 2. The Integrated Community Health Systems Institutionalization Framework (ICHS-IF)

Source: *Developed by the author based on the Ministry of Health, Republic of South Sudan, the WHO Health Systems Framework, and international literature on community health systems strengthening [3, 9, 29-34].*

Interpretation: Figure 2 presents the ICHS-IF as a comprehensive institutional model for integrating CBNs within South Sudan's national community health system. It demonstrates how the seven institutional domains, which include governance and leadership, workforce development, integrated service delivery, sustainable financing, digital health information systems, community participation and accountability, and multisectoral coordination, interact to strengthen resilient PHC systems and advance UHC, supported by cross-cutting monitoring, evaluation, learning, and adaptation.

Institutional Governance Model

Figure 3 presents the governance and coordination architecture for institutionalising CBNs within existing Ministry of Health structures. The model establishes reporting, supportive supervision, coordination, and accountability mechanisms linking national, state, county, payam, health facility, and community levels while promoting collaboration among government, development partners, civil society organisations, faith-based organisations, and communities.

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Figure 3. Governance and Coordination Architecture for Integrated Community Health Systems

Source: *Adapted by the author from the Ministry of Health, Republic of South Sudan CBNs Integration Strategy under the Revised Boma Health Initiative (2024–2028) and informed by WHO health systems governance frameworks [3, 5, 7, 31].*

Interpretation: Figure 3 illustrates the institutional governance architecture for integrating CBNs within the Ministry of Health community health system. It establishes clear reporting pathways, supportive supervision, coordination mechanisms, feedback loops, and shared accountability across national, state, county, payam, facility, and community levels, thereby strengthening government stewardship and multisectoral collaboration.

Theory of Change for Community-Based Networks (CBNs) Integration

Figure 4 presents the Theory of Change underpinning the institutionalisation of CBNs. It demonstrates how strategic inputs and interventions in governance, workforce capacity, service integration, financing, community participation, health information systems, monitoring, and learning are expected to generate progressive improvements in coordination, service quality, accountability, health system performance, resilience, and UHC.

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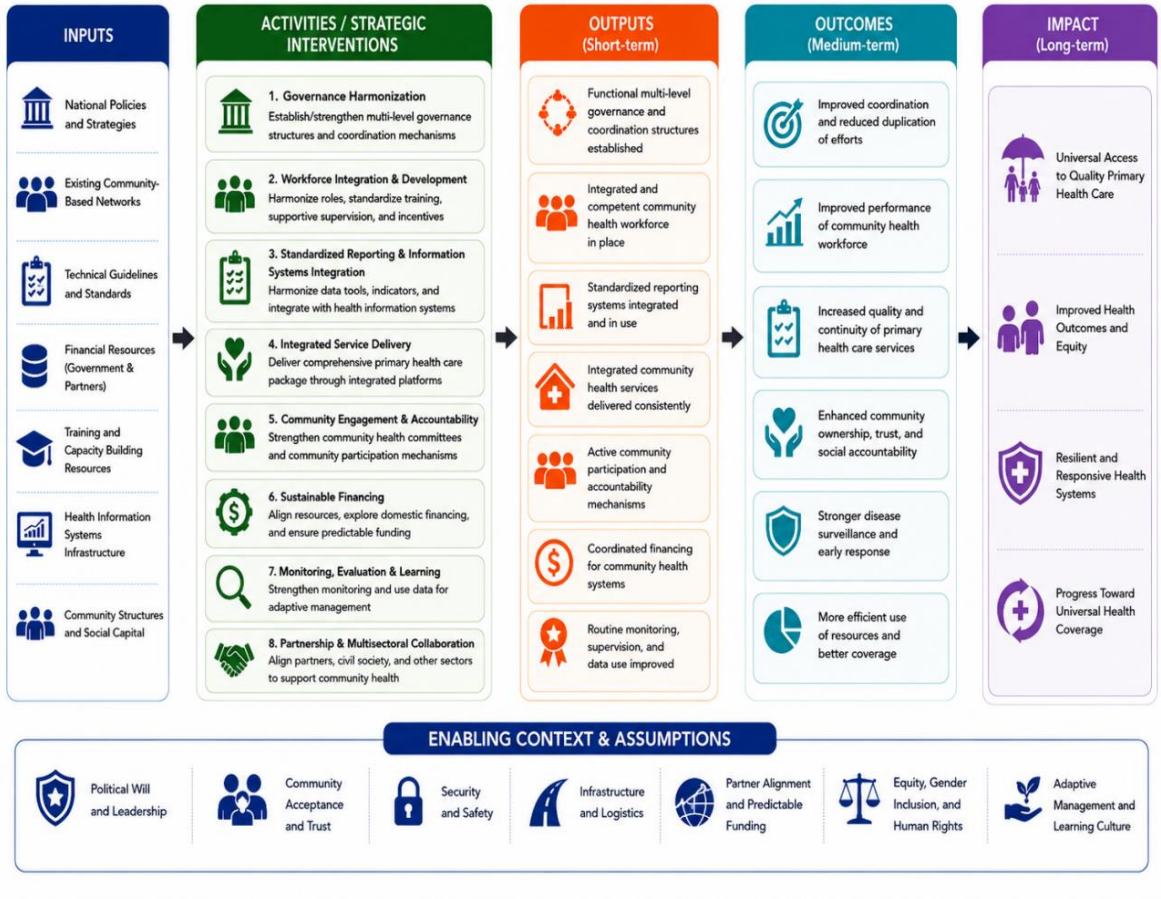


Figure 4. Theory of Change for Community-Based Networks Integration

Source: *Adapted by the author from the Ministry of Health, Republic of South Sudan CBNs Integration Strategy under the Revised Boma Health Initiative (2024–2028) and WHO Primary Health Care and Health Systems Strengthening Frameworks [3-5, 31].*

Interpretation: Figure 4 illustrates the results pathway through which institutionalising CBNs is expected to strengthen community health systems. Strategic investments in governance, workforce development, integrated service delivery, financing, information systems, community participation, and monitoring are expected to generate improved service delivery and system performance, ultimately contributing to resilient PHC and progress towards UHC.

Phased Implementation Roadmap

Table 1 presents a phased implementation roadmap for institutionalising CBNs within South Sudan's national community health system. The roadmap proposes a sequential approach beginning with policy dissemination, governance strengthening, stakeholder orientation, and institutionalisation; followed by systems strengthening and service integration; and culminating in routine monitoring, learning, and continuous improvement.

Table 1. Phased Implementation Roadmap for Institutionalizing CBNs within South Sudan's National Community Health System

Phase	Priority Activities	Expected Outcome
Phase I: Institutionalization	Disseminate policies, strengthen governance structures, and orient stakeholders	National ownership and coordinated leadership established
Phase II: Systems Strengthening	Harmonize workforce management, supervision, reporting, and financing	Functional integrated community health system
Phase III: Service Integration	Roll out integrated service delivery, strengthen referrals, and digitize reporting	Improved quality, efficiency, and continuity of community health services
Phase IV: Monitoring and Learning	Conduct routine monitoring, operational research, and policy reviews	Continuous improvement and sustainable implementation

Interpretation: Table 1 demonstrates that successful institutionalisation requires a structured and sequential process that progressively strengthens governance, harmonizes community health systems, integrates service delivery, and embeds monitoring and continuous learning within routine government structures.

Expected Health System Outcomes

Implementation of the proposed framework is expected to strengthen governance, improve stakeholder coordination, harmonize community health services, enhance workforce performance, strengthen accountability and health information systems, and promote sustainable financing. Collectively, these improvements are expected to increase equitable access to integrated PHC, strengthen preparedness and resilience for public health emergencies, and accelerate progress toward UHC.

Summary of the Study's Original Contributions

Table 2 summarizes the principal theoretical, conceptual, methodological, policy, implementation, practical, and global health contributions of this study. Collectively, these contributions extend existing community health systems literature by reframing CBN integration as an institutional health systems reform and demonstrating how multiple community structures can be systematically integrated within a unified national community health system.

Table 2. Summary of the Study's Original Theoretical, Methodological, Policy, and Practical Contributions

Domain	Original Contribution	Significance
Theory	Reframes Community-Based Networks as a health systems governance reform	Advances Health Policy and Systems Research
Conceptual Framework	Introduces the Integrated Community Health Systems Institutionalization Framework	Provides a transferable analytical framework
Policy	Documents South Sudan's national Community-Based Networks Integration Strategy	Generates evidence for community health policy reform
Methodology	Applies qualitative HPSR to	Demonstrates a replicable

	analyze institutional integration	policy analysis approach
Implementation Science	Identifies institutional determinants of successful integration	Strengthens implementation research
Practice	Provides an operational framework for institutionalizing Community-Based Networks	Supports government-led implementation
Global Health	Generates transferable lessons for fragile and humanitarian settings	Contributes to international community health systems literature

Source: *Developed by the author based on the findings of this study and supported by the reviewed literature on community health systems, health policy, and systems strengthening [3, 9, 17, 26-34].*

Interpretation: Table 2 demonstrates that the ICHS-IF contributes beyond programme-level community health interventions by providing an integrated institutional model linking theory, policy, implementation, and practice. Its principal contribution is a transferable governance framework that can inform community health systems reform in South Sudan and other fragile and humanitarian settings.

Discussion

The findings demonstrate that institutionalising Community-Based Networks (CBNs) within a unified national health system offers a practical strategy for strengthening Primary Health Care (PHC) and advancing Universal Health Coverage (UHC) in fragile and resource-constrained settings. Rather than operating as parallel, donor-supported initiatives, CBNs can be integrated into routine government structures to improve governance, coordination, accountability, service integration, and long-term sustainability. The proposed Integrated Community Health Systems Institutionalization Framework (ICHS-IF) provides an evidence-informed model for supporting this transition.

These findings are consistent with global evidence showing that community health systems perform more effectively when embedded within national governance and health system structures rather than implemented through fragmented vertical programmes [9-12, 17, 26]. Similarly, the Declaration of Astana and the WHO Operational Framework for Primary Health Care emphasise integrated governance, community participation, multisectoral collaboration, and resilient health systems as important foundations for achieving UHC [3, 4]. By aligning these principles with South Sudan's community health reforms, the ICHS-IF translates international health systems principles into a practical institutional model relevant to fragile and humanitarian settings.

A major contribution of this study is its shift from programme-specific interventions towards systems-level institutional reform. Previous studies have largely focused on the effectiveness and performance of Community Health Workers (CHWs) or disease-specific community programmes, with comparatively limited attention to the systematic integration of multiple CBNs within a unified national governance framework [13-18]. The ICHS-IF addresses this gap by demonstrating how governance, workforce development, integrated service delivery, sustainable financing, digital health information systems, community participation and accountability, and multisectoral coordination can function as interconnected domains of a resilient community health system, supported by cross-

cutting monitoring, evaluation, learning, and adaptation.

Fragmented governance emerged as a major barrier to effective community health service delivery. Independent implementation by government institutions, development partners, civil society organisations, faith-based organisations, and other actors can contribute to duplicated roles, inconsistent supervision, fragmented reporting systems, and inefficient use of limited resources. Similar challenges have been reported in low- and middle-income countries where externally supported vertical programmes have sometimes weakened coordination, national ownership, and sustainability [17-19, 27-31]. Institutionalizing CBNs within Ministry of Health structures therefore provides an opportunity to strengthen government stewardship, harmonize implementation, improve accountability, and optimise available resources.

Community participation is another critical determinant of successful institutionalisation. Sustainable community health systems require meaningful engagement of communities in planning, implementation, monitoring, feedback, and accountability. Evidence indicates that strong community participation can improve trust, service utilisation, responsiveness, and programme sustainability [10-12, 15]. The ICHS-IF therefore positions community participation and accountability as core institutional functions rather than stand-alone programme activities.

Sustainable financing and integrated health information systems are equally important for long-term institutionalisation. Increasing domestic investment while aligning external support with national priorities can reduce dependence on fragmented and short-term project financing. Likewise, harmonised health information systems can strengthen monitoring, supportive supervision, accountability, and evidence-informed decision-making by reducing parallel reporting arrangements and promoting routine use of community-level data [28-33].

Although developed from South Sudan's policy reforms and implementation experience, the ICHS-IF has potential relevance to other fragile and conflict-affected settings facing fragmented community programmes, multiple community volunteer platforms, weak institutional coordination, and heavy reliance on external financing. Its core principles, which include government leadership, integrated governance, harmonised systems, sustainable financing, community ownership, continuous learning, and multisectoral collaboration, can be adapted to different national contexts rather than applied as a fixed model.

Overall, the findings suggest that institutional integration should be understood as a strategic health systems reform rather than merely an administrative restructuring process. Embedding CBNs within routine government systems can provide a pathway towards more coordinated, accountable, resilient, and sustainable community health systems capable of responding to routine health needs while strengthening preparedness for public health emergencies.

Policy and Practice Implications

The findings demonstrate that institutionalising Community-Based Networks (CBNs) within national health systems can strengthen governance, improve coordination, reduce programme fragmentation, and enhance the sustainability of community health services. The proposed Integrated Community Health Systems Institutionalization Framework (ICHS-IF) provides a practical approach for governments and development partners seeking to strengthen community health systems, particularly in fragile and humanitarian settings.

For the Government of South Sudan, successful institutionalisation will require sustained political commitment, strong

Ministry of Health leadership, clear governance and accountability mechanisms, harmonised operational policies, and increased domestic investment in community health. Integrating CBNs within existing government structures rather than maintaining parallel programmes can strengthen national ownership, institutional accountability, and long-term sustainability.

For development partners, technical and financial support should align with national policies, strategies, implementation structures, and reporting systems. Greater emphasis should be placed on strengthening government-led systems rather than establishing parallel implementation arrangements. Joint planning, coordinated financing, harmonised reporting, integrated supportive supervision, and shared performance monitoring can reduce duplication and improve the efficiency of investments in community health.

For programme implementers, priority should be given to standardised capacity development, integrated service delivery, supportive supervision, harmonised reporting, and digital health information systems, coordinated incentive mechanisms, and the routine use of community-level data for decision-making. Strengthening community-level governance and accountability structures can further improve service responsiveness, community participation, and the quality of care.

Sustainable financing remains essential for long-term institutionalisation. While external assistance will continue to play an important role in South Sudan's health system, progressively integrating community health priorities into government planning, budgeting, and resource-allocation mechanisms can strengthen predictability, national ownership, and resilience. Partner financing should complement, rather than substitute for, sustainable national systems.

Beyond South Sudan, the ICHS-IF offers an adaptable institutional model for countries facing similar challenges of fragmented community health programmes, multiple community-based structures, weak coordination, and dependence on external financing. Application of the framework should nevertheless be adapted to each country's governance arrangements, health system capacity, financing context, and community structures.

Strategic Recommendations

Based on the study findings, the following actions are recommended:

Policy and Governance: Institutionalise the CBNs Integration Strategy within national health policies, strategic plans, operational guidelines, and government coordination structures. Roles, responsibilities, reporting relationships, and accountability mechanisms should be clearly defined across national, state, county, payam, health facility, and community levels.

Health Systems Strengthening: Integrate CBNs into existing Ministry of Health governance and service-delivery structures; harmonize training, supportive supervision, reporting, performance monitoring, and incentive mechanisms; and strengthen interoperable digital health information systems to support routine decision-making.

Sustainable Financing: Increase domestic investment in community health while improving alignment and coordination of external financing. Community health workforce, supervision, commodities, information systems, and operational costs should be progressively incorporated into routine health-sector planning and budgeting.

Community Participation and Accountability: Strengthen Boma Health Committees, community structures, and other appropriate local mechanisms to enable meaningful participation in planning,

implementation, monitoring, feedback, and social accountability.

Partnership and Multisectoral Coordination: Strengthen government-led coordination among development partners, civil society organisations, faith-based organisations, communities, and other sectors to reduce duplication, align resources, and promote integrated community health programming.

Monitoring, Evaluation and Learning: Establish harmonised indicators, routine monitoring mechanisms, feedback loops, and implementation-learning processes to assess institutionalisation, identify bottlenecks, document lessons, and support continuous adaptation and quality improvement.

Future Research: Validate the ICHS-IF through implementation research in South Sudan and evaluate its effects on governance, workforce performance, service integration, financing, community participation, health outcomes, and health system resilience. Comparative studies in other fragile and conflict-affected settings should assess the framework's adaptability, scalability, and transferability.

Study Contribution, Strengths, Limitations, and Future Research

Study Contribution

This study contributes to Health Policy and Systems Research by proposing the Integrated Community Health Systems Institutionalization Framework (ICHS-IF) as a systems-oriented model for integrating multiple Community-Based Networks (CBNs) within a unified national community health system. Unlike approaches that focus primarily on individual Community Health Worker (CHW) cadres or disease-specific community interventions, the ICHS-IF brings together governance and leadership, workforce development, integrated service delivery, sustainable financing, digital health information systems, community participation and accountability, and multisectoral coordination within a single institutional framework, supported by cross-cutting monitoring, evaluation, learning, and adaptation.

The study further contributes by reframing CBN integration as a health systems institutionalisation process rather than simply the consolidation of community-based programmes. In doing so, it links community-level structures with formal government governance, planning, supervision, financing, information, and accountability mechanisms. This provides both a conceptual contribution to community health systems research and a practical framework for policymakers and implementers seeking to strengthen Primary Health Care (PHC), health system resilience, and Universal Health Coverage (UHC) in fragile and resource-constrained settings.

The specific theoretical, conceptual, methodological, policy, implementation, practical, and global health contributions of the study are summarized in Table 2.

Strengths

A key strength of this study is its systems-level perspective on the integration of diverse CBNs within national community health structures. The analysis draws on national policies, strategic frameworks, programme documents, stakeholder consultation reports, and relevant international literature, enabling evidence to be considered across policy, programme, and health system perspectives.

The study also translates the findings into interconnected products: a conceptual integration pathway, the ICHS-IF, an institutional governance architecture, a Theory of Change, and a phased implementation roadmap. Together, these provide a coherent progression from identifying fragmentation and institutional barriers to defining governance arrangements, implementation

mechanisms, expected results, and longer-term health system outcomes.

Limitations

The study has several limitations. First, it is based primarily on qualitative policy and documentary analysis and therefore does not provide quantitative estimates of the effect of CBN institutionalisation on service coverage, health outcomes, cost-effectiveness, or UHC indicators. Second, although the ICHS-IF is informed by South Sudan's policy reforms and implementation experience, the framework has not yet been prospectively validated through large-scale implementation research.

Third, the framework was developed within South Sudan's specific fragile and humanitarian context; therefore, its transferability to other settings should not be assumed without appropriate contextual adaptation. Differences in governance arrangements, health financing, community structures, workforce models, political economy, and institutional capacity may influence implementation.

These limitations do not diminish the framework's conceptual and policy relevance but indicate the need for empirical validation and implementation research.

Future Research

Future research should empirically test the feasibility, acceptability, effectiveness, sustainability, and scalability of the ICHS-IF using implementation research and mixed-methods designs. Priority outcomes should include governance effectiveness, workforce performance, service integration, supervision, community participation and accountability, financing, data quality and use, service coverage, health equity, and health system resilience.

Longitudinal studies would be particularly valuable for assessing whether institutionalisation produces sustained improvements over time and whether the anticipated outcomes identified in the Theory of Change are achieved. Economic evaluation should also examine implementation costs, efficiency gains, resource requirements, and the financial sustainability of integrating CBNs within routine government systems.

Comparative research across other fragile and conflict-affected settings could further assess the adaptability and transferability of the ICHS-IF and identify which institutional components are universally relevant and which require context-specific modification.

Conclusion

Community health systems are fundamental to strengthening Primary Health Care and advancing Universal Health Coverage, particularly in fragile and conflict-affected settings. This study demonstrates that institutionalising Community-Based Networks within routine national health system structures provides a strategic pathway for addressing fragmented governance, parallel implementation arrangements, inconsistent supervision and reporting, and weak institutional sustainability. The proposed Integrated Community Health Systems Institutionalization Framework (ICHS-IF) provides an evidence-informed model for strengthening governance, service integration, community participation and accountability, workforce development, sustainable financing, information systems, and multisectoral coordination. Although developed from South Sudan's community health reforms and implementation experience, the framework may have broader relevance to other fragile and resource-constrained settings when appropriately adapted to local contexts. Prospective implementation research is required to validate its feasibility, effectiveness, sustainability, and contribution to resilient community health systems, PHC, and UHC.

Conflict of Interest

The author declares no competing interests.

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Author Contributions

Okello David Omwony: Conceptualization; Methodology; Formal analysis; Investigation; Data curation; Visualization; Writing – original draft; Writing – review and editing; Project administration. The author approved the final version for publication.

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No external funding was received specifically for this study. The research was undertaken independently using publicly available policy documents, programme reports, and peer-reviewed literature.

Ethics Approval

Ethical approval was not required because the study was based exclusively on publicly available policy documents, programme reports, and published literature and did not involve human participants or identifiable personal data.

Consent for Publication

Not applicable.

Data Availability

All data supporting the findings are derived from publicly available policy documents, programme reports, and peer-reviewed publications cited in the reference list. Additional information is available from the corresponding author upon reasonable request.

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Role of Electronic Vaccine Intelligence Network (eVIN) in Improving Routine Immunization Services: A Cross-Sectional Assessment in Unnao District, Uttar Pradesh, India

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Abstract *Vaccination remains one of the most cost-effective public health interventions for reducing childhood morbidity and mortality globally. The Universal Immunization Programme (UIP) in India, initiated in 1985, has expanded significantly with technological innovations like the Electronic Vaccine Intelligence Network (eVIN) implemented since 2014 to strengthen vaccine logistics and supply chain management. This cross-sectional study assessed the effectiveness of eVIN implementation in Unnao District from November 2024 to October 2025, evaluating 21 Cold Chain Points (CCPs) across the district. The study examined cold chain infrastructure, vaccine storage practices, logistics management, health worker knowledge, and system performance. Results revealed 100% functional large ice-lined refrigerators and cold boxes, universal compliance with temperature monitoring protocols, and perfect adherence to vaccine storage standards. All healthcare personnel (n = 21) demonstrated competency in freeze-sensitive vaccine enumeration and shake test procedures. However, supervisory oversight gaps emerged with only 33.3% of sites receiving District Immunization Officer reviews in the preceding three months. Critical infrastructure deficits included complete absence of functional vaccine transport vans and dedicated drivers at 95.2% of facilities. eVIN integration demonstrated 95.2% operational efficiency with minimal system issues. The study demonstrates that while technological interventions like eVIN significantly improve vaccine logistics, supply chain transparency, and health worker competencies, sustained performance requires complementary investments in supervision infrastructure, transport logistics, and periodic competency-based training. Digital health solutions integrated with existing immunization approaches present promising opportunities for achieving universal immunization coverage goals and improving service delivery quality at the district level.*

Keywords *Cold Chain Management, Digital Health, Electronic Vaccine Intelligence Network, Health System Strengthening, Health Worker Practices, Immunization Coverage, Supply Chain Management, Vaccine Logistics.*

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Introduction

Vaccination continues to be among the most affordable methods of public health intervention in curbing morbidity and mortality of childhood in the world [1]. Universal Immunization Programme (UIP) in India was initiated in 1985 with the objective of providing life-saving vaccines to all the eligible children and pregnant mothers in the country to prevent them against vaccine-preventable infections [2]. Although there has been a tremendous advancement in the immunization coverage, vaccine and supply-chain business, and cold-chain business challenges have historically dented the efficiency of routine immunization services, especially in rural and underserved regions [3-5]. In order to resolve these systemic gaps, in 2014 the Government of India launched the Electronic Vaccine Intelligence Network eVIN, a new digital health initiative that aims to transform the management of vaccine logistics and enhance the immunization supply chain via this innovation [6].

eVIN system is an indigenously developed smartphone and cloud based platform that digitalises the data on the stocks of the vaccine, real-time monitoring of cold-chain temperature and offering evidence-based information to support the decision-making at every level of the vaccine supply chain [2]. As part of the Health System Strengthening initiative, eVIN was first implemented in 12 states in 2014-2017 with assistance of the United Nations Development Programme (UNDP) and the support of Gavi, the Vaccine Alliance, and has since been expanded to cover all 733 districts of 36 states and union territories of India [4]. The platform connects more than 29,000 cold-chain locations, giving real-time tracking of availability of vaccines, temperature deviations and the movement of stocks between state stores to final mile of service delivery [7]. EVIN has recorded fantastic amounts of success in substituting the traditional paper based systems with electronic vaccine logistics management which has seen 99 + percent availability of vaccines at cold-chain locations, reduction of stock-out cases by 80 percent and enhanced management of wastage of vaccines [1].

The achievement of immunization programmes is not only determined by technological advances but knowledge, practices, and performance of front line health workers who handle storage, transportation, and administration of vaccines [8]. Cold-chain handlers and vaccinators represent some of the most essential human resources as their skills in preserving optimum temperatures of storage, standard operating procedures, and delivery of vaccines on time directly affect the immunization coverage and vaccine strength [9]. Empirical research suggests that sufficient training, supportive supervision, and access to digital tools are excellent in improving health-worker practices and cold-chain management performance. However, knowledge gaps and poor implementation of best practices are still common especially in resource-starved environments where both infrastructure and human-resource constraints exist [10].

Unnao district in Uttar Pradesh is an exemplary setting where routine immunization services are faced with issues of vaccine logistics, health-system capacity and gaps in coverage [4]. As one of the most populated states in India, Uttar Pradesh was one of the first 12 states where eVIN was initiated and has also reported significant cost savings and better vaccine use after the system was introduced [5]. District level effects of the use of eVIN on health-worker practices and routine outcomes of immunization are critical towards establishing strengths, operational bottlenecks, and the scaling up of effective interventions in similar settings [6, 11, 12]. Digital health solutions, combined with existing immunization approaches, can bring about some promising opportunities to improve monitoring, accountability, and the

quality of service-delivery, which also leads to achieving universal immunization coverage goals [13, 14].

The proposed study will determine the effectiveness of eVIN in the Unnao district, estimate the health-worker knowledge and practices associated with vaccine management and cold-chain management, and determine the effects on the routine immunization outcomes, such as the vaccine availability, reduction in stock-out, and immunization coverage. The investigation of the interaction between technological interventions and human-resource capacity will enable this research to present evidence-based advice to enhance the supply chain of the immunization programme and enhance its performance at the district level [15, 16]. The results will help in the general comprehension of how digital health innovations, with the provision of good training and supervision of the health workers, can makeover routine immunization services and guarantee that all children receive timely and effective vaccines.

Materials and Methods

Study Design

This was a cross-sectional study conducted over a period of one year, from 1 November 2024 to 30 October 2025, to assess the role of the Electronic Vaccine Intelligence Network (eVIN) in improving routine immunization services in Unnao District. The study focused on evaluating the eVIN process, examining the awareness, perceptions, and practices related to eVIN among health care personnel, and studying the immunization supply chain (ISC) mechanism. Additionally, it assessed infrastructure, vaccine utilization, distribution, documentation practices, and bottlenecks in the operationalization of eVIN in Unnao District.

Study Setting

The study was conducted across all Cold Chain Points (CCPs) in Unnao District. The district's eVIN system is operational through 21 CCPs.

Study Duration

The study was conducted over one year, from 1 November 2024 to 30 October 2025.

Sample Size and Study Subjects

The study included all key stakeholders and service providers involved in the eVIN system in Unnao District. These stakeholders were from 21 Cold Chain Points (CCPs). The total sample size and key health staff involved were as follows:

Table 1. Sample Size Distribution of Health Staff involved in eVIN

S.No	Key Health Staff Involved in eVIN	Sample Size
1	Chief Medical Officer (CMO)	1
2	District Immunization Officer (DIO)	1
3	Vaccine Logistics and Cold Chain Manager (VCCM)	1
4	Cold Chain Technician (CCT)	1
5	District Vaccine Store Manager (DVSM)	1
6	Routine Immunization Data Manager (RIDM)	1
7	Medical Officer (MO) at each health facility	21
8	Cold Chain Handler (CCH) at each CCP	21

Data Collection

1. **Primary Data**: Collected through interpersonal interviews of stakeholders involved in the eVIN mechanism.
2. **Secondary Data**: Retrieved from the UNDP-eVIN system database and the DIO-HMIS system.

Study Tools

1. **Semi-structured Questionnaire**: A pre-designed semi-structured questionnaire was used for conducting interviews with all the stakeholders involved in eVIN.
2. **Observation Checklist**: A checklist was developed to observe infrastructure, on-site vaccine utilization, distribution, documentation practices, and quality checks, including temperature monitoring. The checklist was based on the UNDP eVIN tools, which standardized the process.
3. **Secondary Data Checklist**: A checklist based on records from the UNDP-eVIN system database and the DIO-HMIS system was used to gather relevant secondary data.

Study Process

1. **Permission**: Permission was obtained from the Chief Medical Health Officer (CMHO) office for conducting the study.
2. **Evaluation of Immunization Supply Chain**: The ISC mechanism and the role of eVIN were evaluated from the initial vaccine point to the final session site.
3. **Stakeholder Interviews**: Interpersonal interviews were conducted with all key stakeholders (CMO, DIO, CCT, DVSM, MOs, RIDM, VCCM, and CCH) to gather information and identify bottlenecks in the eVIN process.
4. **Infrastructure and Vaccine Distribution**: The infrastructure, vaccine utilization, and distribution were studied by analyzing the real-time monitoring system, interviewing healthcare providers, and monitoring the on-site vaccine quality, including temperature monitoring. Documentation practices were also observed and assessed.

Inclusion Criteria

All healthcare personnel working in eVIN in Unnao district who provided consent for participation.

Exclusion Criteria

- Healthcare personnel not involved in eVIN.
- Personnel involved in eVIN who did not provide consent.

Data Analysis

1. **Data Coding**: Data was collected and coded appropriately, and compiled in an MS Excel spreadsheet for analysis.
2. **Descriptive Statistics**: Continuous data was represented using mean and standard deviation. Descriptive statistics (frequencies and percentages) were calculated using MS Excel.
3. **Graphical Representation**: Data was represented visually using figures and tables.
4. **Statistical Analysis**: Z-score tests using SPSS 25 (trial version) software were applied where necessary to analyze associations.

Results

The study assessed 21 cold chain points (CCPs) across Unnao district, with a predominant rural distribution (76.2%) compared to urban areas (23.8%) (Table 2). Cold chain infrastructure revealed that the majority of sites had 2-3 ice-lined refrigerators (57.1% had 2 ILRs), with all sites reporting functional large ILRs, though 9.5% had non-functional units (Table 2). Deep freezer availability showed 61.9% of sites having 2-3 units, with 66.7% reporting at least one functional small deep freezer, while 9.5% had non-functional small deep freezers (Table 2). All sites maintained functional cold boxes with no non-functional small cold boxes

reported (Table 2). Power supply challenges were evident, with 76.2% of facilities experiencing 8-20 hours of daily electricity availability, necessitating power backup systems present in 95.2% of sites through generators, though only 5.0% had functional auto-start features (Table 2). Regarding CFC-free equipment modernization, 47.6% of sites had 5-6 CFC-free CCEs, while 57.1% reported having no equipment older than 10 years (Table 2).

Table 2. Cold Chain Infrastructure and Equipment Status at Cold Chain Points in Unnao District

Infrastructure Component	Frequency (n = 21)	Percentage (%)
Location		
Urban	5	23.8
Rural	16	76.2
Ice-lined Refrigerators (ILR)		
Sites with 2 ILRs	12	57.1
Sites with 3 ILRs	8	38.1
Functional large ILRs (≥1)	21	100.0
Non-functional large ILRs	2	9.5
Deep Freezers		
Sites with 2−3 deep freezers	13	61.9
Functional small deep freezers (≥1)	14	66.7
Non-functional small deep freezers	2	9.5
Cold Boxes		
Sites with functional cold boxes	21	100.0
Non-functional small cold boxes	0	0
Power Supply		
Power availability 8−20 hours/day	16	76.2
Functional power backup (generator)	20	95.2
Auto-start feature functional	1	5.0
CFC-free Equipment		
Sites with 5−6 CFC-free CCEs	10	47.6
CCEs >10 years old (none)	12	57.1

Vaccine storage practices demonstrated excellent adherence to cold chain maintenance standards, with 100% of sites ensuring CCE placement on wooden/plastic blocks, maintaining functional thermometers in each equipment with correct placement, utilizing separate temperature log books, and recording temperatures twice daily (Table 3). All sites maintained recommended temperature ranges for ILRs (+2 to +8°C) and deep freezers (−15 to −25°C), stored only UIP vaccines appropriately, and ensured all vaccines were within expiry dates with usable VVM status (I & II) (Table 3). However, temperature recording on holidays was practiced at 90.5% of sites, and correct ice pack placement in deep freezers was observed in 76.2% of facilities (Table 3). An isolated incident of vaccine found in frozen condition was reported at one site (4.8%) (Table 3).

Table 3. Vaccine Storage Practices and Cold Chain Maintenance Standards in Unnao District

Practice/Standard	Frequency (n = 21)	Percentage (%)
Equipment Placement		
CCE away from sunlight/moisture (All)	19	90.5
CCE on wooden/plastic blocks (All)	21	100.0
Minimum 10 cm gap maintained (All)	20	95.2
Temperature Monitoring		
Functional thermometer in each CCE	21	100.0
Thermometer placed correctly	21	100.0
Separate temperature log book	21	100.0
Temperature recorded twice daily	21	100.0
Temperature recorded on holidays	19	90.5
Temperature Ranges		
ILR temperature +2 to +8°C	21	100.0
DF temperature −15 to −25°C	21	100.0
Vaccine Storage		
Only UIP vaccines in ILR	21	100.0
T-series/Hep-B at top of ILR	21	100.0
All vaccines within expiry dates	21	100.0
All vaccines with usable VVM (I & II)	21	100.0
Vaccines found in frozen condition	1	4.8
Ice Pack Management		
Correct ice pack placement in DF	16	76.2
Ice packs filled and capped properly	21	100.0
Dedicated space for conditioning	19	90.5
Clean cloth for wiping available	21	100.0

Vaccine logistics management and record-keeping practices revealed universal compliance, with 100% of sites maintaining stock registers, distribution registers, documenting expired/wasted vaccines, and conducting physical stock counting within the last three months that matched register entries (Table 4). All facilities implemented dual paper and web-based management systems reflecting eVIN integration (Table 4). However, supervisory gaps emerged with only 33.3% of sites reporting District Immunization Officer (DIO) review of temperature log books in the preceding three months (Table 4). Infrastructure support was robust, with all sites having dedicated cold chain rooms, 95.2% possessing adequate repair/maintenance space, and all technicians equipped with tool kits, though 47.6% reported at least one CCE being non-functional for over one month at the time of visit (Table 4). Critical gaps included the complete absence of functional vaccine transport vans (100% sites) and dedicated drivers for vaccine delivery (95.2% sites), while 52.4% of sites had never disposed of condemned CCEs (Table 4).

Table 4. Vaccine Logistics Management and Record-Keeping Practices in Unnao District

Logistics Component	Status	Frequency (n = 21)	Percentage (%)
Stock Management			
Stock register in use (as per norm)	Yes	21	100.0
All parameters recorded	Yes	21	100.0
Distribution register in use	Yes	21	100.0
Expired/wasted vaccines documented	Yes	21	100.0
Physical stock counting (last 3 months)	Yes	21	100.0
Physical stock matches register	Yes	21	100.0
eVIN Implementation			
Management system type	Paper & Web	21	100.0
Supervision			
DIO review of log book (last 3 months)	Yes	7	33.3
DIO review of log book (last 3 months)	No	14	66.7
Infrastructure Support			
Dedicated cold chain room/space	Yes	21	100.0
Space for CCE repair/maintenance	Yes	20	95.2
Technician has tool kit	Yes	21	100.0
Technician has spare parts	Yes	20	95.2
Dedicated dry storage space	Yes	20	95.2
Equipment Status			
CCE down >1 month (at visit)	Yes	10	47.6
Functional vaccine van available	No	21	100.0
Condemned CCEs never disposed		11	52.4
Driver posted for vaccine delivery	No	20	95.2

The sociodemographic profile of cold chain handlers showed a predominantly male workforce (95.2%) with mean age of 39.86±11.80 years, most commonly Block Health Workers (42.8%) and Health Supervisors (28.6%), with 47.6% having graduation-level education (Table 5). Regarding eVIN implementation, all handlers (100%) received standardized 2-day district-level physical training, with 33.3% having 2 years of eVIN experience and varying CCH training exposure (52.4% trained once, 33.3% twice, and 14.3% thrice) (Table 5).

Table 5. Sociodemographic Profile and Training Status of Cold Chain Handlers in Unnao District

Characteristic	Category	Frequency (n = 21)	Percentage (%)
Location	Urban	5	23.8
	Rural	16	76.2
Gender	Male	20	95.2
	Female	1	4.8
Age Group (years)	<30	7	33.3
	31–40	3	14.3
	41–50	6	28.6
	51–60	5	23.8
	Mean±SD	39.86±11.80	

Position	Block Health Worker (BHW)	9	42.8
	Health Supervisor (HS)	6	28.6
	Health Visitor (HV)	2	9.5
	Pharmacist	2	9.5
	Others (NMA, Ward boy)	2	9.6
Education	8th class	1	4.8
	Intermediate	7	33.3
	Graduation	10	47.6
	Post-graduate	3	14.3
eVIN Experience (years)	1 year	5	23.8
	2 years	7	33.3
	3–10 years	9	42.9
eVIN Training	Trained	21	100.0
	Training venue (District)	21	100.0
	Training duration (2 days)	21	100.0
	Training type (Physical)	21	100.0
CCH Training	Number of trainings (1 time)	11	52.4
	Number of trainings (2 times)	7	33.3
	Number of trainings (3 times)	3	14.3
	Trained in last 3 years	21	100.0

Health worker knowledge and practices demonstrated universal competency, with all handlers able to enumerate freeze-sensitive vaccines and elaborate the shake test procedure (Table 6). System performance was satisfactory, with 95.2% reporting no issues in eVIN execution and only one site (4.8%) experiencing occasional system slowness (Table 6). Back-up cold chain handlers or link persons were available at 85.7% of facilities, and meticulous record maintenance was evident with 95.2% documenting power failures and 100% maintaining defrosting/cleaning records (Table 6). Quality indicators showed perfect compliance, with all sites reporting properly labeled vaccine vials, vaccines within expiry, and usable VVM status (Table 6). Facility standards revealed that 52.4% of sites had separate stabilizers for all ILR and deep freezer units, 85.7% maintained 2–5 functional stabilizers, and 90.5% had no non-functional stabilizers (Table 6).

Table 6. Health Worker Knowledge, Practices, and System Performance Related to eVIN in Unnao District

Knowledge/Practice Component	Status	Frequency (n = 21)	Percentage (%)
Technical Knowledge			
Can enumerate freeze-sensitive vaccines	Yes	21	100.0
Can elaborate shake test	Yes	21	100.0
eVIN System Performance			
Facing issues in eVIN execution	None	20	95.2
Facing issues in eVIN execution	Sometimes slow	1	4.8
Human Resource Support			
Back-up CCH/link person available	Yes	18	85.7
Back-up CCH/link person available	No	3	14.3

Record Maintenance			
Power failure recorded in log book	Yes	20	95.2
Defrosting/cleaning records maintained	Yes	21	100.0
Quality Indicators			
All vaccine vials with readable labels	Yes	21	100.0
All vaccines within expiry	Yes	21	100.0
Usable VVM status (I & II)	Yes	21	100.0
Facility Standards			
Separate stabilizer for ILR+DF	All	11	52.4
Separate stabilizer for ILR+DF	Some	10	47.6
Functional stabilizers (2–5 units)		18	85.7
Non-functional stabilizers (none)		19	90.5

Discussion

The present study findings demonstrate robust cold chain infrastructure and exemplary health worker practices following eVIN implementation in Unnao district, with outcomes that align favorably with national and international benchmarks. The predominant rural distribution of cold chain points (76.2%) in our study reflects the geographical reality of vaccine service delivery in Uttar Pradesh, similar to the pan-India eVIN implementation across 29,000 cold chain points spanning urban and rural areas. Our findings of universal availability of functional large ILRs (100%) and cold boxes (100%) surpass the infrastructure adequacy reported in earlier Indian studies, where Goel et al. [17] documented unsatisfactory maintenance of cold chain equipment in Chandigarh, and Aggarwal et al. [18] reported vaccine carrier shortages in 15% of vaccination clinics in New Delhi. The challenge of intermittent power supply observed in our study, with 76.2% of sites experiencing 8–20 hours daily electricity availability and only 5.0% having functional auto-start generators, mirrors findings from the national cold chain assessment that identified power infrastructure as a persistent bottleneck in India's immunization supply chain. However, the near-universal availability of backup generators (95.2%) in Unnao district represents a substantial improvement over baseline conditions prior to eVIN rollout.

Temperature monitoring practices in our study demonstrated exemplary compliance, with 100% of sites maintaining functional thermometers, separate temperature log books, and twice-daily temperature recording, ensuring optimal vaccine storage within recommended ranges (+2 to +8°C for ILRs and -15 to -25°C for deep freezers). These findings contrast sharply with pre-eVIN assessments in India, where studies in Kolkata by Chatterjee et al. [19] reported temperature readings outside optimal ranges and scarcity of maximum-minimum thermometers at cold chain points. Similarly, a multi-state temperature monitoring study by the National Institute of Epidemiology identified frequent vaccine exposure to sub-optimal temperatures (<0°C or >8°C) at various cold chain levels, highlighting freezing as a critical concern [20]. Our study recorded only one isolated incident of vaccine found in frozen condition (4.8%), suggesting substantial improvement in temperature management following eVIN deployment and health worker training. International evaluations in the UK, Georgia, Canada, Australia, and Ethiopia also documented vaccines exposed to freezing temperatures and suboptimal storage conditions, underscoring cold chain management as a global challenge.

The universal compliance with stock management protocols observed in our study—100% of sites maintaining stock registers, distribution registers, and conducting physical stock counting that matched register entries—validates the effectiveness of eVIN's dual paper-and-web-based management system. These results align with national eVIN assessment reports demonstrating over 99% vaccine availability at cold chain points, 80% reduction in stock-out instances, and improved vaccine wastage control across India. A comparative study by Sharma et al. [6] on the impact of eVIN application in cold chain points similarly reported pivotal improvements in vaccine supply management and stock availability. However, our finding of inadequate supervisory oversight, with only 33.3% of sites reporting District Immunization Officer review of temperature log books in the preceding three months, identifies a critical gap requiring programmatic attention. This supervisory deficit, coupled with 47.6% of sites having at least one CCE non-functional for over one month, suggests that despite technological advances, human resource engagement and accountability mechanisms need strengthening.

Health worker training and knowledge demonstrated universally positive outcomes in our study, with 100% of cold chain handlers receiving standardized 2-day district-level eVIN training and all handlers capable of enumerating freeze-sensitive vaccines and elaborating the shake test procedure. These findings corroborate evidence from multiple studies emphasizing the critical role of on-the-job training in improving knowledge and practices related to vaccine cold chain management. Desta et al., [21] in a systematic review and meta-analysis of health professionals' knowledge on vaccine cold chain management in Ethiopia, found that professionals receiving on-job training were 6.64 times more likely to have good knowledge compared to untrained counterparts. Similarly, Akwaowo et al. [22] reported that health workers trained in vaccine management within the last five years had significantly better knowledge compared to those trained six or more years prior ($p = 0.04735$). Our study's observation of varying CCH training exposure (52.4% trained once, 33.3% twice, 14.3% thrice) suggests opportunities for periodic refresher training to sustain competencies. Studies in Turkey, Yemen, and Malaysia have consistently proven the effectiveness of on-job training in improving health professionals' knowledge and practices, reinforcing evidence-based vaccine handling.

The near-perfect eVIN system performance reported in our study, with 95.2% of handlers experiencing no execution issues and only 4.8% citing occasional slowness, demonstrates successful technology adoption in a district setting. This stands in contrast to initial implementation challenges documented in early eVIN assessments, where infrastructure limitations and network connectivity posed barriers. The availability of backup cold chain handlers or link persons at 85.7% of facilities provides operational resilience, ensuring continuity of vaccine management even during staff absences. However, critical infrastructure gaps persist, notably the complete absence of functional vaccine transport vans (100% sites) and dedicated drivers (95.2% sites), potentially compromising last-mile vaccine delivery efficiency. This finding resonates with the effective vaccine management (EVM) assessment in Gujarat by recent studies, which identified vehicle infrastructure as scoring below WHO-recommended benchmarks despite overall high cold chain performance [23].

The integration of eVIN technology with traditional cold chain practices in Unnao district has yielded measurable improvements in vaccine logistics, temperature control, and health worker competencies, positioning the district favorably within India's Universal

Immunization Programme framework. Our findings of 100% compliance with vaccine labeling, expiry date management, and VVM status monitoring reflect the maturation of quality assurance systems enabled by digital health innovations. These results align with global evidence on digitized supply chains delivering vaccines to the last mile, as documented by eVIN's expansion across all 733 districts of India. The study underscores that while technological interventions such as eVIN are necessary catalysts for cold chain strengthening, sustained performance requires complementary investments in supervision, maintenance infrastructure, transport logistics, and periodic competency-based training for frontline health workers. Future research should evaluate the impact of eVIN implementation on actual immunization coverage rates, vaccine wastage reduction, and adverse events following immunization in Unnao district to establish comprehensive program effectiveness.

Conclusion

This comprehensive assessment of eVIN implementation in Unnao District demonstrates that digital health innovations, when properly integrated with existing immunization service delivery systems, significantly enhance vaccine logistics management, supply chain transparency, and health worker competency. The study documented exemplary cold chain infrastructure, universal compliance with vaccine storage and handling standards, and near-perfect system performance metrics.

However, the identified implementation gaps—including inadequate supervisory oversight, absence of dedicated vaccine transport infrastructure, and limited equipment maintenance facilities—highlight that technology implementation alone is insufficient for optimal program performance. Sustained success requires concurrent investments in strengthening human resource management, enhancing supportive supervision systems, developing transport logistics capacity, and providing periodic competency-based training and refresher programs.

The findings provide evidence-based recommendations for health policy makers and program managers to leverage eVIN's technological capabilities while addressing systemic implementation challenges. As digital health solutions continue expanding globally, Unnao district's experience offers valuable lessons for other resource-constrained settings seeking to strengthen routine immunization services and achieve universal immunization coverage goals through integrated technological and human-resource interventions.

Conflict of Interest

The authors declare no conflicts of interest related to this research study or the institutions mentioned herein.

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Ethical Approval

The present study was approved by ethics committee of the institution, (Ethics Committee of Saraswati Medical College, Unnao). Written permission from CMO (Chief Medical Officer) was also obtained and informed consent was obtained from all study subjects before their participation. Confidentiality of responses was assured, and all measures were taken to protect the identity of the participants.

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Data Availability

The datasets generated and analyzed in the present study are not publicly accessible due to ethical considerations. However, they may be obtained from the corresponding author upon reasonable request and subject to approval from the Government of India.

Author Contributions

Shwetanshu Saxena conceived and designed this study, done data collection and data analysis, and drafted the manuscript. While guide Mr CNV Bharath provided technical guidance on the study design and interpretation of findings. Authors reviewed and approved the final manuscript.

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An Assessment of the Prevalence, Determinants of Viral Hepatitis B and Impact of Infant Vaccine and Circumcision as Preventive Measures in Malawi

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Abstract *Hepatitis B virus is one of the neglected public health diseases leading to deaths in Malawi. However, few studies have examined the burden and factors associated with disease acquisition. The study aimed to assess the prevalence of hepatitis B infection and the factors associated with it in the Malawian population. This retrospective study used secondary data from the scan form register, pulling and analysing data from Jan 2023 to July 2025. Out of 1.9 million total tests, 1.6% (32566) were hepatitis B positive. Hepatitis B burden among males and non-pregnant females was 2.4% (14839/611,970). Males had a higher prevalence of 3% (9,873/334,299) than non-pregnant females at 1.7% (4962/284958). Bivariate analysis showed that males were twice as likely to have hepatitis B compared to females OR = 2, p < 0. 0001. Infant-vaccinated clients were 77% less likely to be infected than the non-vaccinated (OR = 0.3, p < 0.0001). Pregnant women were less likely to be hepatitis B infected than non-pregnant women (OR = 0.8, P < 0.001). The study reveals that hepatitis B is less prevalent than in earlier studies done in Malawi. The Infant Vaccine seems effective in reducing hepatitis B infection among infants who receive this vaccine. Male gender, not being pregnant, and being circumcised increased the risk for hepatitis B infection. Further studies need to be carried out to study the role of circumcision and the association between pregnancy and Viral hepatitis.*

Keywords *Hepatitis B Virus, Infant Vaccine, Pentavalent Vaccine, Scanform Register.*

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Introduction

According to the World Health Organization, viral hepatitis in Africa poses a higher risk of death, surpassing deaths from Malaria, tuberculosis and HIV/Aids, resulting in a significant economic burden through hospitalizations and loss of productive people, which contributes to the socio-economic development of African states. However, despite the seriousness of the disease, data show that the disease is still neglected in many parts of the continent, with a very small proportion of those who need to be treated accessing treatment and vaccines [1].

According to a WHO report (2018), the disease affects 70 million people, of whom 60 million suffer from hepatitis B while 10 million people suffer from hepatitis C infection. Although Hepatitis B infection can be prevented and hepatitis C virus infection (HCV) can be cured, many African countries still show gaps in implementing well-known prevention and treatment strategies [2]. In their study, Lemoine (2017) reports that despite the availability of diagnostic tools and effective treatment, over 90% of people living with hepatitis B and C in Africa lack much-needed care [3]. As a result of the lack of needed health care, about 200 000 people die every year in Africa. These are often among the continent's youngest and middle-aged citizens who would contribute positively to the continent's development. Fewer than 1 in 10 people in Africa have access to testing and treatment, so the disease often progresses to advanced liver disease with its associated huge financial consequences for the families as well as the health care system. In addition to the heavy financial burden on families and the health system, end-stage liver disease causes huge psychological trauma for family members as well as guardians [4]. According to the WHO Global Hepatitis Report, hepatitis B burden was highest in the Pacific region, followed by the African continent, where prevalence was estimated at 6.2% of the population on the continent [5]. In the neighbering countries of Zambia, Mozambique and Tanzania studies in hepatitis B prevalence are scarce except in Tanzania where a meta analysis study showed that prevalence of hepatitis was at 5.9% [6].Vanikoor (2020) states that in Zambia, a study in 12 urban sites and 4 rural sites found a prevalence of 3.7% in the studied population [7]. In Mozambique, one study in Maputo among health workers estimated hepatitis B prevalence at 8.1% of the studied population [8].

Hepatitis B Prevalence Studies in Malawi

Few studies have assessed hepatitis B prevalence in Malawi in recent decades. So far, only three studies have been done: one among students at the College of Medicine in Blantyre and two among the general population. However, these studies were done a long time ago, with one done in 2002 and another in 2004, in which co-infection with HIV was studied. The study found that hepatitis B prevalence was 20% of the samples studied [9]. Participants in this study were sick clients admitted to the hospital, so the results are not generalisable. In the 2002 study done among sugar cane workers, hepatitis B was generalisable. In 16.9% of the participants [10]. However, this was done among people with HIV infection, as in the 2004 study. The earliest study was done 30 years ago, in 1993, where the study was done in rural Shire Valley among HIV positive clients [11]. They found a high prevalence of hepatitis B infection among the participants. However, this study was conducted a long time ago, so the results may not be relevant now, as health systems and demographic dynamics may have changed. Another study among students was conducted in 2014, when first-year students at the College of Medicine were assessed for hepatitis B antigens. The study found that, out of all 213 students, none tested positive for hepatitis B virus [12], but the sample was composed of students only students at the

College of Medicine campus in Blantyre, which was not reflective of the general population, as these were young and based in one geographical location, namely Blantyre city in the Southern part of Malawi [13].

Stockdale (2018) concludes that hepatitis B prevalence is about 8.1 percent of the general population and concludes that Hepatitis B is highly prevalent in Malawi (13). However, they admit a scarcity of epidemiological data from rural areas, where 85% of the population resides. The authors note that no data inform prevalence in rural settings or in the general population. They further recommend that priority research include large-scale, representative community studies to assess the prevalence of hepatitis B, in addition to hepatitis C and others, in Malawi. The aim of the study was to add knowledge regarding hepatitis B burden using the most recent data.

Impact of Hepatitis B vaccine Studies in Malawi

Malawi introduced hepatitis B vaccine for children in 2002 to prevent transmission of hepatitis from their mothers through breastfeeding and other exposures after birth. The weakness of this approach is that intrauterine and perinatal transmission of hepatitis B is not covered by this approach. This is so because the vaccine is only given from 6 weeks after birth when intrauterine and perinatal exposure has already occurred. However, few studies have been carried out to assess the impact of the vaccine in the country. However, despite that we don't not yet have birth dose, infant vaccine offers a potential benefit for those who access it. Therefore, it is still critical to evaluate the impact of the current vaccines in as the results will inform policy on other preventive strategies that are needed to augment the current strategies.

The authors who carried out a meta-analysis to assess the burden of hepatitis in Malawi recommended further studies to evaluate the impact of HBV vaccines for the under-five children, whose impact on the general population is not yet known [13]. So far, only one study has assessed the impact of the infant vaccine in Malawi. The study was conducted in Ndirande township in Blantyre City. In this study, they found that in an urban setting in Blantyre, HBV prevalence among adults born before vaccination started was 5.1%, compared with 0.3% among participants born after the vaccine was introduced across all districts in Malawi [14].

The authors further recommend more similar studies in rural areas. The present study aimed to assess the impact of infant vaccination using large data from across the country.

Circumcision

While hepatitis B virus is a blood-borne disease, it is also considered a sexually transmitted disease because it is also spread through sexual contact through unprotected vaginal, anal and oral sex. While Male Circumcision is known to reduce HIV infection risk by 50%–60% over time and reduces the risk of men acquiring herpes simplex virus-2 and human papillomavirus (HPV), which can cause penile and other anogenital cancers, by 30% there are mixed study findings about the impact of circumcision on hepatitis B infection [15]. Some studies. While there are many studies done on the impact of circumcision on preventing STI, most of the studies have focussed on prevention of HIV, Syphilis, human papilloma virus, gonorrhoea and cervical cancer. Study conducted in Ghana carried out among the university students found that those circumcised had higher risk of hepatitis B infection than those who were not circumcised [16]. A study in Egypt found similar finding that participants who were circumcised while children had a higher risk of hepatitis B infection than those who were not circumcised. The authors hypothesized that the circumcised males were infected during the circumcision itself because of poor hygiene during the procedures. Megan etal found out

that while there was significant reduction of HIV, and other STIs, there was no difference in terms of hepatitis B infection between the circumcised and the non-circumcised [17]. In Malawi no similar studies have been done yet. The present study aimed to assess the impact of male circumcision on the burden of hepatitis B infection in the Malawian context where most of the circumcision was under medical male circumcision program.

Demographic Based burden of Hepatitis B

Like any other disease, certain demographic groups of people are affected disproportionately compared to their counter parts. The study aimed to assess and assess risk of acquiring hepatitis B infection based on gender, pregnancy status, age and circumcision status. An improved understanding of the demographic features and outcomes of chronic HBV infection and hepatitis D virus (HDV) infection may improve prevention, early identification and management both at individual and community levels [18].

The main objective of the study was to define the burden and distribution of the viral hepatitis B infection and to assess the impact of infant vaccines and circumcision as some of the vertically and sexually transmitted diseases preventive public health interventions on viral hepatitis and in the Malawian population. The specific objectives included the following.

1. To assess the viral hepatitis prevalence in the general population in Malawi.
2. To describe the social demographic factors that affect the risk of acquiring viral hepatitis B in Malawi.
3. To assess the impact of hepatitis B vaccination program in Malawi.
4. To analyze the impact of male circumcision on the burden of hepatitis B among the males in Malawi.

Materials and Methods

The study utilized data documented in the Malawi ministry of health register called scan form register where data from all health facilities in Malawi where routine testing for HIV, Hepatitis B and syphilis are recorded. Data from January 2023 to July 2025 was pulled and analyzed using excel. To assess the prevalence rate of hepatitis B in the entire study population sample, prevalence analysis was carried out on the entire collected data. Data for all who tested hepatitis B positive was pulled and used to estimate hepatitis B positivity rate among those who accessed the testing. Secondly prevalence rates within specific socio demographic variables of age, gender, vaccination status, circumcision status, pregnancy status and geographical location was carried out to assess the burden of the diseases within these specific demographic parameters. The number of positive tests was pulled and aggregated for each demographic parameter and used to evaluate the positivity rate within the demographic indicator. Thirdly a bivariate inferential assessment comparing different categories within the demographic factors of gender (Males vs Females), Pregnancy status (Pregnant versus non pregnant), circumcision status (Circumcised Vs non circumcised) Age status (less than 23 years Versus above 23 years was carried out to determine which category was at an increased risk of hepatitis B infection than the other. Medical application using contingency tables was used to assess risk associations and significance of the associations between the categories within the different categories of the demographic factors listed above. To assess statistical significance of the differences in diseases burden within a specific demographic categories, a Z test was used to assess the significance of the associations.

Results

From this data a total of 1.99 million tests were caried out across the country. Of these tests men comprised of 20% (327012) while 80% (1,653,596) were female. Of the females who got the tests, 22% (334299) were non

pregnant while, 78% (1,292,524) were pregnant. Among the men, 34% (112266) were circumcised while 66% (222033) were not circumcised.

Most of the tests were from the southern region at 49% (977502) followed by the central region at 39% (778484). The northern region contributed the least rate at 12% (240139). See Figure 1 below.

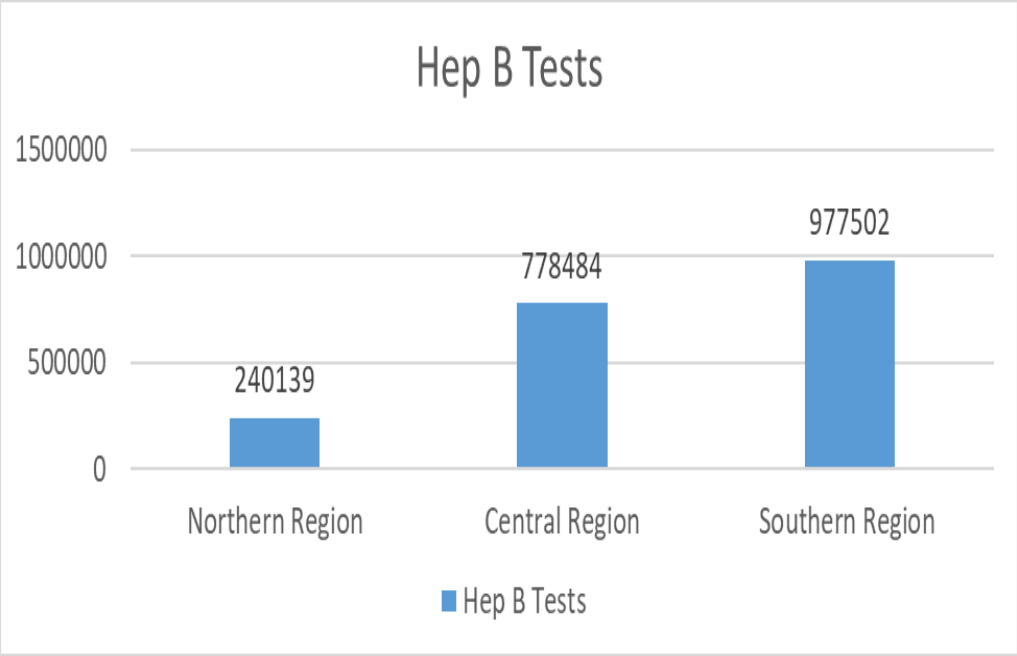


Figure 1. Hepatitis B Testing Numbers by Regions

Diseases Burden

Of all the tests done in the period, 1.6% (32566/1.990,000) tested positive for hepatitis B. After excluding pregnant and breastfeeding females, the prevalence in males and non-pregnant females was 2.4% (14839/611970). This result is significantly lower than the assumed prevalence in the hypothesis. It is also much lower than earlier studies, which reported a Hep B prevalence of 8.1%, according to Stockdale et al. This could be attributed to the introduction of the vaccines in 2002. Secondly, this result may reflect the availability of large datasets that include both rural and urban areas, compared with earlier studies whose data were obtained mainly from urban areas, making their results less representative of the general population. Secondly, most of the earlier studies were done in inpatient settings, resulting in higher prevalence rates.

Disease Burden within Specific Demographic Categories

Although the general population prevalence was lower, there were variations within the specific social demographic variables of age, gender, circumcision status, pregnancy status, as well as regions from where the data were captured, as in Table 1 below.

Table 1. Prevalence of Hep B Demographic Factors and Region of Residence

Table of Test Results for Various Demographic Groups				
Parameters	**All tests**	**Positive**	**Negative**	**HBV Rate (%)**
All	1,988,786	32,566	1,956,220	1.6
Non-Pregnant women and Males	611,970	14,835	597,136	2.4

Men	327,012	9873	317,139	3.0
Circumcised Males	112,266	3596	108670	3.2
No Circumcised Females	222,033	6,277	215756	2.8
Females	1,653,596	22680	1,630,916	1.4
Pregnant women	1,292,524	16261	1,276,271	1.3
Non-Pregnant women	284,958	4,962	279,997	1.7
Northern region	240,139	3367	236772	1.4
Central Region	778,484	11596	766888	1.5
Southern Region	977,502	17747	959755	1.8
Not Vaccinated (Born before 2002)	944,239	24938	919301	2.6
Vaccinated (Born after 2002)	1,044,037	7614	1,036,423	0.7

Prevalence by Gender

Hepatitis B prevalence was higher in males at 3% (9,873/334,299), while in females 1.4% (22,680/1,653,596) were tested positive for hepatitis B virus. Meaning that men have a higher burden of hepatitis B compared to females. Based on pregnancy status, the prevalence among the non-pregnant was higher at 1.7% (4,962/284,9580) while the prevalence rate was 1.3% (16261/1,292,524) among the pregnant women. See Table 1.

Prevalence by Pregnancy

Based on pregnancy status, the prevalence among the non pregnant was higher at 1.7% (4,962/284,9580) while the prevalence rate was 1.3% (16261/1,292,524) among the pregnant women. This was surprising, as the expectation was that there would be a higher prevalence rate among the pregnant women than the non-pregnant women because pregnancy indirectly indicate recent unprotected sexual exposure which is one of the risk factors for hepatitis B infection. See Table 1.

Circumcision Status

There was a higher prevalence rate among the circumcised as compared to the non-circumcised clients. The prevalence among the circumcised was 3.2% (3596/112,266), while it was 2.8% (6,277/222,033) among the non circumcised clients. This was also unexpected result as expected outcome was that prevalence among the circumcised would be lower compared to the circumcised men because like in HIV, male circumcision protects from HIV infection. But these results reveal the opposite that male circumcision was associated with higher prevalence. See Figure 2.

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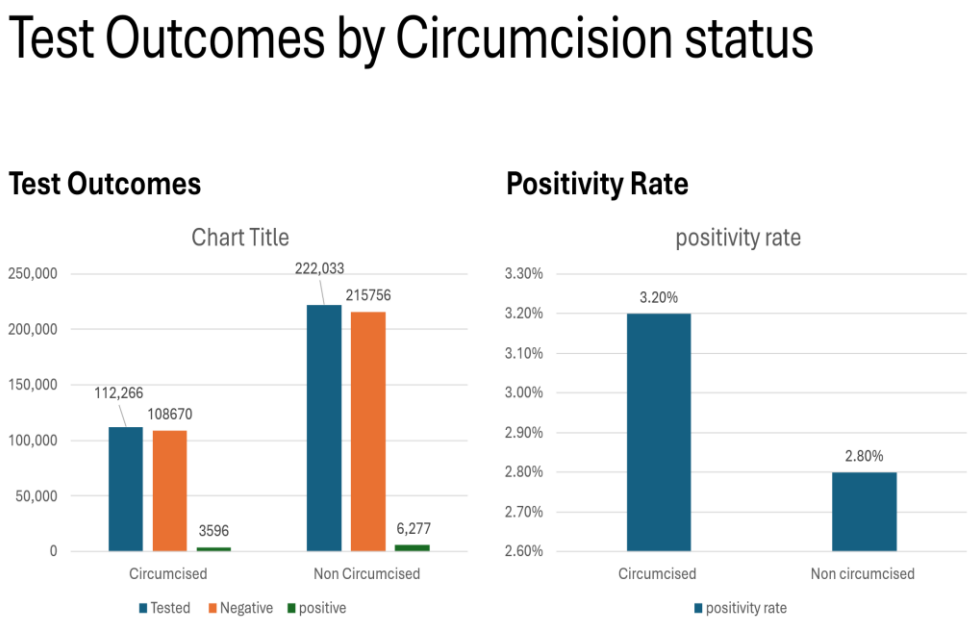


Figure 2. Test Outcomes by Circumcision Status

Vaccination

The study used age as a proxy for vaccination with the pentavalent vaccine -A vaccine that is given to infants after they are born. Since the pentavalent vaccine was introduced in Malawi in 2002, the study assumed all clients born before 2002 were not vaccinated, and all those born after 2002 were vaccinated.

Analysis of hepatitis B prevalence by vaccination status, using age as a proxy for vaccination, showed much lower prevalence among those born after 2002 than among those born before vaccination started. Among those born after 2002 (vaccinated), hepatitis B prevalence was 0.7% (714/104,403), compared with 2.6% (24,938/944,239) among those who were born before 2002 (not vaccinated)

Risk Analysis

The study used inferential statistical analyses to assess whether certain categories of social demographic factors were associated with a higher risk of acquiring hepatitis B virus. A bivariate analysis was carried out, and the results are shown in Table 2 below.

Table 2. Bivariate Analysis for Demographic Factors

Bivariate Analysis comparing demographic factors							
	Positive	**Negative**	**Total**	**Odds**	**Z test**	**95% CL**	**P Value**
Pregnant	16261	1,276,271	1,292,524	0.7	20.179	0.6963 to 0.7424	<0.0001
Non-Pregnant	4,962	279,997	284,958				
Circumcised	3596	108670	112,266	1.1	6.062	1.0910 to 1.1858	<0.0001
Non-Circumcised	6,277	215756	222,033				
Males	9873	317,139	327,012	2.2	65.988		<0.0001

Females	22680	1,630,916	1,653,596			2.1857 to 2.2929	
Not vaccinated (Born before 2002)	24938	919301	944,239		99.178	0.2639 to 0.2779	<0.0001
Vaccinated (Born after 2002)	7614	1,036,423	1,044,037	0.27			

Gender

Gender comparison showed that males were 2 times as likely to have hepatitis B as compared to females (OR = 2, CI 2.0894-2.2909, p < 0.0001). This statistically significant result shows that males, partly due to higher risk-taking behaviour, have an increased risk of acquiring Hep B compared with their female counterparts (Table 2).

Vaccination Status (Pentavalent)

The study found that vaccinated clients were 78 percent less likely to have hepatitis than unvaccinated clients (OR = 0.2708, CI = 0.2639–0.2779, P < 0.0001). This means the vaccine, namely Pentavalent, significantly reduces hepatitis B infection, preventing over 80% of vaccinated individuals from acquiring hepatitis B virus (Table 2).

Circumcision Status

Contrary to expectations, the results revealed that males who were circumcised were at a statistically significant increased risk of contracting hepatitis than those who were not circumcised (OR = 1.1, CI: 0.10910–1.1858, P = 0.0001). This could be attributed to the confidence gained as a result of being circumcised, resulting in some men engaging in more unprotected sex than those not circumcised. Secondly, this could be because most of the clients who are circumcised come from the southern region, where prevalence is higher than in the other two regions.

Pregnancy Status

The study compared the hepatitis B risk between those who are pregnant and those not pregnant, with the assumption that those who are pregnant may have been at an increased risk for acquiring hepatitis than those who are not pregnant. The study revealed that pregnant women had a statistically significant reduced risk of acquiring hepatitis B infection compared to the non-pregnant women (OR = 0.7190, 95% CI: 0.6963–0.7424, P = <0.001)

Vaccination Status

The prevalence among those who were vaccinated was lower (0.70%) than among those who were not vaccinated (2.60%) in the study population. In terms of risk analysis, the vaccinated had a 73% lower risk of acquiring hepatitis B infection than those who were not vaccinated. The prevalence among those who were vaccinated was lower (0.70%) than among those who were not vaccinated (2.60%) in the study population. In terms of risk analysis, the vaccinated had a 73% reduction in the risk of acquiring hepatitis B infection compared with those who were not vaccinated (OR = 0.2708, CI: 0.2639–0.2779, P < 0.0001). See figure 2.

Results

Odds ratio	0.2708
95 % CI:	0.2639 to 0.2779
z statistic	99.178
Significance level	P < 0.0001

Figure 6. Bivariate Risk Analysis comparing the Vaccinated and those not Vaccinated

The figure shows that those who were vaccinated had a 73% reduction in Hep B infection compared with those who were not vaccinated. This was statistically significant.

Discussion

General Prevalence

The prevalence (1.6%) of hepatitis B in the general population is much lower than in earlier studies, where hepatitis B prevalence was estimated at 8.1% and 5.1%, respectively [18, 19]. Earlier studies in Malawi agree with a similar study in Tanzania, where hepatitis B prevalence was estimated at 6.9%, with variations by region [6]. The present prevalence results may be lower than those in earlier studies because the other recent study was a meta-analysis that pooled data from prevalence studies whose participants were selected from self-selected population groups, such as in-patient participants and participants from urban communities. These are clients who were already sick and were coming from urban areas of Blantyre and Lilongwe, where the populations are dense, hence predisposed to a higher chance of acquiring hepatitis B infection. The results from the present study are similar to the most recent results from a study in Zambia, where prevalence was 3.7% in communities across 12 urban centers and 4 rural areas [7]. The results from the present study present the most accurate picture, as they come from large data generated across the country, including urban and rural areas. These results are also in agreement with the WHO estimates, which project that the country has a 2.7% prevalence rate [20].

Circumcision Status

There was a higher prevalence among the circumcised compared to the non-circumcised at 3.4 % and 2.8%, respectively. These results were statistically significant (OR = 1.1, CI: 1.0910−1.1858, $p < 0.001$). This result is surprising as the expectation was that circumcision provides some protective effect on hepatitis transmission. This is in agreement with another study in Ghana which found that hepatitis B was 4 times higher in the circumcised college students compared to those not circumcised [16]. While the study in Ghana assumed the circumcised participants had a higher prevalence of hepatitis B due to the possibility of poor hygiene during circumcision as the community in Ghana does traditional circumcision, which runs the risk of not being done in medically hygienic conditions, the case is different in this study as the data used in this is study was a mixture of medically circumcised and those with traditional circumcision . A study done by Meghan etal found that while circumcision had a protective effect on HIV and Syphilis, it had no impact on hepatitis B transmission [17]. Further studies need to be carried to assess the impact of circumcision on hepatitis in Malawi.

Gender

The study found that the prevalence of hepatitis was higher in men than women, with a prevalence of 1.4% in the study population.

This inferential analysis finding shows that males are 2 times likely to acquire hepatitis B infection than females (OR = 2, CI: 2.0894–2.2909, p < 0.0001). These results are in agreement with findings in the Chiwindi study, where they found a higher prevalence in males (5.1%) than in females (3.4%) of the studied population [19]. Although the trend is similar, the current study found a lower prevalence in both males and females than in the former study. The difference could be partly due to the impact of the infant vaccine (Pentavalent), which includes the hepatitis B vaccine, given to all infants born after 2002, when the vaccine was introduced in Malawi. No known study has been done in Malawi to assess the risk based on gender for hepatitis B infection. More studies are needed in this area.

Infant Vaccination (Pentavalent Vaccine)

The prevalence among those who were vaccinated was lower (0.70%) than among those who were not vaccinated (2.60%) in the study population. In terms of risk analysis, the vaccinated had a 73% reduction in risk of acquiring hepatitis B infection compared with those who were not vaccinated (OR = 0.2708, CI: 0.2639–0.2779, P < 0.0001; Figure 2). This shows that the vaccine, introduced in Malawi in 2002, has a significant protective effect among recipients. These results agree with another study by J Stockdale, which found a 96% reduction rate among those accessing the infant vaccine compared with those not vaccinated [14]. This slight difference in effectiveness may be because the other study was conducted in an urban setting with good access to health services, whereas the present study included participants from rural communities where access to health services, including vaccines, may be more challenging than in urban settings. Further studies are needed in Malawi to ascertain the impact of the vaccine.

Pregnancy Status

The study found that pregnant women had a 30% lower risk of acquiring hep B infection than non-pregnant women (OR = 0.7190, 95% CI: 0.6963–0.7424, P < 0.001). This result is paradoxical in that it is expected that pregnant women would be at an increased risk due to their compromised immune status because of being pregnant, and secondly, by virtue of being pregnant, an indication that they are sexually active and hence more prone to Hep B infection, which is mostly transmitted through unprotected sex, than those women who are not pregnant. This result could be because pregnant women were younger and therefore more likely to have received the infant vaccine, compared with non-pregnant women who may be older and not have received the infant vaccine in addition to having prolonged exposure to sex by virtue of being older. More studies need to be done to understand why pregnant women were at a reduced risk for hepatitis B infection as compared with non-pregnant women.

Conclusion

The study findings show that hepatitis B prevalence is generally lower than in most previous studies in Malawi. This may be partly due to infant vaccination, which started in Malawi over 20 years ago. Secondly, the data in the present study are based on large data pulled across the country, combining urban and rural settings. This provides a more accurate picture of the burden of hepatitis B in Malawi. However, males gender, circumcised men, and non-pregnant women seem to have a higher prevalence and increased risk of getting hepatitis infection female gender, non-circumcised males and pregnant women respectively. There is need for increased awareness among men and non-pregnant women on how to prevent hep B infection. More studies need to be carried out to understand the role of circumcision in prevention of hepatitis B infection.

Conflict of Interest

The authors have no conflict of interest in this work.

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Authors' Contribution

Prof Giuseppe Liotta – Assisted with reviewing and updating the research proposal, data analysis, and interpretation of the results. He also supported manuscript writing for publication.

Haswel Jere – Responsible for study conceptualization and implementation, data analysis and interpretation, and writing the publication.

Ethical Approval

The research proposal was submitted to the National Ethics Committee in December 2025. I am currently waiting for approval. The proposal was resubmitted after amendments based on feedback from the ethics committee.

Funding

The student self-funded the study.

Data Availability

Data from which the results was derived can be assessed from Malawi Scan register with permission from the Ministry of Health at https://auth.scanform.hiv.health.gov.mw/realms/malawi-hts-scale/protocol/openid-connect/auth?approval_promp

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Availability and Functionality of Infection Prevention and Control Systems in Health Facilities Providing TB and COVID-19 Services in Plateau State, Nigeria

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Abstract *Nigeria continues to face the challenge of emerging and resurgence infectious diseases, including tuberculosis (TB) and coronavirus disease 2019 (COVID-19). Healthcare facilities can inadvertently facilitate transmission of these pathogens due to frequent interactions among patients, visitors, and healthcare workers. Strengthening infection prevention and control (IPC) systems is therefore essential to improve health system resilience and advance progress toward universal health coverage. This cross-sectional facility-based study assessed the status of IPC programmes using the World Health Organization Infection Prevention and Control Assessment Framework (IPCAF). Trained field staff administered the IPCAF tool across selected health facilities to evaluate performance across the core components of IPC programmes. Data collected from each facility were compiled in Microsoft Excel and analyzed using IBM SPSS version 25. We assessed a total of thirty health facilities. Overall IPC performance was predominantly at the basic level, with an average score of 41.5%. Some facilities demonstrated intermediate capacity in specific areas such as staffing and infrastructure; however, none achieved an advanced level of IPC performance. These findings highlight significant gaps in IPC implementation across the assessed facilities. Strengthening IPC policies, systems, and institutional capacity is therefore critical. National disease control programmes should prioritize targeted interventions to improve and sustain IPC practices across healthcare facilities in order to reduce the risk of healthcare-associated transmission of infectious diseases.*

Keywords *COVID-19, IPC, Nigeria, Plateau State, Tuberculosis, World Health Organization Infection Prevention Assessment Framework.*

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Introduction

Nigeria, like many countries, faced the concurrent burden of tuberculosis (TB) and COVID-19 between 2020 and 2023. Both are transmitted primarily through airborne or respiratory droplets and contribute substantially to morbidity and mortality [1, 21]. The overlap in transmission dynamics underscores the critical importance of robust infection prevention and control (IPC) systems. Effective implementation of IPC measures is central to reducing transmission in healthcare facilities and other congregate settings [7]. IPC frameworks guide health institutions in adopting proactive, evidence-based strategies to interrupt the spread of infectious pathogens [27].

These strategies include administrative, environmental, and personal protective interventions aimed at minimizing transmission of Mycobacterium tuberculosis and other respiratory pathogens [9]. Beyond TB and COVID-19, IPC practices also play a broader role in preventing healthcare-associated infections, strengthening laboratory biosafety, limiting antimicrobial resistance, and improving preparedness for emerging and re-emerging infectious diseases [6, 11]. Strengthened IPC systems therefore represent a foundational component of resilient health systems and epidemic preparedness [12, 26].

The global health landscape is increasingly shaped by emerging and re-emerging infectious diseases [2, 10]. Tuberculosis (TB), a longstanding infectious disease, continues to persist and re-emerge in various forms, including drug-resistant strains [5]. More recently, coronavirus disease 2019 (COVID-19), first identified in Wuhan, China, has further underscored health systems' vulnerability to novel respiratory pathogens [13]. Both TB/MDR and COVID-19 primarily affect the respiratory system and are associated with substantial morbidity and mortality worldwide [3, 11].

Inadequate infection prevention and control (IPC) practices contribute significantly to the transmission of these infections, particularly within healthcare settings [8]. Although IPC is widely recognized as a core health system strengthening strategy, global evidence indicates persistent gaps in its implementation across countries and income levels [22]. Barriers to effective IPC adherence include organizational constraints, environmental limitations, and individual factors among health workers. In Nigeria, previous assessments have similarly documented suboptimal implementation of IPC measures across different tiers of healthcare delivery [14].

Healthcare facilities are high-risk environments for respiratory infection transmission because of frequent interactions among patients, visitors, and health workers [16, 18]. TB, caused by the Mycobacterium tuberculosis complex, and COVID-19, caused by SARS-CoV-2, exemplify pathogens that can spread efficiently in such settings [15, 17]. Strengthening IPC systems is therefore critical not only to mitigate TB and COVID-19 transmission, but also to address healthcare-associated infections, antimicrobial resistance, and future public health threats, in line with the International Health Regulations [24].

This study therefore undertook a rapid appraisal of IPC practices across primary, secondary, and tertiary health facilities in Plateau State, Nigeria. Plateau State was purposively selected due to its experience with both TB and COVID-19. The objectives were to:

1. Assess the status of IPC core components across levels of care.
2. Identify strengths and gaps in implementation.
3. Generate aggregate weighted performance scores and classify facilities according to World Health Organization IPC performance categories (inadequate, basic, intermediate, or advanced).

4. Propose context-specific recommendations [25].

Methodology

Setting and Study Population

Plateau State is located in North Central Nigeria with a projected population of 5,273,387 (WHO State Office, 2026) and a total land mass of 8,000 square kilometers. The State is divided into 17 Local Government Areas (LGAs), which are further grouped into three senatorial districts, namely, Plateau North, Plateau Central and Plateau South for the purpose of political representation in the upper chamber in the Nigerian National Assembly. Health care services are delivered through a network of 724 public and 556 registered private health facilities. The former comprises 696 primary health care facilities, 26 secondary and 2 tertiary hospitals, while the private facilities include 484 PHC facilities, 70 secondary and 2 tertiary hospitals. In all, 31 health facilities met the selection criteria: 6 primary health facilities; 21 secondary and all four tertiary health facilities in the state. However, one secondary facility (i.e., Nigeria Air Force Hospital, Jos) did not participate because the authority did not grant permission. These facilities were spread across the LGAs as follows, as shown in Figure 1 below.

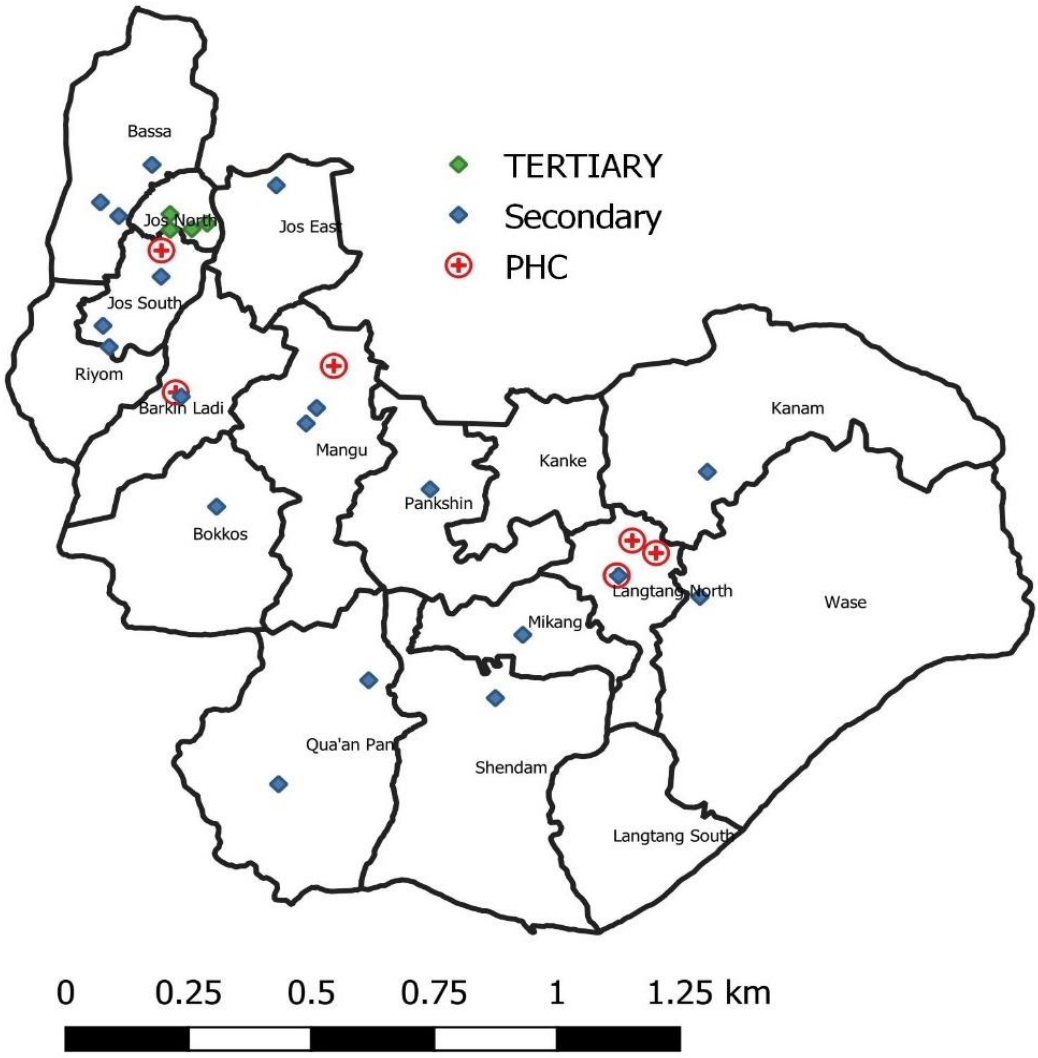


Figure 1. Map of Plateau State Showing the Local Government Areas (LGAs) and the Spatial Distribution of Selected Health Facilities in the LGAs

Source: Extract from Dr Samuel Ogiri Ogiri, PhD Dissertation, 2026 [23].

Research Design

The study was a descriptive cross-sectional study. The WHO Infection Prevention and Control Assessment tool at the health facility level (IPCAF), a structured and closed-format questionnaire, was administered to the IPC staff in the selected facilities along the eight core components of the WHO IPC programmes, comprising: IPC guidelines; IPC education and training; healthcare-associated infection surveillance; multi-modal strategies; monitoring/audit of IPC practices and feedback; workload, staffing and bed occupancy; and built environment, materials and equipment for IPC and a total of 81 indicators [25].

Exclusion/ Inclusion Criteria

Health facilities were purposively selected based on the provision of both TB and COVID-19 services; co-location of IPC measures with either focal persons and/or committees was also considered. A total of thirty-one health facilities met the inclusion criteria. Facilities that met the inclusion criteria but could not obtain ethical clearance from management were excluded.

Comparative Statistical Analysis

This study employed Analysis of Variance (ANOVA) to determine whether significant differences existed among PHFs, SHFs, and THFs across the IPC core components. These results provided statistical validation of performance disparities between facility levels, particularly in programme-related components such as the IPC programme, guidelines, and education and training. The statistical testing notation can be described as follows:

Let the average IPC (Infection Prevention and Control) performance scores for the three types of healthcare facilities be:

$$\bar{X}_{1i} mean\ IPC\ score\ for\ Primary\ Health\ Facilities\ (PHFs)$$

$$\bar{X}_{2i} = mean\ IPC\ score\ for\ Secondary\ Health\ Facilities\ (SHFs)$$

$$\bar{X}_{3i} = mean\ IPC\ score\ for\ Tertiary\ Health\ Facilities\ (THFs)$$

Their corresponding population means are denoted by: μ_1, μ_2, μ_3

To test whether IPC performance differs significantly across facility types, the hypotheses were stated as:

$$H_0: \mu_1 = \mu_2 = \mu_3$$

$$H_1: At\ least\ one\ \mu_i \neq \mu_j\ for\ some\ i \neq j$$

ANOVA Test Statistic

The one-way ANOVA F-statistic was calculated as:

$$F_{cal} = \frac{MS_B}{MS_W} = \frac{SS_B/(k-1)}{SS_W/(N-k)}$$

where:

- SS_B: between-group sum of squares (variation between facility types),
- SS_W: within-group sum of squares (variation within each facility type),
- k: number of facility groups here, $(k = 3)$,
- N: total number of observations.

Decision rule: At a 5% significance level i.e., $\alpha = 0.05$, if $F_{cal} > F_{tab,}$ reject the null hypothesis H_0 otherwise fail to reject the H_0. Alternatively, a result with $p < 0.05$ indicates that the difference in mean IPC performance across facility types is statistically significant

Sampling Techniques

Multistage sampling methods were adopted, using the three senatorial districts—Plateau North, Plateau Central, and Plateau South. Afterward, convenient sampling was used to select primary health facilities, and simple random sampling was used for secondary health facilities. All tertiary health facilities were included in the study except one where consent for ethical clearance was not obtained.

Data Collection/ Analysis

Trained field staff administered the IPCAF tool at each health facility, focusing on the core components of IPC programs. Data collected

from each facility were entered into a database and analyzed using IBM SPSS version 25. Deployed IPCAF tools were pretested and validated before field application. Descriptive analysis tools were used to summarize and interpret facility-level data

Expected Output

The research will help to achieve the following:

1. Determine the status of IPC components at the different levels of health care, i.e., primary, secondary, and tertiary health facilities in Plateau State.
2. Identify performance and gaps in the implementation of each of the core components of IPC programmes in the health facilities.
3. Determine aggregate weighted performance scores for each facility and the proportion of health facilities that meet the WHO differentiated levels of IPC performance, namely, inadequate, basic, intermediate and/or advanced.
4. Make appropriate recommendations based on the findings from the research.

Results

Table 1, (23) indicates overall bed space, staff strength across facility categories and total thirty health facilities assessed across Plateau State, comprising 6 (20%) Primary Health Facilities (PHFs), 20 (67%) Secondary Health Facilities (SHFs), and 4 (13%) Tertiary Health Facilities (THFs). PHFs had a total combined number of 91 (5%) beds and 62 staff, secondary facilities had the largest bed capacity (1,096 beds, 60%) and 480 staff, and tertiary facilities reported 648 (35%) beds and the largest workforce (721 staff). The distribution reflects the dominance of SHFs (67%) in the sample, followed by PHFs (20%) and THFs (13%). The number of bed spaces aligns generally with the scope and complexity of services delivered by the various tiers of health and clinical services with the PHC being relatively smaller than the secondary and thence to the tertiary facilities. Similarly, the human resource distribution as captured in table 3 shows that the tertiary health facilities have higher numerical and skilled human resources because of the capacity of services they offer: this is coterminous with their role as referral centers for specialized and complex care.

Table 1. Summary of Participated Facilities

	PHFs	**SHFs**	**THFs**	**Total of Beds**
No. of Health facilities (%)	6 (20%)	20 (67%)	4 (13%)	
No. of beds in Male ward	39	379	359	784
No. of beds in Female ward	39	479	241	759
Total No. of Beds	91	1096	648	1835
Total No. of Staff	62	480	721	1,263

Source: Extract, Data Analysis from Dr Samuel Ogiri Ogiri, PhD Dissertation, 2026, [23].

Table 2 below presents (23), the distribution of bed spaces, staff strength, and IPC training status across the different wards of the PHFs, SHFs, and THFs. Overall, the PHFs had a total of 91 beds, with the medical ward (38 beds) and pediatric ward (29 beds) accounting for the majority of wards at PHFs. Isolation capacity was very limited, with only 5 beds distributed across the six PHFs, while the surgical (6 beds), accident and emergency (9 beds), and obstetrics and gynecology wards (4 beds) had minimal representation. No psychiatric services were available at the PHFs.

At SHFs, The medical (461 beds) and surgical (258 beds) wards accounted for the largest capacity, supported by 150 and 144

staff, respectively. Importantly, both wards had some IPC-trained personnel (56 and 52 staff), reflecting progress compared to Primary Health Facilities (PHFs). Isolation wards were also present, with 63 beds and 33 staff, of whom 11 were trained in IPC. Pediatric wards (120 beds, 68 staff) reported a relatively stronger IPC coverage, with 43 trained staff, while obstetrics and gynecology wards (160 beds, 54 staff) had 15 trained staff.

For THFs, Medical wards accounted for the largest capacity, with 225 beds and 186 staff, including 48 trained in IPC. Surgical wards (116 beds, 119 staff) and obstetrics and gynecology wards (93 beds, 152 staff) also represented major service areas, though IPC training coverage remained limited, with only 8 and 16 trained staff respectively. Pediatric wards (87 beds, 126 staff) revealed critical vulnerability, with only one staff member trained in IPC despite the large patient base. Isolation wards (35 beds, 30 staff) had six trained staff, showing modest preparedness for managing infectious cases. Accident and Emergency (A&E) wards (46 beds, 107 staff) had no IPC-trained staff, representing a major risk given the high turnover of emergency cases. Psychiatric wards (46 beds, 1 staff) also lacked any IPC-trained personnel.

In terms of staffing, the medical ward had the largest number of personnel (43 staff), followed by pediatrics (16 staff). However, across all wards, no staff had received any training on infection prevention and control (IPC). This represents a significant performance gap with regards to the WHO minimum requirements, which emphasize the need for all health workers to receive basic IPC training [27]. The absence of trained personnel, particularly in high-risk areas such as emergency, surgical, and isolation wards, underscores the vulnerability of PHFs in preventing healthcare-associated infections (HAIs) and other highly infectious and epidemic diseases [26].

SHFs by contrast, psychiatric wards (24 beds, 6 staff) had no IPC-trained personnel, representing a significant gap in mental health service readiness. Accident and Emergency (A&E) wards, despite being critical entry points, had only 10 beds and 25 staff, with 12 trained in IPC. Overall, while SHFs demonstrated better infrastructure and higher levels of IPC training compared to PHFs, coverage remained uneven, with notable weaknesses in psychiatric, isolation, and emergency services.

Table 3 below shows that IPC training coverage was uneven across wards and remained insufficient. While SHFs recorded the highest absolute number of trained staff (189), this represented only about 39% of their workforce. THFs, despite having the largest staff numbers, had only 79 IPC-trained personnel (11%), with entire units such as Accident & Emergency and psychiatry lacking trained staff. PHFs had no trained personnel in any ward. These findings underscore that training has not kept pace with infrastructural and staffing growth, leaving significant gaps in IPC readiness, particularly at the frontline level.

Still, Table 3 (23) shows a consistent gradient of improvement in average IPC component scores across facility levels.

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Table 2. Health Facility Bed Capacity and IPC Training by Ward

Ward	PHF Male Beds	PHF Female Beds	PHF Total Beds	PHF Staff	PHF IPC Trained	SHF Male Beds	SHF Female Beds	SHF Total Beds	SHF Staff	SHF IPC Trained	THF Male Beds	THF Female Beds	THF Total Beds	THF Staff	THF IPC Trained
Isolation Ward	1	2	5	0	0	48	44	63	33	11	25	14	35	30	6
Surgical	3	3	6	0	0	120	133	258	144	52	82	64	116	119	8
Medical	20	18	38	43	0	174	243	461	150	56	137	118	225	186	48
Psychiatric	0	0	0	0	0	6	4	24	6	0	0	0	46	1	0
Pediatric Ward	8	10	29	16	0	16	21	120	68	43	72	6	87	126	1
Obstetrics & Gynaecology	0	4	4	3	0	15	34	160	54	15	30	36	93	152	16
Accident & Emergency	7	2	9	0	0	0	0	10	25	12	13	3	46	107	0

Source: Extract, Data Analysis from Dr Saamuel Ogiri Ogiri, PhD Dissertation, 2026

1. **Programme-related components:** IPC programme (12.5% → 38.1% → 68.0%), IPC guidelines (10.8% → 49.4% → 70.0%), education and training (6.7% → 33.5% → 56.3%), and multimodal strategies (11.7% → 26.3% → 51.3%) all improved steadily from PHFs to SHFs to THFs. This indicates progressive institutionalization of IPC systems with increasing facility complexity. The ANOVA test result for IPC programme ($p = .0001 < 0.01$) confirms that the differences across the three levels are statistically significant.
2. **Surveillance-related components:** HAI surveillance showed comparable results at PHFs (45.0%) and SHFs (41.3%), with stronger performance at THFs (57.0%). This suggests that surveillance systems are functional but remain underdeveloped at lower tiers.
3. **Monitoring and audits:** This remained the weakest domain across all tiers, with PHFs (10.0%) and SHFs (33.6%) scoring poorly, and THFs (28.8%) performing only marginally better. These results reflect a system-wide gap in quality assurance and accountability.
4. **Structural components:** Workload, staffing, and bed occupancy improved steadily (48.3% → 58.8% → 67.8%), as did built environment, materials, and equipment (52.3% → 54.7% → 64.4%). These findings indicate that structural readiness is progressively stronger at higher levels but is not effectively leveraged due to weak training and monitoring.

The study further shows (23) that the weighted performance classifications are as follows:

1. PHFs were predominantly rated inadequate, with minimal progress in surveillance, staffing, and infrastructure, and total absence of training and programme systems.
2. SHFs performed mostly at the basic level, with moderate gains in guidelines, training, and surveillance, and intermediate performance in staffing and infrastructure.
3. THFs achieved largely intermediate performance, with improvements across programme, guidelines, training, surveillance, and infrastructure. However, monitoring and audits with feedback remained only at the basic level.

This tiered pattern confirms clear progression: PHFs (inadequate) → SHFs (basic) → THFs (intermediate), but none attained the advanced level required by WHO.

Table 3. Average IPC Component Scores across the PHFs, SHFs, and THFs

	PHFs	**SHFs**	**THFs**	**Anova P-value**
1. IPC programme	12.5	38.1	68.0	0.0001 < 0.01
2. IPC guidelines	10.8	49.4	70.0	
3. IPC education and training	6.7	33.5	56.3	
4. HAI surveillance	45.0	41.3	57.0	
5. Multimodal strategies	11.7	26.3	51.3	
6. Monitoring/audits of IPC practices and feedback	10.0	33.6	28.8	
7. Workload, staffing and bed occupancy	48.3	58.8	67.8	
8. Built environment, materials, and equipment for IPC at the facility level	52.3	54.7	64.4	

Source: Extract, Data Analysis from Dr Samuel Ogiri Ogiri, PhD Dissertation, 2026, [23].

Discussions

Infection Prevention and Control constitute evidence-based policies and practices to minimize infection transmission in the community and in health care settings [19]. These guidelines focus mainly on the hierarchy of IPC: administrative, engineering, and personal protection [20]. However, in light of emerging and re-emerging epidemics, pandemics, and the need for a more effective response to healthcare-associated infections and antimicrobial resistance (AMR), WHO introduced and updated guidelines on Core Components of Infection Prevention and Control Programmes at the National and Acute Health Care Facility Level [10, 24].

As described earlier, this tool provides a standardized format, which has been validated and proved reliable for the assessment of a complex intervention like the WHO IPC core components and has become an effective tool for the improvement of IPCAF at the health facility levels. Again, the IPCAF tool was successfully used at the global, national and health facility levels with robust outcomes [25]. In the light of the foregoing, the IPCAF tool was adopted for our study and to the best of knowledge and understanding, neither this tool nor this type of study have conducted in any health facility in Plateau State.

Facility Selection and Characterization

The study was a cross-sectional study conducted in 30 health care facilities across Plateau State in North Central Nigeria. These facilities comprised of 6 primary care facilities (4 public and 2 faith-based), 20 secondary health facilities (a military and non-governmental, 5 faith-based and 13 public cottage/general hospitals) and all the four tertiary health facilities (2 public and 2 faith-based). The status of implementation of IPC programmes across these facilities seems to vary with the functional and infrastructural capacities of these facilities. The distribution reflects the dominance of SHFs (67%) in the sample, followed by PHFs (20%) and THFs (13%). Compared to the other levels of health care, the scope of services, including the co-location of IPC programmes, was limited to the six primary health care facilities selected; hence, the few PHCs involved in the assessment. More so, any attempt to balance the number of health facilities will introduce bias because the inclusion criterion was quite specific. The tertiary health facilities are the apex of care and usually more expansive in the provision of diagnostic and clinical services hence their limited number compared to the primary and secondary health facilities [4]. However, all the four tertiary facilities in the States were selected

Availability and Functionality IPC Programme Implementation across the PHF, SHF, and THF in Plateau State, Nigeria

The overall analysis reveals that IPC implementation in Plateau State is characterized by a structural–functional imbalance. While the state has moderate infrastructure, adequate bed distribution, and relatively sufficient staffing, these advantages are undermined by limited IPC training, weak programme structures, underdeveloped multimodal strategies, and the absence of monitoring and auditing mechanisms [25].

In effect, IPC performance across the state remains largely at the basic level, with isolated intermediate strengths in staffing and infrastructure. No facility level or IPC domain has attained advanced performance. This underscores the urgent need for state-wide interventions to:

1. Expand IPC training coverage across all cadres, especially in high-risk units.
2. Institutionalize functional IPC programmes and ensure dissemination of guidelines.
3. Strengthen multimodal strategies to embed sustainable practices.

4. Establish robust monitoring, audit, and feedback systems to support continuous quality improvement.

Primary Health Facilities (PHFs) in Plateau State are critically underprepared to implement infection prevention and control (IPC) in line with WHO minimum requirements. Bed and staffing capacities are modest, with most resources concentrated in medical and pediatric wards, while isolation, surgical, emergency, and obstetric services remain poorly equipped. Crucially, none of the staff across all wards had received IPC training, representing a major gap in compliance, and leaving both patients and healthcare workers exposed to preventable risks of healthcare-associated infections [25].

The weighted performance scores further reveal that the majority of IPC components, namely IPC programme, guidelines, education and training, multimodal strategies, and monitoring/audits, are at inadequate levels, confirming the absence of functional programmes, structured guidelines, and institutionalized systems [25]. Two components, HAI surveillance and workload/staffing/bed occupancy, attained only basic performance, suggesting that rudimentary systems exist but remain underdeveloped and inconsistently applied. Only the built environment, materials, and equipment reached the intermediate level, reflecting some infrastructural readiness that, however, cannot substitute for the absence of functional systems and capacity-building [25].

Overall, these results highlight a profound imbalance between structural resources and functional IPC implementation at the PHF level. While some infrastructure and staffing capacity exist, a lack of trained personnel, institutional programmes, and systematic monitoring means PHFs cannot deliver safe and effective IPC [25]. This underscores the urgent need to strengthen IPC governance, provide structured staff training, disseminate guidelines, and establish routine monitoring mechanisms in order to reduce HAIs and enhance outbreak preparedness at the primary healthcare level in Plateau State.

The weighted performance scores for secondary health facilities (SHFs), illustrate the overall status of IPC implementation. Six of the eight IPC core components, namely IPC programme, guidelines, education and training, HAI surveillance, multimodal strategies, and monitoring/audits, were rated at the basic level, indicating that minimum systems are in place but remain underdeveloped [25]. Only two components, workload/staffing/bed occupancy and built environment, materials, and equipment, reached the intermediate level, reflecting moderate strength in infrastructure and staff resources. None of the components achieved the advanced level of performance.

The results for SHFs show that facilities are better resourced and have made some progress in IPC implementation, particularly in medical, surgical, and pediatric wards. However, IPC performance remains concentrated at the basic level, with no component reaching advanced status [22]. Structural aspects such as infrastructure and staffing are moderately adequate, but functional dimensions, including programmes, guidelines, training, multimodal strategies, and monitoring, remain weak. This imbalance indicates that while SHFs have laid some foundations for IPC, they fall short of WHO's minimum requirements. Strengthening institutional frameworks, scaling up staff training, establishing systematic surveillance, and embedding multimodal strategies will be essential for achieving sustainable IPC practices at the secondary care level [25].

The weighted performance scores for tertiary health facilities (THFs) confirm that seven of the eight IPC components, including IPC programme, IPC guidelines, IPC education and training, HAI surveillance, multimodal strategies, workload/staffing, and built environment, achieved intermediate performance [25]. This shows that tertiary facilities have developed functional structures and systems but have not yet attained advanced

maturity. Monitoring and audits with feedback remained at the basic level, reflecting a lack of routine evaluation and systematic feedback mechanisms. Importantly, no component achieved advanced performance, underscoring that THFs are still below WHO's minimum benchmarks for IPC [25].

The results from the THFs demonstrate that tertiary facilities possess the high level of IPC readiness the tertiary health facilities in Plateau State. They are supported by stronger infrastructure, higher staffing levels, and partially institutionalized IPC programmes and guidelines [22]. However, the absence of widespread IPC training across wards, especially in Accident and Emergency, pediatric, and surgical services, represents a major gap [27]. While most IPC domains were rated as intermediate, the persistent weakness in monitoring and audits with feedback underscores the lack of continuous evaluation and corrective mechanisms. The absence of advanced performance across all components highlights that THFs, although better resourced, are still not fully compliant with WHO's minimum IPC standards [25]. To strengthen IPC implementation, tertiary facilities must expand staff training, consolidate surveillance systems, and institutionalize robust monitoring and feedback processes to ensure sustainable infection prevention and control [25].

Overall, Plateau State demonstrates incremental progress in IPC implementation but remains below WHO's minimum standards, highlighting critical areas for policy and programmatic strengthening.

Conclusions

This study is the first to assess the availability and functionality of IPC at the facility level in Plateau State. The study has helped to identify strengths, gaps, and opportunities for improvement. Patients' safety and quality of care continue to be affected by the growing burden of HAI and AMR. This can hamper the achievement of Universal health coverage. There is a need to strengthen the development, enforcement, monitoring and leadership for IPC implementation, especially at the health facilities, by policymakers and decision-makers in health.

Conflict of Interest

The Authors declare that there is no conflict of interest.

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Ethical Approval

Ethical clearance was collected from the Ethical Review Board Plateau State Ministry of Health to cover the primary health care and secondary health facilities while the Ethical Review Boards of each of the four tertiary health facilities provided ethical clearance for the research. The tertiary health facilities include Bingham University Teaching Hospital (BUTH), Jos University Teaching Hospital (JUTH), Our Lady of Apostle (OLA) Specialist Hospital and Plateau State Specialist Hospital (PSSH), all located in Metropolitan Jos. The

Ethical Clearance from the Ministry of Health and Tertiary health facilities are all attached in.

Authors Contributions

Samuel Ogiri Ogiri conceptualized the study and developed the methodology. Data collection and analysis were conducted by Sunday Agbochenu Aboje, Shadrach Dimang, Gonen Lakda, and Emmanuel John Azi. Samuel Ogiri Ogiri prepared the original draft of the manuscript. Opeyemi Emmanuel contributed to manuscript review and editing. Olusoji Daniel and Amitabye Luximon-Ramma provided overall supervision. All authors reviewed and approved the final version of the manuscript and agreed to be accountable for its content.

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Data Availability

The datasets generated and/or analysed during this study are available in the IPC Analysis workbook repository at: https://docs.google.com/spreadsheets/d/1WExOiKWrLsNrMMJoOi5GKjABOfjzC_E_/edit?gid=736495188#gid=736495188

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Assessing Preparedness of Ghanaians for Future Infectious Disease Outbreaks: COVID-19 Experience

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Abstract *The COVID-19 pandemic exposed preparedness gaps and reinforced the role of individual and household behaviours in preventing infectious disease transmission. This study assessed preparedness for future outbreaks among adults in Ghana, using lessons from the COVID-19 experience. A community-based cross-sectional mixed-method study was conducted among 1,307 adults in six districts across the Ashanti, Greater Accra, and Savannah regions, using purposive and cluster sampling. Data were collected with a semi-structured questionnaire covering socio-demographic characteristics, knowledge, attitudes, preventive practices, access to health services, and health information sources. Preparedness was measured using a composite knowledge, attitudes, and practices (KAP) score. Quantitative data were analysed using descriptive statistics, multivariate regression, and mediation analysis, while qualitative responses were examined using deductive thematic content analysis. Respondents demonstrated moderate preparedness, with preventive practices stronger than disease-specific knowledge. Reported behaviours included COVID-19 vaccination (70%), LLIN use among children (91%) and adults (87%), handwashing with soap and water (70%), rabies vaccination for dogs (94%), mask use and avoidance of sick people during outbreaks (60%), health facility visits when sick (75%) and keeping essential supplies for at least 72 hours (52%). Preparedness seemed associated with sex, residence, access to vaccines, LLINs and health facilities, and credible health information, which may have mediated socio-demographic influences. Persistent gaps included vaccine safety concerns, LLIN use, reporting of unusual health events, and access to hygiene facilities and preventive resources. Strengthening health literacy, trusted risk communication, community engagement, and equitable access to routine preventive services may improve preparedness for future infectious disease outbreaks.*

Keywords *Attitude, Ghana, Household Preparedness, Knowledge, Outbreak, Practices.*

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Introduction

Infectious disease epidemics remain a challenge to health, economic stability, and social systems worldwide. In 2018, WHO warned that although the timing and location of the next pandemic could not be ascertained, its cost would likely be severe for both human life and the global economy [1]. This prediction was realized with the COVID-19 outbreak in 2020, resulting in a pandemic and exposing major weaknesses in health systems and preparedness strategies worldwide. Globally, at least 779 million confirmed COVID-19 cases and 7.1 million fatalities have been reported by March 2026 [2]. Africa was hit by over 9.5 million cases and more than 175,000 deaths, with Ghana recording 173,000 cases and 1,500 deaths during the same period [2].

The COVID-19 pandemic is frequently compared to the 1918 Spanish influenza pandemic because of its widespread health, social, and economic consequences [3]. Beyond its immediate impacts, the COVID-19 pandemic highlighted the critical importance of preparedness at the individual, community, and health system levels. While governments and international organizations implemented interventions such as surveillance, vaccination, physical distancing, hand hygiene, and mask use to control transmission [4], these measures depended largely on public acceptance and adherence [5-7].

Preparedness for infectious disease outbreaks extends beyond institutional readiness and includes individuals' capacity to recognize risk, adopt routine preventive behaviours, seek timely healthcare, and respond appropriately during health emergencies. In this study, preparedness refers to individual and household-level readiness reflected through knowledge, attitudes, preventive practices, and intended responses to future infectious disease outbreaks. Knowledge encompasses understanding of epidemic-prone diseases, symptoms, transmission, prevention, and reporting, while attitude reflects willingness to vaccinate, report disease, follow restrictions, and trust health authorities. Preventive practices refer to actual preventive behaviours such as food and hand hygiene, vaccination, LLIN use, PPE use and reporting of strange events or when sick. This study focused on vaccination (humans and animals), LLIN use (vector-borne diseases), hand and food hygiene, infection control (use of PPEs, handwashing with soap and water), participation in community activities, and adherence to outbreak control measures.

Evidence from previous outbreaks shows that knowledge, risk perception, trust in health authorities, and access to credible information influence public compliance with health interventions [8-10]. In Sub-Saharan Africa, the COVID-19 pandemic contributed to greater adoption of preventive behaviours, including hand hygiene, mask use, and vaccination uptake. However, these behavioural gains have not always been translated into sustained improvements in disease knowledge or overall preparedness [11-13]. In Ghana, existing studies have largely examined public awareness, risk perceptions, vaccination acceptance, and behavioural responses during the COVID-19 pandemic, with limited attention to how these experiences have shaped preparedness for future outbreaks and the factors influencing it [14-17]. The Health Belief Model provides a useful framework for understanding preparedness behaviours [18]. The model proposes that individuals are more likely to adopt protective actions when they perceive themselves to be susceptible to a health threat, believe the consequences are serious, recognize the benefits of preventive actions, and receive cues that motivate behaviours [8-21]. Exposure to credible health information may therefore influence preparedness by improving knowledge, shaping risk perceptions, and encouraging preventive practices. The Learned Resourcefulness Theory [35], which postulates coping skills, self-control, and adaptive

behaviour following an experience, also provides useful constructs on individual preparedness behaviours.

Materials and Methods

Study Site

This study was carried out in two districts per the Savannah, Greater Accra, and Ashanti regions of Ghana. The Ashanti region is located in the tropical rain forest, the Savannah region in the Guinea Savannah, and the Greater Accra Region in the Coastal belt. We selected the districts with the highest and lowest confirmed cases for each area [22-25]. Thus, Ayawaso West Municipality and Ada East were chosen for Greater Accra. We selected West Gonja and North Gonja districts in the Savannah Region, and Kumasi Metropolitan and Adanse Akrofuom districts in the Ashanti Region.

Study Design and Population

A community-based cross-sectional survey using purposive selection of study districts and cluster sampling of households was conducted between August and September 2025 [26]. This follows five years after the COVID-19 pandemic and that all intensive preventive and control activities had waned down. The cross-sectional design was appropriate for assessing the levels of preparedness and associated factors at a single point in time. Interviews were conducted at the household level with 1307 individuals who were at least 18 years.

Inclusion and Exclusion Criteria

Eligible participants were adults aged 18 years and above who were resident in the selected communities during the COVID-19 pandemic and provided informed consent. Individuals who were unable to communicate effectively because of severe illness, or cognitive impairment or not present during the pandemic at the time of the survey were excluded.

Data Collection and Study Instruments

The semi-structured questionnaire was developed from published literature on knowledge, attitudes, and practices related to epidemic-prone diseases and outbreak preparedness. It was aligned with the study objectives and covered disease awareness, transmission, symptoms, preventive behaviours, care-seeking, vaccination, household readiness, health information sources, and willingness to follow public health measures during future outbreaks.

Public health and epidemiology experts assessed the questionnaire for face and content validity. The team pretested it with 30 adults from non-study communities to assess clarity, sequencing, translation, understanding, administration time, and field feasibility. Pretest findings informed revisions to wording, skip patterns, and question order before final data collection.

Data were collected using the finalized semi-structured questionnaire, which captured both quantitative and qualitative information on individual and household preparedness for future infectious disease outbreaks. The 89-item tool included closed- and open-ended questions in three areas: socio-demographic and household characteristics; knowledge, attitudes, and practices on outbreak prevention and response; and mediating factors such as access to health information, vaccines, insecticide-treated nets, water and hygiene facilities, health services, and domestic animals or pets.

Household-level interviews were conducted with eligible adults aged 18 years and above in the selected communities. Trained data collectors administered the questionnaire face-to-face in a language understood by the respondent after explaining the purpose of the study, confirming eligibility, and obtaining informed consent. Open-ended responses were recorded verbatim or as closely as possible, particularly for COVID-19 experiences, vaccination concerns, household preparedness,

barriers to preventive behaviours, and intended actions during future outbreaks.

Statistical Analysis

Stata version 18 was used to enter, clean, and analyze the data (StataCorp, College Station, TX, USA). The socio-demographic characteristics were summarized using descriptive statistics, where continuous variables were shown as means and standard deviations and categorical variables as frequencies and percentages.

For each of the domains knowledge, attitudes, and practices, the respective questions were scored '0' for the wrong response and '1' for the appropriate one to questions about epidemic-prone diseases, risk perception, healthcare seeking behaviour, and preventive practices. The total score for each was obtained by summing the constituent responses/variables. The preparedness score was obtained by generating a composite sum of all three domains. These were converted to the percentage scale by dividing the total score obtained by the highest possible score after accounting for conditional totals where present. The mean scores (on the percentage scale) were then computed across the various sociodemographic and mediating variables, stratified by the regions. Pearson's chi-square tests were used in bivariate analyses to reveal relationships between preparedness and sources of health information and socio-demographic characteristics. To identify the independent predictors of preparedness, variables score significant at $p < 0.05$ were added to a multivariate linear regression model. The results included 95% confidence intervals and adjusted regression coefficients. To determine if sources of health information (e.g. Ministry of Health, healthcare professionals, media platforms, and social media) affected the relationship between socio-demographic factors and preparedness, mediation analysis was further carried out. The threshold for statistical significance was established at $p< 0.05$. Deductive thematic content analysis using a framework approach was used for qualitative data and the findings were integrated with quantitative results to explain or contextualize the statistical findings.

Results

Socio-demographic Characteristics

About 55.7% of respondents were females, and the mean age of 31.9 (Std =11.3) and an average household size of 4.7 (Std=2.8) was reported. We observed 33.5% of respondents had attained tertiary education, 77.7% had an active National Health Insurance (NHIS) card and 32.4% sourced pipe-borne water (Table 1).

Table 1. Description of Socio-demographic Characteristics of Respondents across Study Areas

	Region, N (%)			
	Ashanti	**G. Accra**	**Savannah**	**Total**
	434 (33.2)	439 (33.6)	434 (33.2)	1,307 (100.0)
Heard of the COVID-19 outbreak				
No	2 (0.5)	8 (1.8)	8 (1.8)	18 (1.4)
Yes	432 (99.5)	431 (98.2)	425 (97.9)	1,288 (98.5)
Don't know	0 (0.0)	0 (0.0)	1 (0.2)	1 (0.1)
Sex				
Male	172 (39.6)	174 (39.6)	233 (53.7)	579 (44.3)
Female	262 (60.4)	265 (60.4)	201 (46.3)	728 (55.7)
Residence				

Urban	204 (47.0)	157 (35.8)	74 (17.1)	435 (33.3)
Peri-urban	66 (15.2)	43 (9.8)	2 (0.5)	111 (8.5)
Rural	164 (37.8)	239 (54.4)	358 (82.5)	761 (58.2)
Age (years)				
<20	28 (6.5)	43 (9.8)	8 (1.8)	79 (6.0)
20–29	195 (44.9)	233 (53.1)	136 (31.3)	564 (43.2)
30–39	103 (23.7)	107 (24.4)	166 (38.3)	376 (28.8)
40–49	67 (15.4)	37 (8.4)	81 (18.7)	185 (14.2)
50–59	26 (6.0)	11 (2.5)	19 (4.4)	56 (4.3)
60+	15 (3.5)	7 (1.6)	15 (3.5)	37 (2.8)
Marital Status				
No response	5 (1.2)	0 (0.0)	9 (2.1)	14 (1.1)
Single, Never Married				
living with family	198 (45.6)	177 (40.3)	72 (16.6)	447 (34.2)
not living with family	47 (10.8)	131 (29.8)	32 (7.4)	210 (16.1)
Married, living with a family with				
one spouse	139 (32.0)	106 (24.1)	254 (58.5)	499 (38.2)
more than one spouse	24 (5.5)	13 (3.0)	40 (9.2)	77 (5.9)
Divorced	9 (2.1)	2 (0.5)	8 (1.8)	19 (1.5)
Separated	6 (1.4)	7 (1.6)	10 (2.3)	23 (1.8)
Widowed	6 (1.4)	3 (0.7)	9 (2.1)	18 (1.4)
Religion				
No response	0 (0.0)	1 (0.2)	5 (1.2)	6 (0.5)
Christianity	398 (91.7)	396 (90.2)	102 (23.5)	896 (68.6)
Islam	34 (7.8)	38 (8.7)	325 (74.9)	397 (30.4)
Traditional religion	2 (0.5)	4 (0.9)	2 (0.5)	8 (0.6)
Highest education completed				
Never attended school	36 (8.3)	11 (2.5)	113 (26.0)	160 (12.2)
Primary	32 (7.4)	26 (5.9)	50 (11.5)	108 (8.3)
JHS/JSS	87 (20.0)	92 (21.0)	76 (17.5)	255 (19.5)
SHS/SSS	98 (22.6)	134 (30.5)	114 (26.3)	346 (26.5)
Tertiary	181 (41.7)	176 (40.1)	81 (18.7)	438 (33.5)
Mean (SD)				
Age (years)	32.3 (12.1)	28.6 (10.0)	34.9 (10.9)	31.9 (11.3)
No. of people living in household	4.4 (2.6)	4.3 (2.6)	5.3 (3.1)	4.7 (2.8)

Table 2 presents respondents' knowledge on diseases with epidemic potentials and symptoms. Majority of respondents indicated COVID-19 (79.3%) and cholera/diarrhoea (35%) as diseases with highest epidemic potentials. While cough (56.4%) and fever 45.1%) as the most symptoms mentioned. Table 3 reveals respondents' knowledge on transmission and prevention of diseases.

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Table 2. Knowledge on Diseases with Epidemic Potential and Symptoms

	Region, N (%)			
	Ashanti	**G. Accra**	**Savannah**	**Total**
	434 (33.2)	439 (33.6)	434 (33.2)	1,307 (100.0)
Diseases or conditions with epidemic potential				
None	1 (0.2)	0 (0.0)	1 (0.2)	2 (0.2)
COVID-19	397 (91.5)	285 (64.9)	355 (81.8)	1,037 (79.3)
Cholera/Diarrhoea	139 (32.0)	166 (37.8)	153 (35.3)	458 (35.0)
Yellow Fever	38 (8.8)	21 (4.8)	91 (21.0)	150 (11.5)
Meningitis	35 (8.1)	13 (3.0)	78 (18.0)	126 (9.6)
Ebola	83 (19.1)	37 (8.4)	72 (16.6)	192 (14.7)
Influenza	22 (5.1)	7 (1.6)	24 (5.5)	53 (4.1)
Monkey Pox	89 (20.5)	24 (5.5)	49 (11.3)	162 (12.4)
Chicken Pox	48 (11.1)	21 (4.8)	41 (9.4)	110 (8.4)
Dengue fever	8 (1.8)	2 (0.5)	7 (1.6)	17 (1.3)
Measles	31 (7.1)	17 (3.9)	54 (12.4)	102 (7.8)
Polio	27 (6.2)	10 (2.3)	29 (6.7)	66 (5.0)
Anthrax	9 (2.1)	4 (0.9)	13 (3.0)	26 (2.0)
Rabies	15 (3.5)	5 (1.1)	2 (0.5)	22 (1.7)
Zika virus	8 (1.8)	4 (0.9)	0 (0.0)	12 (0.9)
Marburg	7 (1.6)	1 (0.2)	4 (0.9)	12 (0.9)
Chikungunya	0 (0.0)	2 (0.5)	1 (0.2)	3 (0.2)
Leishmaniasis	1 (0.2)	2 (0.5)	0 (0.0)	3 (0.2)
Don't know	9 (2.1)	72 (16.4)	29 (6.7)	110 (8.4)
Signs and symptoms diseases/conditions mentioned above normally present				
None	1 (0.3)	0 (0.0)	1 (0.3)	2 (0.2)
Fever	180 (57.5)	91 (27.1)	158 (52.1)	429 (45.1)
Cough	239 (76.4)	107 (31.8)	191 (63.0)	537 (56.4)
Shortness of breath	115 (36.7)	100 (29.8)	109 (36.0)	324 (34.0)
Difficulty breathing (severe)	108 (34.5)	84 (25.0)	120 (39.6)	312 (32.8)
Tiredness/fatigue	53 (16.9)	110 (32.7)	76 (25.1)	239 (25.1)
Loss of taste or smell	76 (24.3)	66 (19.6)	94 (31.0)	236 (24.8)
Vomiting	33 (10.5)	120 (35.7)	67 (22.1)	220 (23.1)
Jaundice	8 (2.6)	9 (2.7)	13 (4.3)	30 (3.2)
Runny or blocked nose	12 (3.8)	72 (21.4)	69 (22.8)	153 (16.1)
Sore throat	64 (20.4)	30 (8.9)	21 (6.9)	115 (12.1)
Aching body/muscle pain/myalgia	12 (3.8)	18 (5.4)	10 (3.3)	40 (4.2)
Itching body	11 (3.5)	13 (3.9)	8 (2.6)	32 (3.4)
Headache	83 (26.5)	69 (20.5)	64 (21.1)	216 (22.7)
Conjunctivitis	1 (0.3)	4 (1.2)	6 (2.0)	11 (1.2)
Diarrhoea	20 (6.4)	104 (31.0)	50 (16.5)	174 (18.3)
Bleeding from the nose, ears, mouth	19 (6.1)	6 (1.8)	29 (9.6)	54 (5.7)
Skin rashes	11 (3.5)	10 (3.0)	10 (3.3)	31 (3.3)

Sudden paralysis	3 (1.0)	3 (0.9)	0 (0.0)	6 (0.6)
Others	0 (0.0)	6 (1.8)	1 (0.3)	7 (0.7)
Don't know	4 (1.3)	5 (1.5)	7 (2.3)	16 (1.7)

Table 3. Knowledge on Spread and Prevention of Diseases with Epidemic Potential

	Region, N (%)			
	Ashanti	**G. Accra**	**Savannah**	**Total**
	434 (33.2)	439 (33.6)	434 (33.2)	1,307 (100.0)
How disease of epidemic potential mentioned previously are spread/transmitted?				
Coughing, sneezing, spitting or speaking	270 (86.3)	147 (43.8)	230 (75.9)	647 (68.0)
Drinking contaminated water	54 (17.3)	130 (38.7)	71 (23.4)	255 (26.8)
Eating contaminated food	46 (14.7)	117 (34.8)	69 (22.8)	232 (24.4)
Bite of animals like dogs, cats	7 (2.2)	13 (3.9)	14 (4.6)	34 (3.6)
Eating sick or dead animals	14 (4.5)	15 (4.5)	14 (4.6)	43 (4.5)
Contact with infected animals or its parts	29 (9.3)	21 (6.2)	34 (11.2)	84 (8.8)
Bite of mosquitoes	10 (3.2)	2 (0.6)	15 (5.0)	27 (2.8)
Through contaminated hands by touching contaminated surfaces	89 (28.4)	116 (34.5)	85 (28.1)	290 (30.5)
Through unprotected sexual intercourse	5 (1.6)	5 (1.5)	3 (1.0)	13 (1.4)
Transfusing contaminated blood	3 (1.0)	5 (1.5)	12 (4.0)	20 (2.1)
Other	0 (0.0)	4 (1.2)	5 (1.7)	9 (0.9)
Don't know	6 (1.9)	6 (1.8)	10 (3.3)	22 (2.3)
How disease of epidemic potential mentioned previously is prevented in a community				
Wash hands with soap and water before eating	245 (78.3)	232 (69.0)	187 (61.7)	664 (69.7)
Wash hands with soap and water after using the toilet	155 (49.5)	179 (53.3)	142 (46.9)	476 (50.0)
Wash hands with soap and water when you return to the house	145 (46.3)	166 (49.4)	122 (40.3)	433 (45.5)
Vaccinate people against diseases (vaccine preventable diseases)	152 (48.6)	123 (36.6)	107 (35.3)	382 (40.1)
Sleeping under LLINs/ITNs	18 (5.8)	6 (1.8)	17 (5.6)	41 (4.3)
Conducting residual spraying (outdoor and indoor)	15 (4.8)	8 (2.4)	7 (2.3)	30 (3.2)
Using window screens, door screens	12 (3.8)	2 (0.6)	4 (1.3)	18 (1.9)
Wear protective clothing-like nose mask	140 (44.7)	48 (14.3)	93 (30.7)	281 (29.5)
Drink safe (treated) water	30 (9.6)	63 (18.8)	22 (7.3)	115 (12.1)
Eat food prepared under hygienic condition	34 (10.9)	66 (19.6)	18 (5.9)	118 (12.4)
Avoid eating meat from dead or sick animals	17 (5.4)	17 (5.1)	7 (2.3)	41 (4.3)

Vaccinate animals (domestic and livestock) against diseases	11 (3.5)	11 (3.3)	6 (2.0)	28 (2.9)
Remove stagnant water to avoid breeding sources for mosquitoes	2 (0.6)	9 (2.7)	2 (0.7)	13 (1.4)
Wear protective clothes to avoid insect (mosquito) bites	12 (3.8)	7 (2.1)	4 (1.3)	23 (2.4)
Apply repellents to exposed skin	4 (1.3)	5 (1.5)	2 (0.7)	11 (1.2)
Clear bushes around dwellings	4 (1.3)	3 (0.9)	5 (1.7)	12 (1.3)
Practice personal hygiene (bathing, use washed clothes and beddings)	22 (7.0)	20 (6.0)	25 (8.3)	67 (7.0)
Others	1 (0.3)	4 (1.2)	3 (1.0)	8 (0.8)
Don't know	7 (2.2)	2 (0.6)	15 (5.0)	24 (2.5)

More than two-thirds of the respondents mentioned infectious disease spread through droplet nuclei and airborne like cough, sneezing, spitting and indicated handwashing, vaccination and wearing protective clothing as preventive measures.

Sources of Health Information

Almost two-thirds of respondents reported receiving health education during the COVID-19 pandemic and continue to receive an average of three times yearly. The mass media (TV, Radio) accounted for 59.8%, followed by doctors or healthcare workers (43.2%) and social media (31.5%) (Figure 1). Moreover, respondents reported that the knowledge they received helped them secure their families and themselves.

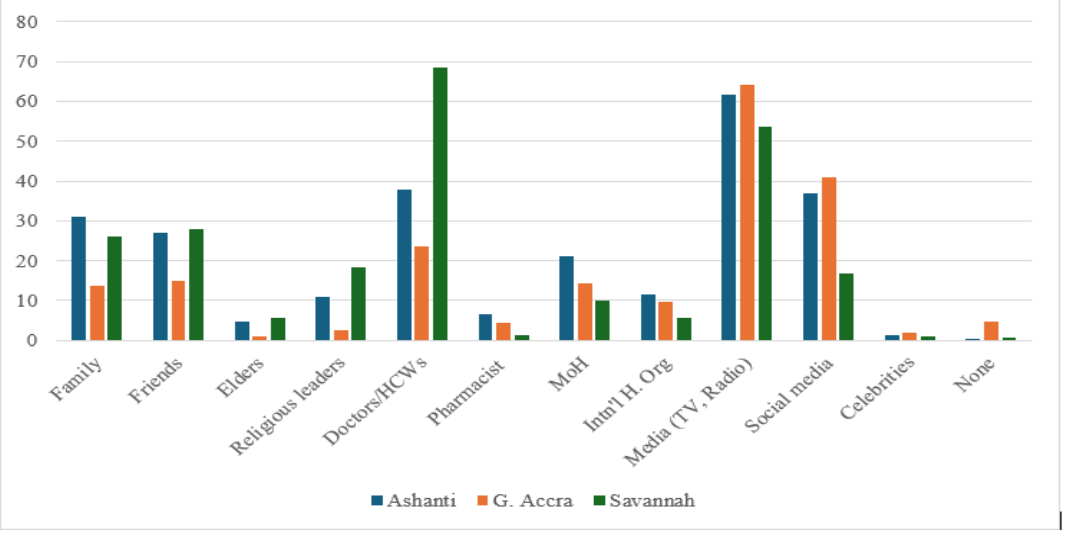


Figure 1. Sources of Respondents COVID-19 Health Education across the Study Areas

Key: Ministry of Health (MoH); Healthcare workers (HCWs); International Health Organization (Intn'l Org).

Concerns and Actions towards Potential Future Epidemic

Respondents demonstrated moderate concern and readiness towards a future outbreak. About 50.4% expressed concern about themselves or family members contracting a disease, and majority (79.3%) were comfortable visiting health facilities for care. Mask-wearing (53.2%), keeping a physical distance (46.6%), staying indoors (44.4%), and staying away from infected people (39.8%), among others. One participant

summed his concern as *"During that time there was no gatherings even if a relative passed on you couldn't bury and even if you're allowed to bury your dead you cannot perform the funeral"*. Based on knowledge gained during COVID-19, nearly 50% of respondents said they were confident in their ability to protect themselves. Nonetheless, 22.8% of respondents said that purchasing precautionary supplies was costly. Respondents mentioned community-level actions such as alerting local authority (34.7%), staying indoors (20%), as well as minimizing contact with ill people (20.1%) to prevent the spread of the disease. Even though 43.4% of respondents said they were prepared to report instances of unusual events, a comparable proportion (43.9%) were uncertain on what to do (see Table 4) below.

Table 4. Community Risk to Potential Future Outbreaks across Regions

	Region, N (%)			
	Ashanti	**G. Accra**	**Savannah**	**Total**
	434 (33.2)	439 (33.6)	434 (33.2)	1,307 (100.0)
Action that will be taken if a strange disease/condition among people or animals in the community is suspected				
Stay at home	92 (21.2)	138 (31.4)	32 (7.4)	262 (20.0)
Keep away from people or warn people against the strange disease	62 (14.3)	138 (31.4)	63 (14.5)	263 (20.1)
Inform the local health authority	94 (21.7)	155 (35.3)	205 (47.2)	454 (34.7)
Inform the local government or traditional authorities	23 (5.3)	74 (16.9)	43 (9.9)	140 (10.7)
Go to a hospital or health centre	298 (68.7)	140 (31.9)	265 (61.1)	703 (53.8)
Contact the state health hotline (Surveillance unit)	34 (7.8)	32 (7.3)	25 (5.8)	91 (7.0)
Pray or go to my religious leader for prayers	11 (2.5)	15 (3.4)	10 (2.3)	36 (2.8)
Other	0 (0.0)	13 (3.0)	0 (0.0)	13 (1.0)
Don't know	24 (5.5)	27 (6.2)	13 (3.0)	64 (4.9)
Readiness of people in community to share information about strange diseases/conditions with authorities				
No	63 (14.5)	49 (11.2)	54 (12.4)	166 (12.7)
Yes	201 (46.3)	159 (36.2)	207 (47.7)	567 (43.4)
Don't know	170 (39.2)	231 (52.6)	173 (39.9)	574 (43.9)

Individual Infectious Disease Preventive Practices

With 69.6% of adults vaccinated against COVID-19 and 50.7% against yellow fever, respondents indicated moderate routine vaccination uptake among adult population. However, a worrying expression of vaccination-related problems were noted, such as beliefs regarding infertility 38%, fear and anxiety 10.6%, and side effects concerns 22.2%, and could be the reasons for vaccine refusal. One respondent expressed the following *"People were having misconceptions about the covid-19 vaccine, that you can't conceive, men might be impotent when they take the vaccine"*. Another respondent also said this *"I remember people saying they didn't believe covid-19 existed, and that the vaccine was brought to harm us"*.

High levels of malaria prevention practices were observed as 91.7% of respondents reported that their children slept under insecticide bed nets and 86.1% of adults slept under the insecticide bed net the previous night. One respondent was emphatic about the need to sleep under mosquito net. *"Sleeping under LLIN will prevent us from malaria, keeping our surroundings clean will also prevent us from sickness"* The research revealed that mosquito repellent 55.5%, spray 60.5% and protective gear 44.8% were additional preventive measures. Respondents also demonstrated good knowledge of proper maintenance of insecticide bed nets. Hand hygiene practices were high among the respondents (84% generally practice handwashing with soap and water and 89% wash their hands with soap and water before eating) 60% of the participants use hand sanitizer. Moderate observations on water and food hygiene practices were revealed: 59% drink treated water, 60% avoid eating undercooked food and 72% wash fruits and vegetables before eating. Among the 258 dog-owing participants, 95% had vaccinated their dogs against rabies. About 50% of the respondents have essential supplies for at least 72 hours to keep them going should there be a crisis (outbreaks/pandemic) as shown in Table 5.

Table 5. Infectious Disease Preventive Practices

	Region, N (%)			
	Ashanti	**G. Accra**	**Savannah**	**Total**
	434 (33.2)	439 (33.6)	434 (33.2)	1,307 (100.0)
COVID-19 vaccination	258 (59.4)	292 (66.5)	359 (82.7)	909 (69.5)
Yelow Fever vaccination	176 (40.6)	135 (31.1)	333 (76.7)	647 (49.5)
Sleep under treated bed nets (LLINs)-Adults	353 (81.3)	384 (87.5)	388 (89.4)	1,125 (86.1)
Sleep under treated bed nets (LLINs)- Children	365 (84.1)	421 (95.9)	411 (94.7)	1,197 (91.6)
Wash hands with soap and water before eating	381 (87.8)	418 (95.2)	365 (84.1)	1,164 (89.1)
Practice hand washing with soap and water	401 (92.4)	330 (75.2)	375 (86.4)	1,106 (84.6)
Often practice the use of hand sanitizer	335 (77.2)	240 (54.7)	212 (48.8)	787 (60.2)
Drink safe and portable (treated water)	254 (58.5)	273 (62.2)	239 (55.1)	766 (58.6)
Avoid eating under cooked food or meat	273 (62.9)	271 (61.7)	241 (55.5)	785 (60.1)
Wash fruits and vegetables before eating	313 (72.1)	354 (80.6)	275 (63.4)	942 (72.1)
Vet Vaccination (Dog)*	48 (78.6)	124 (99.2)	72(100)	244 (94.5)
Have essential supplies for at least 72 hours against a crisis (outbreaks/pandemic)	263 (60.6)	232 (52.8)	179 (41.2)	674 (51.6)

Dog owners (N=258)

Preparedness Concerning Future Outbreaks based on Knowledge, Attitudes, and Practices

The levels of knowledge, attitudes, practices and preparedness are presented in Figure 2 below. Knowledge score was generally poor, but Attitudes showed modest change, with Practices showing far greater improvement, as a result of their COVID-19 experiences. Preparedness which is a composite of all the KAP domains is however not the best.

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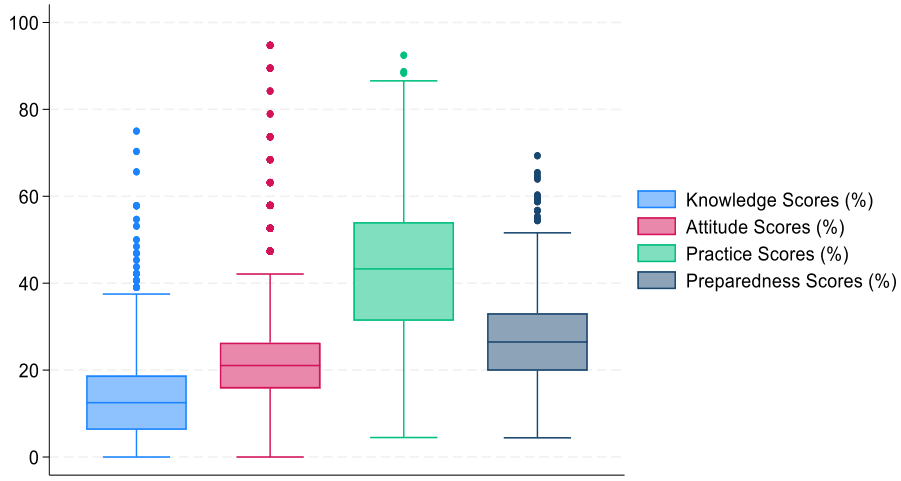


Figure 2. Knowledge, Attitudes, Practices and Preparedness Scores for Future Outbreaks

The study found that age, sex, and sources of health information were identified by the Linear regression analysis as important predictors of preparedness. In the crude model, older age was associated to decline in preparedness (β = −0.06, 95% CI: −0.11, −0.01; p = 0.015), but this relationship was not significant after adjustment. Again, women preparedness scores were considerably higher than men's, with a crude difference of 2.35%. This difference remained after adjustment (1.15%, p = 0.015) as present in Table 5.

Among those who reported the Ministry of Health as their regular source of health information, they showed stronger preparedness scores compared to others (Crude β = 10.75, 95% CI: 9.27, 12.23; p < 0.001). After adjustment, this effect became significant, highlighting the importance of sources of information as a mediating factor and a major determinant of preparedness (Table 6).

Table 6. Bivariate and Multivariate Regression Analysis on Socio-demographic Factors and Preparedness

Socio-demographic factors	**Crude**		**Adjusted**	
	β (95% CI)	**p-value**	**β (95% CI)**	**p-value**
Age (years)	−0.06 (−0.11, −0.01)	0.015	−0.02 (−0.07, 0.04)	0.548
Sex		<0.001		0.015
Male	Ref.		Ref.	
Female	2.35 (1.21, 3.49)		1.15 (0.22, 2.08)	
Residence		<0.001		<0.001
Urban	Ref.		Ref.	
Peri-urban	2.65 (0.47, 4.83)		3.76 (1.95, 5.56)	
Rural	2.86 (1.63, 4.10)		2.33 (1.14, 3.52)	
Marital status		0.002		0.895
Single	Ref.		Ref.	
Married	−2.03 (−3.21, −0.86)		−0.17 (−1.32, 0.99)	
Div/Sep/Wid/Unk	-2.35 (-4.87, 0.18)		−0.52 (−2.74, 1.70)	
Religion		0.174		
Christian	Ref.			
Moslem	0.74 (−0.50, 1.99)			

Other	−3.90 (−9.46, 1.66)			
Highest education completed		<0.001		0.168
None	Ref.		Ref.	
Primary	−2.20 (−4.71, 0.31)		−1.23 (−3.28, 0.82)	
JHS/JSS	−1.24 (−3.27, 0.79)		−1.51 (−3.24, 0.22)	
SHS/SSS	−0.26 (−2.19, 1.66)		−1.92 (−3.65, -0.18)	
Tertiary	4.16 (2.30, 6.02)		−0.83 (−2.67, 1.00)	
No. of people living in household	0.48 (0.28, 0.68)	<0.001	0.23 (0.06, 0.41)	0.008
Household category		<0.001		<0.001
Not enough money, even for food	Ref.		Ref.	
Can buy foods, purchasing of clothes a serious problem	−0.02 (−3.55, 3.50)		−3.16 (−6.04, −0.28)	
Can buy food and clothes, difficult buying gadgets (e.g. TV, fridge)	3.48 (0.26, 6.69)		−0.46 (−3.12, 2.20)	
Can afford main household gadgets, can't buy a car	5.89 (2.79, 8.98)		2.12 (−0.51, 4.76)	
Earnings sufficient to purchase anything except expensive items (e.g. a house or apartment)	7.38 (3.85, 10.91)		0.26 (−2.72, 3.25)	
Can buy apartment or a house if necessary	9.56 (5.57, 13.55)		0.85 (−2.51, 4.22)	
Don't know	−0.63 (−4.32, 3.06)		−2.61 (−5.59, 0.38)	
Have health difficulties	−1.64 (−3.42, 0.13)	0.070		
Have chronic conditions	−1.26 (−2.73, 0.20)	0.091		
Other mediating factors	β (95% CI)	p-value	β (95% CI)	p-value
Regular source(s) of health information *				
Family	3.71 (2.38, 5.05)	<0.001	0.85 (−0.49, 2.19)	0.215
Friends	3.91 (2.57, 5.25)	<0.001	0.53 (−0.81, 1.87)	0.437
Elders	5.30 (2.33, 8.26)	<0.001	0.94 (−1.58, 3.45)	0.464
Religious Leaders	3.78 (1.93, 5.64)	<0.001	−1.17 (−2.81, 0.47)	0.161
Doctors or health practitioners in the country/community	4.67 (3.54, 5.79)	<0.001	2.07 (1.08, 3.07)	<0.001
Pharmacist	9.41 (6.59, 12.24)	<0.001	1.45 (−1.08, 3.97)	0.261
Ministry of Health	10.75 (9.27, 12.23)	<0.001	6.37 (4.82, 7.92)	<0.001
International health organization	10.38 (8.46, 12.30)	<0.001	3.46 (1.56, 5.36)	<0.001

Media Sources (TV, Radio (FM), etc)	4.05 (2.90, 5.19)	<0.001	1.87 (0.87, 2.88)	<0.001
Social media	6.96 (5.79, 8.13)	<0.001	4.01 (2.92, 5.09)	<0.001
Celebrities	6.86 (1.97, 11.75)	0.006	−0.41 (−4.37, 3.55)	0.839
Traditional healer	2.15 (-3.61, 7.91)	0.464		
Other	2.36 (-2.54, 7.26)	0.345		
Practice hand washing with soap and water	5.29 (3.73, 6.85)	<0.001	1.64 (0.28, 3.01)	0.019
Face challenges practicing frequent hand washing with soap and water	0.68 (−0.87, 2.22)	0.389		
Often practice the use of hand sanitizer	4.81 (3.67, 5.94)	<0.001	4.27 (3.27, 5.27)	<0.001
Use LLIN	3.99 (1.74, 6.23)	0.001	4.37 (2.58, 6.15)	<0.001
Have vaccine access (humans)	8.58 (7.05, 10.11)	<0.001	5.73 (4.25, 7.20)	<0.001
Have domestic animals	4.49 (3.37, 5.61)	<0.001	3.32 (2.36, 4.27)	<0.001
Have vaccine access (animals)	7.28 (5.03, 9.53)	<0.001		

Outcome: Preparedness score (0 = Lowest, 100 = Highest). Ref: Reference category (N = 618)

Mediation Analysis

The data revealed that with differing effects of health information sources, the mediation analysis showed a strong relationship between preparedness and sex, place of residence, and household socioeconomic status. Females had a higher preparedness score compared to males (1.49%, p = 0.005). However, doctors or health practitioners exhibited a negative mediating effect on this relationship (−0.14%, p = 0.070). Similarly, peri-urban residence demonstrated higher preparedness score compared to urban residence (2.96%, p = 0.003). The Ministry of Health showed a significant negative mediating effect (−1.24%, p = 0.033), with the adjusted effect of other factors increasing further (4.20%, p < 0.001).

It was observed that as household conditions improved, so did preparedness for household socioeconomic status. Again, the relationship between better household status and higher preparedness scores was reinforced by social media's beneficial mediation effect (Table 7).

Table 7. Mediating Effects of Regular Health Information Sources on Preparedness

	Doc		**MOH**		**IHO**		**MS**		**SM**	
	Effect	**p**	**Effect**	**p**	**Effect**	**p**	**Effect**	**p**	**Effect**	**p**
Sex										
Indirect effect										
Male	Ref.		Ref.		Ref.		Ref.		Ref.	
Female	−0.14	0.070	0.31	0.138	0.17	0.253	0.00	<0.001	0.05	0.748
Direct effect										
Male	Ref.		Ref.		Ref.		Ref.		Ref.	
Female	1.50	0.004	1.16	0.018	1.26	0.012	1.24	0.016	1.25	0.011
Total effect										

Male	Ref.		Ref.		Ref.		Ref.		Ref.	
Female	1.36	0.009	1.47	0.005	1.43	0.006	1.24	0.016	1.30	0.013
Residence										
Indirect effect										
Urban	Ref.		Ref.		Ref.		Ref.		Ref.	
Peri−urban	−0.63	0.115	−1.24	0.033	−2.76	<0.001	0.80	0.135	0.30	0.282
Rural	0.32	0.006	−1.33	<0.001	−0.80	0.001	0.68	<0.001	−0.82	<0.001
Direct effect										
Urban	Ref.		Ref.		Ref.		Ref.		Ref.	
Peri-urban	3.93	<0.001	4.20	<0.001	5.57	<0.001	2.85	0.007	3.07	0.001
Rural	0.06	0.928	1.66	0.009	0.79	0.203	−0.28	0.657	1.18	0.052
Total effect										
Urban	Ref.		Ref.		Ref.		Ref.		Ref.	
Peri-urban	3.30	0.001	2.96	0.003	2.81	0.005	3.65	<0.001	3.37	0.001
Rural	0.37	0.553	0.33	0.591	−0.01	0.990	0.39	0.529	0.36	0.561
Household Category										
Indirect effect										
Not enough money, even for food	Ref.		Ref.		Ref.		Ref.		Ref.	
Can afford food, purchasing of clothes a serious problem	0.38	0.271	−0.60	0.359	−0.26	0.463	0.80	0.266	0.31	0.579
Can afford food and clothes, difficult purchasing durables (e.g. TV, fridge)	0.34	0.148	−0.25	0.697	0.13	0.735	1.42	0.003	0.83	0.041
Can afford main household appliances, purchasing a car is beyond means	0.02	0.783	−0.64	0.235	−0.44	0.346	−0.03	0.923	0.97	0.001
Earnings sufficient to buy anything except expensive ones (e.g. house)	1.01	0.079	0.79	0.287	0.48	0.499	1.52	0.029	2.39	0.002
Can afford apartment or a house if necessary	2.21	0.032	1.90	0.047	0.11	0.857	2.34	0.049	2.65	0.037
Don't know	0.56	0.457	−0.11	0.848	−1.35	0.222	0.54	0.452	0.81	0.211
Direct effect										
Not enough money, even for food	Ref.		Ref.		Ref.		Ref.		Ref.	
Can afford food, purchasing of clothes a serious problem	−2.57	0.140	−2.00	0.208	−2.50	0.128	−3.07	0.064	−2.93	0.075
Can afford food and clothes, difficult	1.22	0.445	1.17	0.407	0.62	0.683	0.05	0.976	0.24	0.878

purchasing durables (e.g. TV, fridge)										
Can afford main household appliances, purchasing a car is beyond means	3.48	0.031	3.42	0.016	3.00	0.045	3.47	0.038	2.06	0.180
Earnings sufficient to buy anything except expensive ones (e.g. house)	2.73	0.129	2.27	0.145	2.30	0.165	2.09	0.251	0.78	0.647
Can afford apartment or a house if necessary	3.32	0.081	3.15	0.079	4.62	0.018	3.09	0.179	2.37	0.297
Don't know	−2.93	0.077	−2.58	0.120	−1.50	0.385	−2.86	0.103	−3.20	0.065
Total effect										
Not enough money, even for food	Ref.		Ref.		Ref.		Ref.		Ref.	
Can afford food, purchasing of clothes a serious problem	−2.19	0.224	−2.60	0.130	−2.76	0.106	−2.27	0.205	−2.62	0.132
Can afford food and clothes, difficult purchasing durables (e.g. TV, fridge)	1.56	0.349	0.92	0.560	0.75	0.636	1.47	0.375	1.07	0.502
Can afford main household appliances, purchasing a car is beyond means	3.50	0.034	2.78	0.075	2.56	0.102	3.44	0.036	3.03	0.054
Earnings sufficient to buy anything except expensive ones (e.g. a house)	3.74	0.043	3.07	0.084	2.78	0.116	3.61	0.049	3.17	0.076
Can afford apartment or a house if needed	5.53	0.009	5.04	0.014	4.74	0.022	5.43	0.010	5.02	0.015
Don't know	−2.37	0.212	−2.69	0.135	−2.86	0.113	−2.31	0.219	−2.39	0.191

Doc: Doctors or health practitioners in the country/community, MOH: Ministry of Health, IHO: International health organization, MS: Media Sources (TV, Radio (FM), etc), SM: social media, p: p-value

Discussion

This study assessed the preparedness of individuals in Ghana for future infectious disease outbreaks based on the COVID-19 pandemic experiences. The present study found moderate preparedness for future infectious disease outbreaks among Ghanaian adults, characterized by relatively strong preventive practices but lower levels of disease-specific knowledge. Similar findings have been reported in Ghana and other Africa countries during and after the COVID-19 pandemic, where compliance with preventive measures often exceeded underlying knowledge of disease transmission [7, 27, 28]. Studies from Nigeria, Kenya, South Korea, and other lower- and middle-income countries have similarly

reported that public adherence to preventive behaviours was strongly influenced by risk perception and public health messaging rather than comprehensive disease knowledge [29-32]. These findings suggest that behavioural adaptations acquired during public health emergencies may persist and perhaps strengthen routine preventive practices even when detailed understanding of outbreak risks remains limited. This gap suggests that even in the absence of a minimum set of knowledge of disease transmission, people may respond to perceived risk and public health education and adopt recommended preventive practices, stressing the use of risk communication in health emergency situations and, an essential requirement for ongoing health education following a crisis [11, 33, 34]. This underscores the need to make reliable health information accessible for outbreak preparedness at the individual and household level.

Generally, findings on attitude towards disease prevention were encouraging. Most respondents said they were worried about future epidemics and were willing to take precautions including mask use, avoiding contact with infected individuals, and getting medical help when needed and would report a strange health event to the authorities. These results imply that COVD-19 pandemic increased people's perception of risks and emphasized the importance of preventive health behaviours, which are critical for compliance under public health emergencies. Many research works conducted during the pandemic reveal comparable changes in public perceptions, with greater risk perception leading to a rise in preventive measures and confidence in healthcare systems [7, 27, 28].

On preventive practices, the study sought to determine if COVID-19 pandemic experience served as a wakeup call on infectious disease preventive practices among individuals to be better prepared for future outbreaks. Preventive practices were relatively strong, reflected in COVID-19 vaccine uptake (70%), LLIN use among children (91%) and adults (87%), handwashing with soap and water (67%), drinking treated water (59%), avoiding undercooked foods (60%), wash fruits and vegetables before eating (72%), and dog vaccination against rabies (95%). It was noteworthy that about 52% of the respondents have essential supplies that will sustain them for at least 72 hours should there be a crisis (outbreaks/pandemic). These patterns suggest potential long-term behavioural change, likely influenced by the pandemic's intensive public health efforts, and align with Learned Resourcefulness Theory, which emphasizes learned skills for managing health risks [35]. Although LLIN use, dog vaccination, food and water hygiene and others are not directly linked to COVID-19 prevention, the high uptake might indicate strong epidemic-prone disease prevention habits among individuals and thus, efforts should encourage and sustain the positive practices.

The study revealed that access to credible health information could be associated with higher preparedness scores. This goes to stress the need of effective, transparent communication systems in shaping public behaviours and more especially, reducing misinformation during disease outbreaks [27, 28].

The observed association between preparedness and information sources is conceivable because trusted information channels may improve awareness of disease risks, increase confidence in public health recommendations, and facilitate timely adoption of preventive behaviours. Information provided by healthcare professionals, ministries of health, and international health organizations may also be perceived as more credible than informal sources, reducing susceptibility to misinformation. Similar observations reported during the COVID-19 pandemic, where trust in public institutions and access to accurate information were associated with greater compliance with public health

recommendations [7, 27, 28]. Preparedness may also be associated with sociodemographic factors. Women were more prepared than men to engage in health-seeking behaviours and household health management [36]. Regarding residency, peri-urban residents were better prepared compared to their urban counterparts. This could be explained to a more robust community engagement initiative and local communication frameworks that promote interpersonal communication and adherence to behavioural norms in the peri-urban areas. The significance of integrating continuous community-based communication into national preparedness strategies is underscored by evidence from prior epidemics in West Africa [37, 38]. This underlines the necessity of involving the community and improving local communication systems for public health practices.

The relationship between preparedness and socio-economic indicators seemed inconsistent. Higher-income households were initially more prepared, but this was likely due to easier access to preventive services. The observation was decreased after adjustment, indicating that access to reliable information may be as crucial as financial resources. Similar associations between socioeconomic status and preventive health behaviour have been reported by other research works examining household resilience during epidemics [11]. Consequently, ensuring equitable access to health information for all demographic groups is key to enhance outbreak preparedness.

Misconception about vaccine remains a challenge. Several respondents expressed concerns about vaccination safety and misconceptions. One respondent expressed the following “People were having misconceptions about the covid-19 vaccine, that you can't conceive, men might be impotent when they take the vaccine”. Another respond also said this “I remember people saying they didn't believe covid-19 existed, and that the vaccine was brought to harm us”.

These findings reflect broader global patterns of vaccine skepticism influenced by misinformation and mistrust, [12, 13] and call for clear, focused risk communication and community involvement in tackling vaccine hesitancy elements to boost vaccine confidence. Individuals with access to vaccination services may also be more connected to healthcare systems and preventive health programs, which could contribute to higher preparedness scores. Vaccination uptake may therefore serve as an indicator of broader engagement with preventive health behaviours rather than preparedness alone.

Overall, the findings show that there are still differences in preparedness for future epidemics even though the COVID-19 pandemic might have reinforced preventative behaviours. Access to credible health information, gender, residential environment, and socioeconomic factors might explain the higher preparedness score. The practices observed tend to be stronger than underlying knowledge of preparedness. Building resilient communities that can effectively respond to future infectious disease emergencies requires strengthening health literacy, improving risk communication systems, and removing structural obstacles to preventive practices.

Policy Implications

The findings have important implications for epidemic preparedness policy in Ghana. First, preparedness plans should explicitly include individual, household, and community-level readiness, alongside surveillance, laboratory capacity, and emergency response systems. Policies should build on preventive behaviours reinforced during COVID-19, including hand hygiene, vaccination, LLIN use, healthcare seeking, and household readiness, while addressing knowledge gaps and uncertainty about reporting unusual health events.

Second, risk communication and community engagement should be routine preparedness functions before, during, and after outbreaks.

Trusted channels such as health workers, mass media, community leaders, and appropriate digital platforms should deliver clear, culturally relevant messages and support misinformation management, community feedback, and timely reporting.

Third, preparedness policy should link health promotion with equitable access to essential preventive services and commodities, including vaccination, LLINs, safe water, handwashing facilities, hygiene materials, health services, and basic household emergency supplies. Particular attention is needed for rural and underserved populations, and preparedness education should be integrated into primary healthcare, community health systems, schools, and local government structures.

Fourth, community-based surveillance and early warning systems should be strengthened by improving public knowledge of reportable events and clarifying reporting pathways. Simplified and well-publicized mechanisms, including local health authority contacts, community surveillance volunteers, hotlines, and local government channels, should be promoted alongside a One Health approach for zoonotic and vector-borne threats such as rabies, yellow fever, dengue, and malaria.

Finally, routine monitoring of individual and household preparedness indicators should be incorporated into broader health security assessments. A composite KAP-based preparedness measure could help identify less-prepared groups and assess communication, vaccination, WASH, vector control, and community engagement interventions. Overall, Ghana's preparedness policies should invest in sustained, community-centred systems that improve knowledge, build trust, reduce misinformation, and support prompt household action during future outbreaks.

Strengths and Limitations

This study provides important evidence on individual and household preparedness for future infectious disease outbreaks across diverse ecological settings in Ghana. Despite its limitations, the findings offer valuable insights into factors that may be associated with outbreak preparedness. The use of multivariable and mediation analyses strengthened the exploration of potential determinants of preparedness. However, the cross-sectional design precludes causal interpretation of the observed associations. In addition, preventive practices, including vaccination history, use of LLINs, dog vaccination, and hand and food hygiene, were self-reported and may therefore be subject to recall and social desirability biases. The purposive selection of study districts may also limit the generalizability of the findings to the broader Ghanaian population. Data were collected several years after the peak of the COVID-19 pandemic, and changing public perceptions and experiences may have influenced reported preparedness levels. Residual confounding from unmeasured factors, including previous outbreak experiences, health literacy, contemporary health issues during the period of data collection, and trust in public institutions, cannot be excluded. Finally, internal consistency reliability was not assessed using Cronbach's alpha in the current study. Although the questionnaire was reviewed by experts and pretested before implementation, the absence of a formal reliability assessment may limit confidence in the consistency of the measured constructs.

Developing an index for optimal individual KAP could support a more systematic assessment of outbreak preparedness. Longitudinal research is also needed to better understand how preparedness changes over time and how routine community-based interventions can strengthen resilience. Future studies should further refine the concept of disease outbreak preparedness at the individual and household levels and identify factors that support sustained preventive practices.

Conclusion

This study demonstrates that experiences from the COVID-19 pandemic may have contributed to improved preventive practices and moderate individual and household preparedness for future infectious disease outbreaks among adults in Ghana. Respondents reported strong adoption of several routine protective behaviours, including hand hygiene, use of LLINs, vaccination, healthcare seeking, and maintenance of basic household supplies. However, these behavioural gains were not matched by consistently high knowledge of epidemic-prone diseases, transmission routes, early warning signs, or appropriate reporting actions. This suggests that while the pandemic may have strengthened some preventive habits, important gaps remain in outbreak literacy, risk recognition, and response readiness.

The findings further show that preparedness is shaped by socio-demographic characteristics, access to preventive services, and exposure to credible health information. Health information sources appear to play an important mediating role by influencing knowledge, attitudes, and adoption of protective practices. Persistent concerns about vaccine safety, uncertainty about reporting unusual health events, and barriers to hygiene and preventive resources highlight the need for sustained, trusted, and context-specific health communication. Strengthening health literacy, risk communication, community engagement, and equitable access to vaccination, LLINs, hygiene facilities, and health services should therefore be central to preparedness planning.

Overall, the study underscores the importance of moving preparedness beyond health-system response capacity to include individual, household, and community-level resilience. Future outbreak preparedness strategies in Ghana should build on the preventive behaviours reinforced during COVID-19 while addressing misinformation, knowledge gaps, and inequities in access to essential preventive tools. Continued investment in community-centred preparedness, trusted communication channels, and routine preventive services will be critical for sustaining protective behaviours and improving readiness for future infectious disease threats.

Conflict of Interest

I hereby state that there is no conflict of interest in conducting the research, authorship and publication.

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Ethical Approval

Ethical approval for this study was obtained from the Ghana Health Service Ethics Review Committee (Approval No. GHS-ERC 006/03/25) in June 2025 before commencement of data collection. Permission to conduct the study was also obtained from relevant regional, district, and community authorities in the selected study areas. Participation in the study was entirely voluntary. Eligible participants were informed about the objectives, procedures, potential risks, and benefits of the study before enrolment. Written informed consent was obtained from all participants prior to data collection. Participants were assured that their responses would be treated confidentially, anonymized during analysis, and used solely for research purposes. No personal identifiers were included in the analytical dataset. Participants were informed of their right to decline participation or withdraw from the study at any stage without any consequences or loss of benefits to which they were otherwise entitled.

Data Availability

The corresponding author will make the data available upon request.

Author Contributions

MOA conceptualized the study. The methodology, data collection and analysis, initial draft, and write up including editing, were done by MoA and DG. Supervision, review, and editing were done by DG and SOS. The final draft was done by MOA; review and approval were done and accepted by all authors.

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The Temporal and Spatial Patterns of Cholera Outbreaks in the Rohingya Refugee Camps, Cox's Bazar, Bangladesh

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Abstract *Cholera remains a major public health threat in humanitarian settings such as the Rohingya refugee camps of Cox's Bazar, Bangladesh, which are characterised by congestion, inadequate water and sanitation, and overstretched health services. This study analysed the temporal and spatial patterns of cholera in the camps to identify seasonal variation and distribution across camps and to inform control. We used secondary data from the World Health Organization's Early Warning, Alert and Response System (EWARS), sentinel surveillance, and laboratory surveillance to construct annual weekly trend lines and epidemic curves for acute watery diarrhoea and culture-confirmed cholera, and to map case distribution across the 33 camps from 2018 to 2026. Syndromic surveillance showed year-round acute watery diarrhoea transmission with multiple non-stable seasonal peaks and a steady decline over seven years, from about 231,000 cases in 2018 to about 122,000 in 2025. Laboratory surveillance indicated that cholera was endemic, characterized by recurrent upsurges; the largest outbreak occurred in 2024 with 534 culture-confirmed cases. The dominant cholera peak occurred in the post-monsoon period (mid-September to December), diverging from the April–June pre-monsoon peak historically reported for south-eastern Bangladesh. Transmission was largely sporadic across camps without persistent hotspots, except during the 2021 and 2024 outbreaks, and shifted over time from early Teknaf-based coastal camps to the densely populated inland-located Ukhiya-based camps. These findings indicate a need to update earlier seasonality evidence and to target preventive water, sanitation, hygiene and vaccination interventions to the post-monsoon period and the high-density Ukhiya camps.*

Keywords *Cholera, Cox's Bazar, Rohingya Refugees, Seasonality, Spatial Epidemiology, Vibrio Cholerae.*

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Introduction

Cholera remains a major global public health problem, disproportionately affecting low- and middle-income countries and humanitarian settings [1]. It is an acute diarrhoeal disease caused by the bacterium *Vibrio cholerae* and is transmitted through the ingestion of food or water contaminated with faecal matter; common sources include unsafe drinking water and contaminated or undercooked food, including shellfish [2]. Without prompt treatment, severe cholera can kill within hours through profuse watery diarrhoea and dehydration [1]. Globally, an estimated 1.3 to 4.0 million cases and 21,000 to 143,000 deaths occur each year, although the true burden is under-ascertained [2, 3].

Seven cholera pandemics have occurred since 1817; the seventh, caused by the El Tor biotype, began in 1961 and continues today [4]. The Bay of Bengal has historically been a major hub for global cholera spread, having seeded six of the seven pandemics [5]. Approximately 1.3 billion people are at risk worldwide, including in Bangladesh, where transmission is persistent; surveillance compiled by the World Health Organization (WHO) from 45 countries reported 535,321 cases and 4,007 deaths in 2023 [6]. The recent global resurgence of cholera has been linked to conflict, climate-related disasters, displacement, and chronic under-investment in water, sanitation and hygiene (WASH) [7].

The WHO defines cholera as endemic when confirmed cases occur in at least three of the previous five years [8]. In Bangladesh, cholera is endemic with year-round transmission and seasonal outbreaks. Long-running surveillance at the International Centre for Diarrhoeal Disease Research, Bangladesh (icddr,b) in Dhaka has described peaks before and after the monsoon, with lower incidence during cooler months and the height of the monsoon [9]. Importantly, the literature reports geographically distinct peak seasons: in northern Bangladesh, transmission peaks in October and November, whereas in the south, including Cox's Bazar, where Rohingya refugee camps are situated, earlier studies described a peak from March to April [10]. Foodborne-illness surveillance by icddr,b and the Institute of Epidemiology, Disease Control and Research (IEDCR) reported about 8% culture-confirmed cholera among diarrhoeal specimens in Cox's Bazar, designating the district a high-transmission area [11].

In August 2017, approximately 700,000 Rohingya refugees fled targeted violence in Myanmar and entered Cox's Bazar, and the new wave of influx in 2024 has been estimated at 150,000 refugees arriving in camps, bringing the total displaced population to roughly 1.2million across 33congested camps in the Ukhiya and Teknaf sub-districts by 30 June 2026 [12]. Rapidly constructed shelters and spontaneous settlements on hilly, deforested terrain were vulnerable to monsoon flooding, landslides, and storm surges that repeatedly damaged WASH infrastructure [13]. Limited sanitation, suboptimal hygiene, high acute malnutrition and initially limited cholera vaccination increased vulnerability to acute watery diarrhoea (AWD) and recurrent cholera outbreaks from 2018 onward [14].

Following the influx and upsurge of communicable diseases, WHO, in collaboration with the Civil Surgeon's Office, the Refugee Relief and Repatriation Commissioner and the Health and WASH Sectors, established an Early Warning, Alert and Response System (EWARS) for priority conditions, including cholera [15]. A multi-layered surveillance architecture—combining community-based surveillance, indicator-based syndromic surveillance, sentinel-site rapid diagnostic testing and laboratory culture confirmation—supports early detection, investigation and response [16]. Despite this system and sustained humanitarian investment, cholera has persisted and periodically surged, indicating that the drivers of transmission remain

incompletely understood [9]. This study, therefore, analysed the temporal and spatial patterns of AWD and culture-confirmed cholera in the camps from 2018 to 2026, intending to characterise seasonal variation and spatial distribution and compare current seasonality with previously reported regional patterns to inform context-specific control.

Materials and Methods

Study Site

The study was conducted in the 33 officially designated Rohingya refugee camps of Cox's Bazar district, south-eastern Bangladesh, which host approximately 1.2 million displaced persons across the Ukhiya and Teknaf sub-districts. Twenty-five camps are in Ukhiya Upazila, including the Kutupalong mega-settlement, and the remaining eight are in Teknaf, several of which border the Bay of Bengal. The district experiences a tropical monsoon climate with a pronounced wet season between June and September, during which the camps are exposed to heavy rainfall, flooding and landslides that periodically damage WASH infrastructure [13].

Data Sources

Secondary data generated through the WHO's Early Warning and Alert Response System (EWARS), sentinel testing/surveillance, and laboratory surveillance were extracted and re-analysed. Weekly AWD counts from indicator-based syndromic surveillance and weekly culture-confirmed cholera counts from laboratory surveillance, confirmed by the IEDCR field laboratory in Cox's Bazar Medical College, were obtained, reviewed and synthesised for 2018 to 2026. A camp-by-year matrix of culture-confirmed cases across the 33 camps was used for the spatial analysis. Meteorological context was drawn from Bangladesh Meteorological Department records for the Cox's Bazar and Teknaf stations.

Statistical Methods

Weekly cholera and AWD data were cleaned and converted into complete weekly time series, with epidemiological weeks lacking reported cases retained as zero-case weeks to preserve continuity. Annual weekly trend lines and epidemic curves were plotted on a common scale to enable comparison across years. Cases were aggregated to annual and monthly totals and classified into four climatic seasons—winter (December–February), pre-monsoon (March–May), monsoon (June–September), and post-monsoon (October–November)—to characterise seasonal structure. For the spatial analysis, sentinel-site and laboratory data were used to construct a camp-by-year case matrix and to compare the Ukhiya-based and Teknaf-based camp clusters over time. Descriptive results were cross-checked against operational WHO epidemiological bulletins to confirm fidelity. Analyses were conducted using standard statistical software.

Results

Temporal Trends in Acute Watery Diarrhoea

Indicator-based syndromic surveillance indicated year-round AWD transmission with multiple peaks of varying intensity (Figure 1). The highest activity occurred between August and December (epidemiological weeks 35–50; post-monsoon), with a second, moderate peak from mid-April to June (epidemiological weeks 17–24; pre-monsoon); transmission decreased from mid-January to mid-April and during July and August. The overall AWD burden declined steadily across seven years, from approximately 231,000 cases in 2018—when WASH services were least developed—to approximately 122,000 in 2025, a reduction of nearly half (Table 1). This decline is consistent with the maturation of WASH infrastructure, hygiene promotion, and health-service coverage over time.

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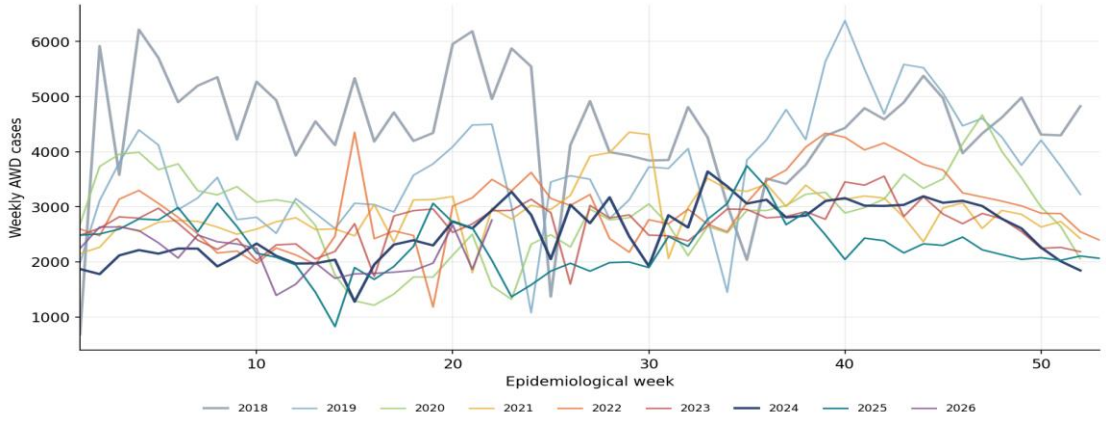


Figure 1. Annual Weekly Trends of Acute Watery Diarrhoea, Rohingya Refugee Camps, 2018–2026

Table 1. Annual Acute Watery Diarrhoea and Culture-confirmed Cholera Burden, Rohingya Refugee Camps, 2018–2026

Year	AWD cases	Confirmed cholera	Notable feature
2018	231,378	—	Highest AWD; pre-confirmation baseline
2019	193,083	183	First major confirmed cholera year
2020	147,689	5	Pandemic restrictions; reduced testing
2021	151,861	136	Resurgence: outbreak declined, reactive OCV campaign in October and November 2021
2022	157,945	70	Sustained endemic transmission
2023	138,903	81	Ad hoc waterline-linked outbreak
2024	132,522	534	Largest outbreak on record
2025	121,951	59	Lowest AWD; post-outbreak decline triggered by the reactive OCV campaign
2026*	47,063	8	To epidemiological week 22

**2026 data are partial (to epidemiological week 22). AWD declined steadily, while confirmed cholera cases fluctuated episodically after the reactive OCV outbreak campaign in January 2025. OCV = oral cholera vaccine.*

Temporal Trends in Culture-Confirmed Cholera

Laboratory surveillance indicated endemic cholera, with cases reported year-round for more than three years (Figure 2). Confirmed cases numbered 183 in 2019, fell to 5 in 2020—a year of COVID-19 pandemic-related restrictions and reduced testing—then rose to 136 in 2021 before settling at 70 and 81 in 2022 and 2023, respectively (Table 1). In 2024, the count surged to 534 confirmed cases, documenting the largest outbreak on record due to more than three years of waned population immunity after the 2021 OCV campaign. The 2025 outbreak (59 cases) continued the large outbreak in 2024, which was contained in January by the scale-up of the oral cholera vaccine (OCV) campaign. The highest annual peak consistently occurred between epidemiological weeks 39 and 50 (mid-September to December; post-monsoon), with a milder peak in epidemiological weeks 25 to 30 (mid-June to July; monsoon). More than five outbreaks were observed over the period, except in 2020.

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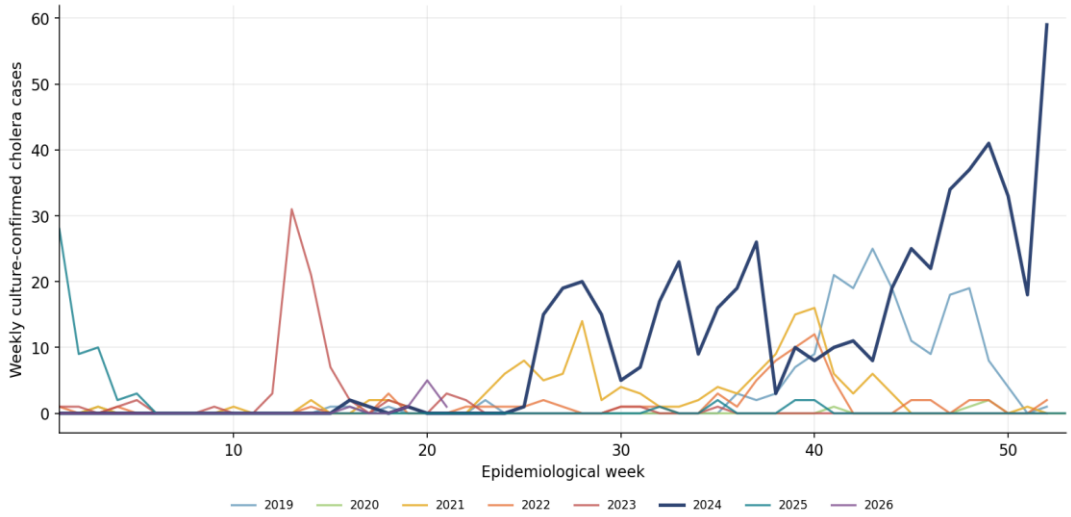


Figure 2. Weekly Culture-confirmed Cholera Cases by Year, Rohingya Refugee Camps, 2019–2026

Superimposing the AWD and culture-confirmed cholera curves (Figure 3) showed similar peak timing (epidemiological weeks 35–46) in 2019, 2021, and 2024, with variation in other years. The 2023 event was an ad hoc outbreak linked to waterline contamination in two camps (Camps 2W and 6) and was reportedly contained within three weeks (epidemiological weeks 13–15) by a joint Health and WASH response. The most intense transmission occurred during the 2024 outbreak, from epidemiological week 44 of 2024 to early 2025, aligning with the post-monsoon period. The divergence between the steadily declining AWD trend and the episodically surging cholera trend indicates that confirmed cholera transmission follows a dynamic distinct from that of the general diarrhoeal disease burden.

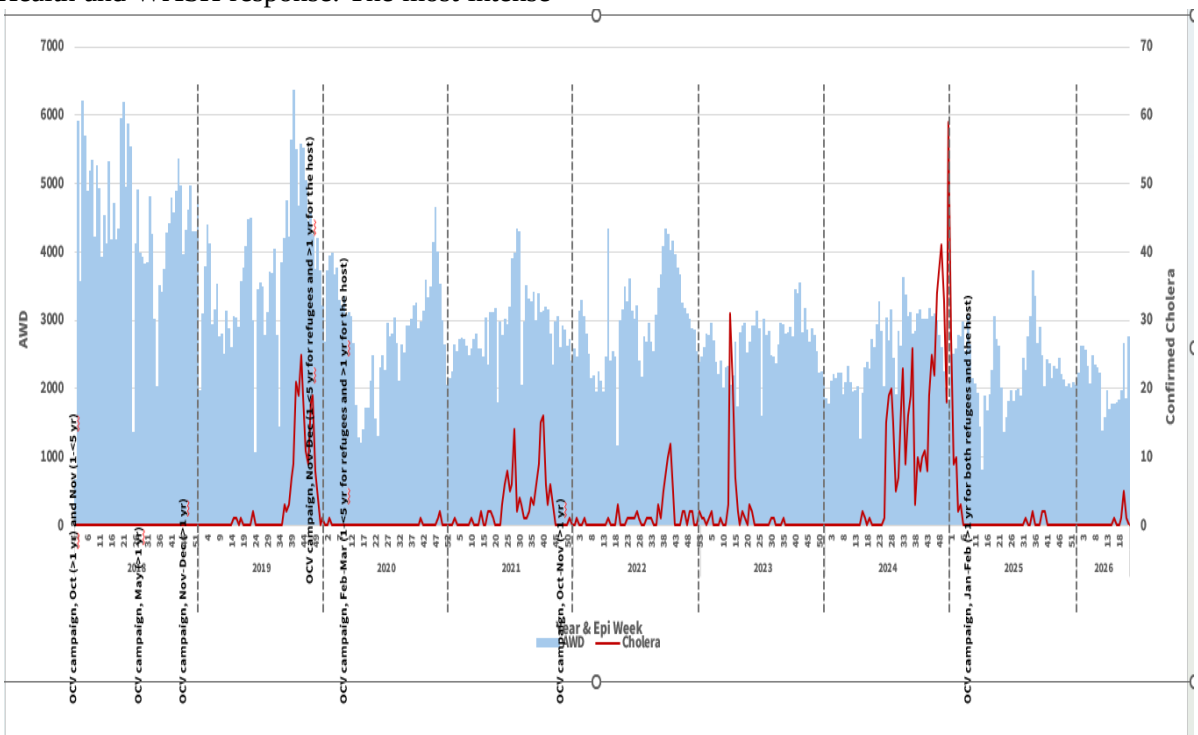


Figure 3. Superimposed Monthly Trends of Acute Watery Diarrhoea, Culture-confirmed Cholera and OCV Campaigns Conducted from 2018–2026

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Seasonal Distribution

When confirmed cases were aggregated by climatic season, the post-monsoon season carried the highest mean monthly burden (27.5 cases per month), more than double that of the monsoon (12.8) and winter (11.0) seasons, and more than six times that of the pre-monsoon season (4.4) (Table 2). The post-monsoon and monsoon seasons together accounted for the majority of confirmed cases. Negative binomial regression confirmed that the post-monsoon season carried an approximately six-fold higher cholera case rate than the pre-monsoon season. This post-monsoon dominance diverges from the April–June pre-monsoon peak historically described for south-eastern Bangladesh by scientists [10].

Table 2. Seasonal Distribution of Culture-confirmed Cholera Cases, Rohingya Refugee Camps, 2019–2025

Season	Total cases	Mean cases/month	Median cases/month	Share of cases
Winter (Dec–Feb)	232	11.0	1.0	21.7%
Pre-monsoon (Mar–May)	92	4.4	1.0	8.6%
Monsoon (Jun–Sep)	359	12.8	2.0	33.6%
Post-monsoon (Oct–Nov)	385	27.5	4.5	36.0%

The post-monsoon season carries the highest mean monthly burden, indicating a dominant post-monsoon peak that diverges from the historically reported March–April peak for south-eastern Bangladesh.

Spatial Distribution

The camp-by-year analysis showed that, in most years, cases were distributed sporadically across many camps without persistent, year-on-year hotspots—a pattern consistent with widespread environmental seeding rather than a single fixed-point source (Figure 4 and 5). The principal exception was the 2024 outbreak, during which cases clustered intensely in a subset of densely populated Ukhiya camps. Cumulatively, a minority of camps accounted for a disproportionate share of confirmed cases.

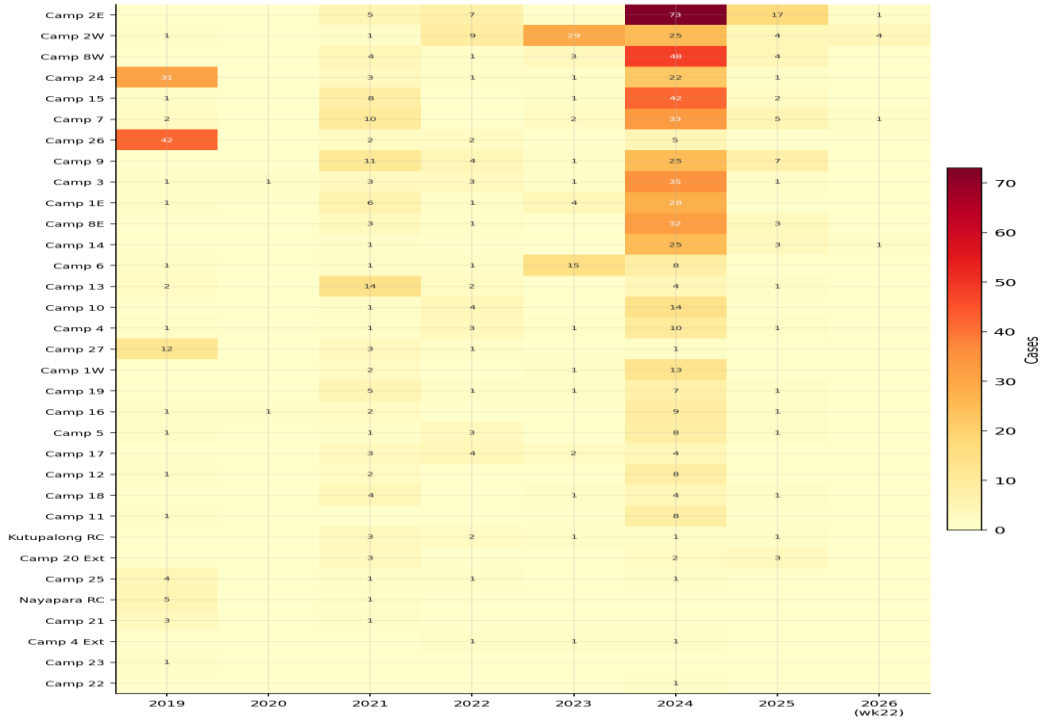


Figure 4. Culture-confirmed Cholera Cases by Camp and Year, Rohingya Refugee Camps, 2019–2026

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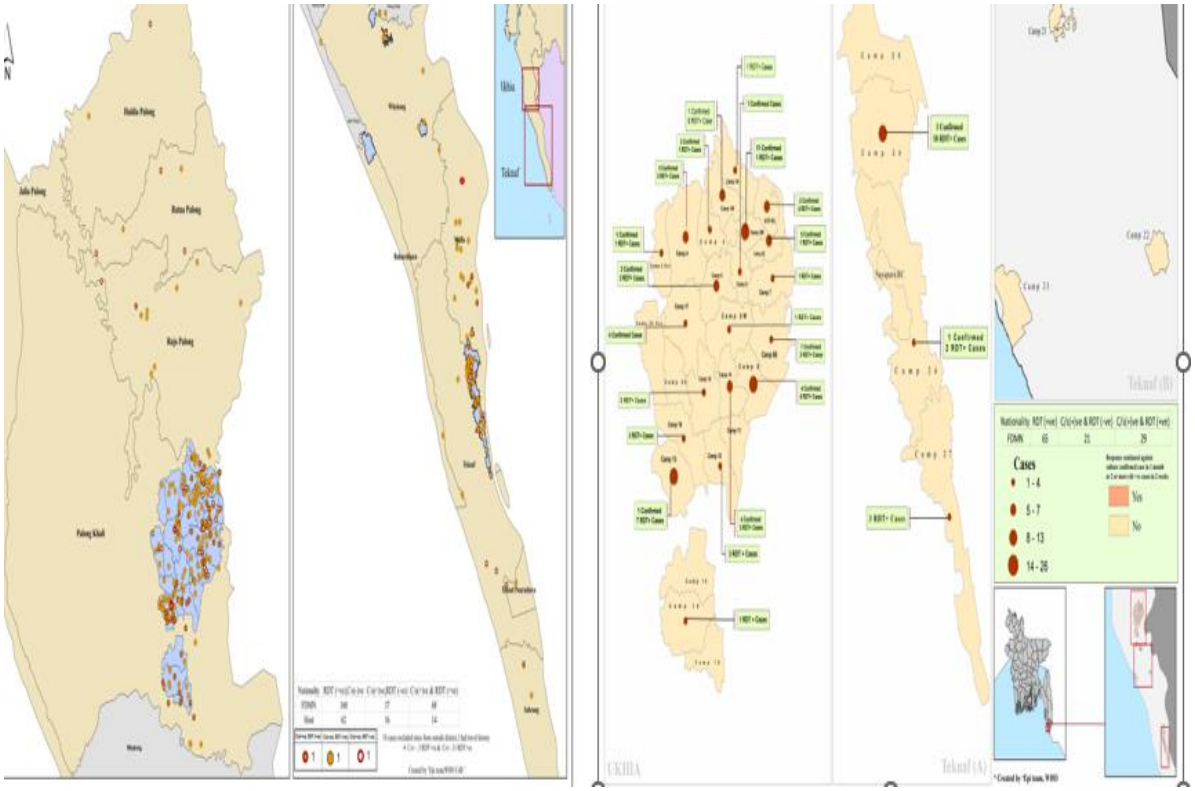


Figure 5. Distribution of Cholera Cases in Ukhya and Teknaf-based Camps in 2021 and 2022

Aggregating cases by sub-districts/Upazilas hosting Rohingya refugee camps revealed a striking spatial dynamic (Figures 6 and 7). In 2019, confirmed cholera was concentrated overwhelmingly in the Teknaf-based coastal camps, which recorded 98 cases compared with 14 in the Ukhiya-based camps, consistent with the proximity of these camps to the brackish coastal aquatic reservoir of V. cholerae [13]. From 2021 onward, the pattern reversed decisively: the Ukhiya-based camps came to dominate transmission, recording 467 confirmed cases against only 30 in the Teknaf-based camps in 2024. This shift towards the densely populated Ukhiya mega-settlement reflects the role of population density and person-to-person amplification in sustaining transmission once the pathogen is established.

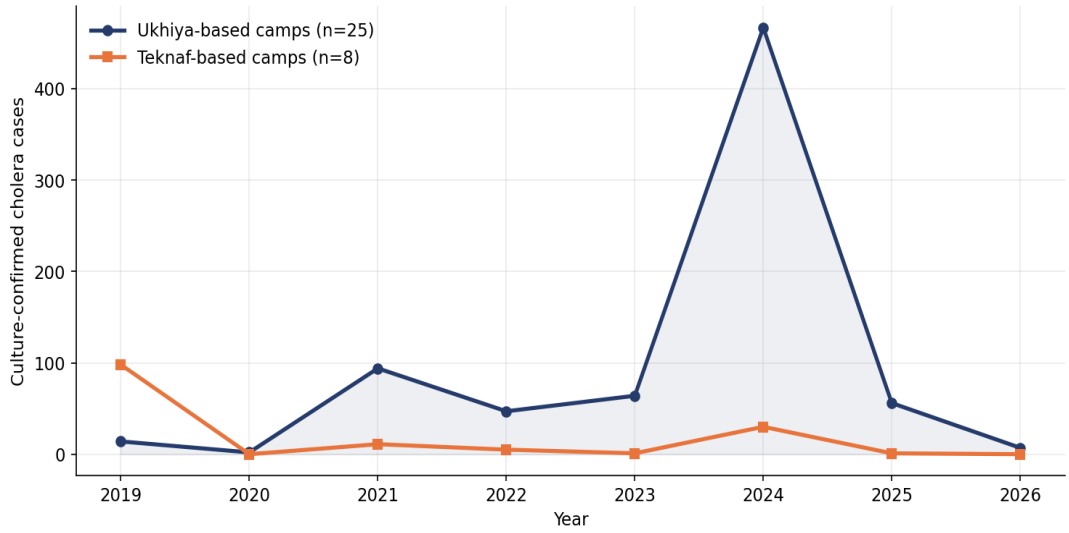


Figure 6. Distribution of Culture-confirmed Cholera Cases in Ukhiya-based Versus Teknaf-based Rohingya Refugee Camps, 2019–2026

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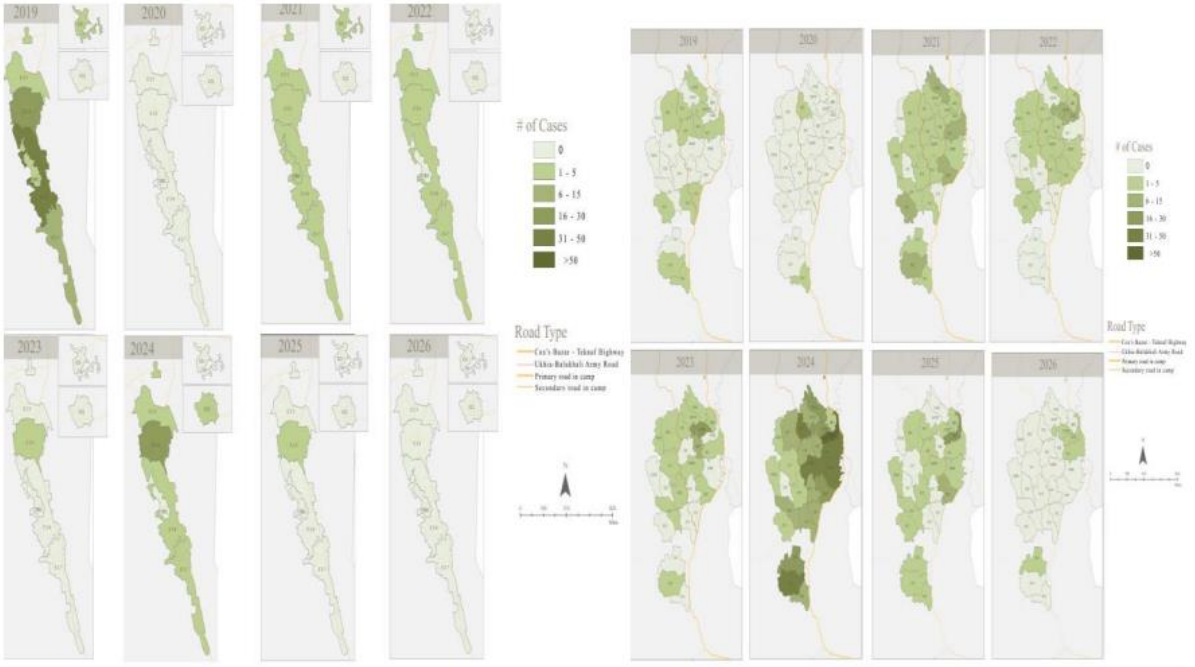


Figure 7. Distribution of Culture-confirmed Cholera Cases in Teknaf and Ukhya-based Rohingya Refugee Camps in Cox's Bazar, Bangladesh from 2019 to mid-2026

Discussion

This analysis shows that AWD transmission is year-round, while cholera is endemic with recurrent seasonal and occasional ad hoc outbreaks in the Rohingya camps. AWD peaks mainly in the pre-monsoon and post-monsoon periods and has declined steadily over seven years, consistent with maturing WASH services. Cholera transmission is also year-round, with peak activity from mid-September to December (post-monsoon). This differs from earlier published findings suggesting peak transmission in south-eastern Bangladesh from March to April [10], highlighting the need to review and update seasonality evidence for the Rohingya camps and possibly the wider Cox's Bazar district [9].

Several mechanisms may account for the apparent seasonal shift. The post-monsoon period follows the inundation, infrastructural damage, and faecal–oral contamination of the monsoon but occurs once standing water has begun to recede and human activity resumes—conditions that may favour both environmental persistence and person-to-person amplification [17, 18]. The offset between the rainfall maximum (monsoon) and the cholera peak (post-monsoon) is the temporal signature expected if transmission is driven by the delayed consequences of monsoon flooding rather than by rainfall itself [19]. Whatever the precise mechanism, the operational implication is that preventive interventions calibrated to a pre-monsoon peak would be mistimed.

Sentinel and laboratory data suggest cholera transmission intensified between 2021 and 2024 relative to 2019–2020, despite ongoing WASH and health-sector interventions. These observations are consistent with surveillance findings reported for diarrhoea and cholera early warning among Rohingya populations [20]. Geospatial analysis indicates that transmission is generally sporadic and lacks well-defined clustering across camps, except during the large 2024 outbreak, a pattern consistent with widespread water contamination and limited persistent secondary transmission in endemic years [21]. The distinction between dominant sporadic, environmentally seeded transmission noted over the seven years and limited clustered, density-driven outbreak transmission noted in

2024 has direct implications for control: the former calls for area-wide measures, the latter for targeted, case-area interventions [22].

From the available data, cholera appears to have originated in the Teknaf-based camps bordering the Bay of Bengal during the 2019 outbreak, consistent with the role of coastal aquatic reservoirs in seeding transmission [23]. It then spread to the 25 Ukhiya-based camps, where intensified transmission has been sustained, while transmission in Teknaf slowed after 2020. This evolution—from an environmentally seeded coastal focus to a density-driven inland epidemic—implies that prevention should be both spatially and temporally targeted, directed at the highest-burden Ukhiya camps in the run-up to the post-monsoon season [24]. These findings should be interpreted considering the limitations of surveillance data, which are subject to under-ascertainment and reporting variation, and the reliance on culture confirmation, which may underestimate true incidence [25].

Conclusion

Cholera remains endemic in the Rohingya refugee camps, with year-round transmission and recurrent outbreaks, while AWD transmission is persistent across the year, coupled with multiple peaks, and has gradually declined from 2018 to mid-2025. Recent surveillance indicates that the cholera peak season has shifted from the previously reported April–June period to mid-September–December, suggesting changes in seasonal dynamics and the need to update prior evidence [10]. Cholera outbreaks intensified in 2021–2024 compared with 2019–2020, despite ongoing WASH and health-sector interventions, while AWD declined steadily. Spatial patterns are largely sporadic across camps, with notable clustering mainly during the 2024 outbreak, likely to reflect widespread water contamination [21]. Transmission appears to have begun in the Teknaf-based camps during the 2019 outbreak and to have seeded the densely populated Ukhiya-based camps, which have sustained persistent, intensified annual transmission. These findings support context-specific prevention—reactive oral cholera vaccination and WASH intensification timed to precede the post-monsoon season and targeted to the high-density camps [24, 26]. Further research, including molecular characterisation of circulating strains and time-series modelling, is needed to strengthen early warning and control [27, 28].

Conflict of Interest

The authors declare that they have no conflict of interest.

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Ethical Approval

The study used routine, de-identified surveillance, laboratory, and meteorological data generated through the operations of the World Health Organization, the Institute of Epidemiology, Disease Control and Research, and the Bangladesh Meteorological Department, used with appropriate authorization for academic purposes. Ethical oversight was sought from the relevant national and institutional review bodies (local IRB at Cox’s Bazar Medical College and Refugee Relief and Repatriation Commission).

Author Contributions

O. D. Otieno conceptualised the study, curated and analysed the data, and drafted the manuscript. M. F. Khan and H. S. Sabbir contributed to data acquisition, surveillance

data review, and critical revision of the manuscript. Toha M R. Apolot, K. S. Kaddu and P. Abiodun contributed to the final revision of the manuscript. All authors read and approved of the final manuscript.

Data Availability

The surveillance, laboratory and meteorological datasets analysed in this study were generated through the routine operations of the World Health Organization Health Emergencies Programme in Cox's Bazar, the Institute of Epidemiology, Disease Control and Research, and the Bangladesh Meteorological Department. Aggregated data supporting the findings are available from the corresponding author on reasonable request and subject to the data-sharing policies of the responsible institutions.

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Perceptions, Barriers, and Opportunities to Strengthen Tuberculosis Prevention and Control in Nigeria: A Qualitative Study of Policymakers and Program Managers

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Abstract *Policymakers and program managers play a critical role in shaping tuberculosis (TB) control strategies, yet their perspectives on implementation barriers remain underexplored. This qualitative study examined perceptions of TB control, preventive activities, and implementation challenges in Nigeria. Nine key informants from national and subnational TB programs and partner organizations were purposively selected. Data were collected through in-depth interviews and analyzed thematically in NVivo 12. Participants reported progress in TB control, including the expansion of community-based services, improved access to diagnostics, the scale-up of tuberculosis preventive therapy (TPT), and strengthened monitoring systems. However, these gains are constrained by persistent system-level and contextual barriers. Stigma, low awareness, and financial constraints limit uptake of preventive services, while workforce shortages, staff attrition, supply chain inefficiencies, and reliance on paper-based reporting undermine program effectiveness. Respondents emphasized the need for service integration, increased domestic financing, and accelerated digitalization. TB control efforts in Nigeria are advancing but remain constrained by structural limitations. Addressing these gaps will require coordinated strategies to strengthen health systems, expand access, and improve program efficiency.*

Keywords *Health Systems, Health Policy, Infection Prevention, Nigeria, Programme Managers, Qualitative Research, Tuberculosis.*

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Introduction

Tuberculosis (TB) remains a major public health challenge despite being preventable and curable. Tuberculosis remains a leading cause of death from a single infectious agent globally, disproportionately affecting low- and middle-income countries where health system constraints limit access to timely diagnosis and treatment [1, 2]. In 2023, the World Health Organization (WHO) estimated that 10.8 million people developed TB and more than one million died from the disease [1]. The WHO End TB Strategy emphasizes early diagnosis, effective treatment, preventive therapy, patient-centered care, and strong health systems as core pillars for TB elimination [1, 3, 4].

Barriers to effective TB prevention and control are multidimensional and interrelated, spanning the community, provider, facility, program, and policy domains. At the community level, stigma, limited awareness, and socioeconomic constraints can delay care-seeking and reduce uptake of preventive services. At the provider and health-system levels, common barriers include shortages of trained personnel, weak drug and diagnostic supply chains, inadequate contact investigation, weak service integration, and limited access to rapid molecular diagnostics [1, 5, 6]. Financing shortfalls further constrain scaling up preventive activities in many low- and middle-income countries [1].

At the same time, program experience has produced several promising approaches. These include integrating TB services into broader healthcare delivery, using shorter, better-tolerated TPT regimens, adopting digital tools to support adherence and reporting, and strengthening laboratory networks to enable rapid diagnosis. These strategies are more likely to succeed when supported by political commitment, financing, and implementation capacity [1].

Policy makers and program managers occupy a critical position between global guidance and frontline implementation. Their perceptions, priorities, and decisions determine which interventions are considered feasible, urgent, and worthy of investment. Their perspectives are therefore essential to understanding why evidence-based TB preventive measures are implemented successfully in some settings but not in others [7, 8].

Understanding this decision-making layer is crucial for closing the gap between recommendations and implementation in TB prevention and control. This study therefore examined policymakers' and program managers' perceptions of TB control activities, barriers to implementation, and opportunities to strengthen TB prevention and control efforts in Nigeria.

Methods

Study Setting

This study was conducted in Nigeria and included policymakers and program managers at the national level and in three states in Southeast Nigeria: Enugu, Ebonyi, and Abia. The study team purposively selected these states to capture subnational TB program experience within its operational context. Nigeria has a three-tier public health system, with primary care managed by local governments, secondary care by state governments, and tertiary care by the federal government.

Study Design

This qualitative descriptive study used key informant interviews to explore perceptions of TB control and preventive activities, implementation barriers, and opportunities for improvement in Nigeria.

Study Participants and Sampling

Participants included national TB program officers, state TB program managers, and

representatives of partner organizations involved in TB control in Nigeria, such as WHO, KNCV, CARITAS, IHVN, and GLRA. Participants were selected purposively based on their roles, experience, and involvement in TB policy or program implementation. Heads of agencies or senior representatives were invited to participate. A total of nine key informants were interviewed.

Data Collection and Analysis

Data were collected using a pretested key informant interview guide. The guide was piloted with program staff who were not included in the final study, and minor revisions were made for clarity. Interviews were conducted in English, either face-to-face or by phone when in-person interviews were not feasible. Each interview lasted 45 to 60 minutes and was audio-recorded with the participant's consent. Field notes were also taken to capture nonverbal cues and contextual observations.

Audio recordings were transcribed verbatim and cross-checked against field notes for completeness and accuracy. Transcripts were imported into NVivo version 12 for analysis. Coding followed a thematic approach that drew on predetermined themes from the interview guide and on new themes that emerged during analysis. Codes were reviewed and reconciled by the research team, and related codes were grouped into broader thematic categories. The final analysis yielded themes related to TB control activities, preventive activities, barriers, service integration, reporting systems, and recommendations for program improvement. Data saturation was reached when no new themes emerged from subsequent interviews.

Ethical Considerations

Ethical approval was obtained from the Health Research Ethics Committee of the University of Nigeria Teaching Hospital (UNTH). Written informed consent was obtained from all participants after the study's purpose was explained. Participation was voluntary, and participants were informed of their right to withdraw at any time without consequence. All information provided was treated confidentially, and transcripts were anonymized before analysis.

Results

Participant Characteristics

Nine key informants participated in the study, including seven males and two females. All participants were married and had tertiary education. The mean age of participants was 48 years (SD ± 9.39). Participants included policymakers, program managers, and representatives of partner organizations involved in TB control and prevention in Nigeria.

Perceptions of TB Control Activities

Most key informants described themselves as highly experienced in TB control and prevention. They generally agreed that the TB burden in Nigeria is responding to ongoing program interventions, including active and passive case finding, strengthened engagement with primary healthcare, improved diagnostics, digital chest X-ray, and monitoring and evaluation activities. Respondents consistently viewed these efforts as evidence of progress in case detection, linkage to care, and program reach, particularly at the primary healthcare and community levels.

> *"…The most important thing that has been done is community structure and primary health care has been empowered to provide care (TB care) which is very important because it's helping us reach health inequality because people at the rural area, the hardly-reached communities…and also to ensure that the patent medical vendors, the community structures are fully involved in TB"* (CARITAS KI)

> *"….So by and large, they continue to ensure that the drugs are available, diagnostics are available. We even with the introduction of these artificial intelligence*

*for screening, portable digital screening, we see that bringing cutting-edge technology closer to the people, offering like a holistic care…." (*CARITAS KI)

Participants consistently reported significant progress in TB control activities. One of them said the following in support of the benefits of the control activities:

*"…., I would say that the implementation of the TB control and preventive activities in our state has witnessed notable progress, ……*we have hit 1,885 cases as a state and more than half of these cases either came from the BPM component or the community BPM component. So that is why I said we have witnessed notable progress, most especially in case finding…." ***(Abia KI)***

*"….Before we used to have diagnostic issues, but with the inflow of access to diagnostic, now we have TD Lab, we have TUNAS, I think it has been addressed. So, diagnosis now is not a whole major issue because then it was dependent on electricity and all those but with the inflow of these other diagnostic too, I think diagnosis is getting better…" **(CARITAS KI)***

These respondents also noted a very impactful outcome in preventive activities, especially with the introduction of TPT for highly risk contacts with Tb cases. One respondent emphasized this

"…….Okay, my TPT is, in fact, is a laudable introduction in the TB programme. ***….****Yes, it is something I admire a lot and I believe that it has very good potentials going forward. However, there are still a few challenges that has to do with the acceptability of the TPT, especially among contacts of TB patients…."* (**Abia KI)**

As part of control activities, a few respondents noted that their responsibilities include supporting TB control, such as conducting M&E activities using the designated tools. They track program performance. One of them stated

"…., my experience also involves providing evidence-based feedback for the programme manager and other stakeholders in the programme, which ensures that we improve our service delivery across board, as well as monitoring the uptake of TBT and identifying any other gap in the programme…" (Abia KI)

The attitude of healthcare workers was also noted

*". a lot has been said about this, and there are a lot of studies showing that the attitude of health care workers may be a barrier to health-seeking behaviour in the communities…"(*KNCV KI)

Barriers to TB Preventive Activities

The most commonly reported barrier to TB preventive activities was low uptake of tuberculosis preventive therapy (TPT). Respondents cited mainly hesitancy, poor awareness, inadequate counseling, stigma, transport costs, and the perceived burden of a long treatment duration. Many participants noted that the earlier 6-month isoniazid regimen was poorly accepted, whereas shorter regimens, such as 3HR and 3HP, were more acceptable and had higher completion rates (World Health Organization, 2024).

"…*They will want to find out why they will take a medication for six months, at which is also the same duration the relative or contact will also take. So it's just like Mr. A is saying, if Mr. B has TB and is taking medication for six months, I myself, if I do not have TB, why do I also have to take medication for six months? Yeah. So which is, and their concerns are genuine…." (Abia KI)*

"… you know, so one of the things also that we have also noticed in the programme within this field is that the shorter regimen, the three HR, the three HP and the one HP has also helped in acceptability. It has improved acceptability…." (Abia KI)

"…that the awareness about TB preventive therapy or preventive control or preventive practices. (CARITAS KI)

Interactions with these key informants have also shown stark differences in the uptake of control activities compared with preventive activities, with control activities favored. The rate of uptake of control activities is notably higher than that of preventive activities. These include stigma, financial constraints, hesitancy to seek counseling and testing, poor counseling, delays in acceptance of TPT, low acceptance rates for TPT, lack of social support, and perceived untoward side effects of the TPT regimen that discourage uptake.

"…***stigma*** *is part of it. People, because of stigma, they stay at home. They stay at home and don't come out to be treated…"(*Ebonyi KI*)*

The preventive activities have also been negatively affected by a lack of access or financial resources on the part of the patients. This occurs in various forms, including the cost of transportation to and from the DOT center, as one of the respondents noted.

"…. So we've had situations, you know, spend money, give them to transport themselves down to their houses. We've also had situations where patients have defaulted and as a result of patient defaulting, the DOT provider tracks the patients by initiating a phone call and the patients, you know, reveals to the DOT officer over the phone that the reason why he or she has not come to pick the refill is because he or she does not have money for transportation…" (Abia KI)

Stigma also featured prominently among the barriers to TB control services. Both self-stigmatization and community stigmatization (family and friends) are implicated, as reported by a key informant.

"…the other one you talked about stigma, stigma is still thrive in the society and one of the challenges with stigma is that it leads to people concealing their signs and symptoms and they'll keep concealing it up to a point where they eventually present late…" (Abia KI)

The long regimen of TPT has generally been criticized and regarded as a major barrier to its uptake, and this has been reversed with the shortening of the duration from 6 to 3 months.

*"…like I told you earlier, this shorter regimen have, in fact, the progression of the shorter regimen have to be very large extent, taking care of that issue…"(*Abia KI)

A low level of awareness of preventive services was also noted by almost all respondents, as some shared their insights.

*"…and that person does not have information, the acceptability will not be that high, that's just it…"(*CARITAS)

Barriers to TB Control Activities

Respondents identified several barriers to TB control activities in Nigeria. These included inadequate funding, weak social support for patients, insecurity, staff attrition, insufficient staffing, limited access to services in rural areas, low staff motivation, insufficient continuing training, low community awareness, stigma, and gender-related differences in health-seeking behavior. Participants emphasized that these barriers reduce case finding, treatment continuity, and overall program performance.

".the incentive has a role it plays in the motivation of DOT officers….Insecurity is a very big challenge… "(Abia KI)

Attrition was also a major problem, leading to the depletion of trained staff, as confirmed by a stakeholder.

"…So you see someone in a facility today, by the next time you are coming, the person may have relocated out of the country. Everybody is, of course, looking for greener pastures…"(KNCV KI)

A few complained about a lack of basic TB services in rural areas. They decried the inverse distribution of healthcare facilities and workers across the state, noting fewer workers and facilities in rural communities and more in

urban areas. Funding has been a recurring complaint among these respondents. One of them stated

" *…the governments have not really…the counterpart funding for most of the states are not forthcoming and with the dwindling funds, and what we are seeing in the global landscape currently, is actually a barrier…"(*CARITAS KI)

"…, I would say that many, a couple of rural areas in my state lack basic TB services. And…yes and, in the sense that there are a lot of health facilities within the urban areas compared to what is obtainable at the rural areas*…." (Abia KI)*

Accessibility of the facilities was also a major issue, as a client had to spend significant time reaching the facility.

"…so you find a situation where somebody in the rural area has to travel for a longer distance to access the nearest health centre compared to the distance somebody in the urban area would have to travel…."(Abia KI)

The issue of social support for patients was also noted as one of the barriers

"…Social support for patients is also a major barrier, you know TB is like, in quote or unquote, the use of the drug, so most times you're trying to give someone drug and the person not eaten, the person has other underlying issues, Yes…which could help in getting this person to do well. .So, it's a major barrier.*"(CARITAS KI)*

The Monday sit-at-home order by non-state actors affects attendance in service areas, as noted by most.

"….we noticed that monday, people were really not coming to the hospital again and those that missed opportunities, because those who would have come and would have been screened for TB were not. So, in fact, the insecurity in Imo, we also noticed that some hospitals that were in areas that had high insecurity, even up to now, they have not really been able to get themselves. So, it has an indirect impact on the programme…." (CARITAS)

However, with the sit-at-home order on Mondays relaxed by the current state government, an unprecedented increase has been observed in case finding and enrollment, as confirmed by a KI.

*"…We have now started witnessing an increase in notified cases from that LGA, which buttresses the point that insecurity has a role it plays on case finding and, you know, running of the TB programme in a location…" (*Abia KI)

Poor awareness or ignorance about TB control activities among the population has also been noted, as mentioned by one of them.

"…knowledge gap in the community. ……there are some places you go to, and you encounter presumptive cases, and they tell you they have been coughing for a long time, and none of them have thought of TB at all…" (Abia KI)

*"….Nobody wants to die! If you interview your patient very well, the one that is defaulting from treatment or refuses treatment, it's because the patient is ignorant. He doesn't understand what you are saying…" (*Ebonyi KI)

Inadequate staffing also affects activities

"Health worker issue is a general problem for the country and even for the world. We don't…we don't have enough but with tasks shifting…and in fact even the capacity of the ones we have, is also a major issue. But by and large, there is not enough health workers currently…" (CARITAS KI)

Gender is also acknowledged as a factor affecting the uptake of these services. Some respondents noted that females were the greater beneficiaries compared to males, but surprisingly, they felt there were more females who came for TB screening, while more males seemed to be cases.

"…and TB disproportionately affects men…So when you look at the numbers, I've done screening there, you see you have

*screened more women, then as you move towards presumptive, you start seeing you're seeing more men, then as you move towards case…it's almost double. You understand? The screening is more of women, but the cases are more of men…."(*CARITAS KI)

Stigma is still considered a major challenge by most of these informants.

"TB still has a stigma. In as much as we are still struggling in the community trying to raise awareness, there's still self-stigma that the person thinks and there's still stigma from the around. So, those affect the uptake of TPT…" (CARITAS KI)

Perceptions of DOTS

Respondents regarded the DOTS strategy as a major strength of TB management in Nigeria. They described it as effective in promoting adherence, reducing treatment defaults, facilitating follow-up, and lowering the risk of drug resistance. Participants also noted that DOTS enables closer patient monitoring and contact tracing. However, some respondents reported that recent stock-outs of anti-TB medicines had affected implementation.

"…., in terms of adherence, well, I would say that the DOT strategy has helped a lot. We've had a significant compliance with treatment, that is, uptake of treatment among TB patients…" (Abia KI)

DOTS offers TB healthcare workers a great opportunity to get to know these patients closely and follow them up, preventing attrition and tracking contacts. A stakeholder stated

". and most times when you call them, they will not tell you that they have travelled to this place, they can't come back, or they have relocated. So, what we do in that situation is now to find a way to link them to the nearest facility there, so that they can continue treatment over there…" (Abia KI)

One of the challenges of DOTS recently was drug stock-out syndrome, as noted by a respondent.

"*…for the past one year or thereabouts, we had a disruption with the global supply chain system for for TB drugs, where we had a very serious stock out of these commodities…"(NTBCL KI)*

*"….ab initio (before now), but I think we're practising expanded DOT or something…the DOS is still there, because now the patient goes home but he's supposed to have a treatment supporter…"(*CARITAS KI)

Views on Integrated TB Services

All respondents supported integrating TB services with other healthcare services. They viewed this approach as more patient-centered, more efficient for the health system, and potentially helpful in reducing stigma. Several participants believed that service integration had already contributed to improved case detection and broader program reach, provided that TB service quality is maintained.

"….for now, our cases are increasing, our case started increasing from 300, from 600. It's now over 1,000. It's there because I am playing and I integrate my programme with other programmes. I don't say just because I am a TB man, I cannot work with nutrition. I don't say because I am a TB man, I cannot work with MNC…." (Ebonyi KI)

"…Like, I'm a champion of integration now. Anything that is not integration doesn't have me, any backstop project…" (CARITAS)

They also look beyond increasing case finding and view the integration of services as a way to address socio-cultural issues such as stigma, as one respondent stated:

"…So integration is very good because if you work in solitude, you can't get to all the people, because if you work in integration, the stigma will reduce. The reduction of stigma can only survive in integrated services…". (Ebonyi KI)

Perceptions of the Recording and Reporting System

Respondents expressed general satisfaction with the standardized TB recording and reporting system, noting it is consistent and widely used across facilities and program levels. However, many emphasized that continued reliance on paper-based tools is costly and inefficient. Digitization was repeatedly described as overdue, particularly because shortages of printed forms often lead to photocopying, which can compromise data quality and standardization.

"…Our recording and reporting system are okay, even though we've had situations where other programmes that uses the quarterly system of reporting. And I don't know why they always quick to tell us that because some of them are either reporting monthly or bimonthly but for us in the programme, it is very effective. It is very efficient, including the, you know, the route of reporting, starting from the health facility up to the local government level, to the state level, to the national level, very sound…" (Abia KI)

"…I must tell you sincerely in terms of recording and reporting system we have, it is one of the best in the world, in the sense that anywhere you go in Nigeria, any facility you go, we have the standard way of recording and reporting TB interventions. The indicators are the same across the board. And the same tools, the same reporting, irrespective of who is supporting it and as a national programme." (NTBLC KI)

While they acknowledge that the reporting tools were needed quarterly, the recording tools are used daily. Most of them noted with sadness the inadequacy of these instruments, which necessitates photocopying and might affect the standardization and quality of the tools, as they have noted.

"…The only challenge we've had with the reporting and recording system is that for some time now, we have not had adequate reporting tools. While the recording tools have been in adequate supply, the reporting tools are not adequate in supply…resulting to photocopying … it affects the standardization…*"* (Abia KI)

…"So with that, it makes it a bit challenging that currently we are having some stock out of some recording tools. For example, like the sample specimen request form, they are in shortage in Nigeria, though there are top-line preparations to print enough this year…." (NTBLCP KI)

Recommendations for Improving TB control

Respondents proposed several strategies to improve TB control and prevention in Nigeria. These included increased domestic funding, stronger political commitment, improved community sensitization, engagement of religious and traditional leaders, staff recruitment and retraining, social support for patients, greater integration of services, digitization of reporting systems, and expansion of local production of TB medicines and diagnostics. Participants also emphasized the need to fully integrate TB services into national health insurance.

"…So I recommend that every stakeholder, including the government of Nigeria at all levels, should intensify funding to ensure that adequate resources by way of funding is available for the TB programme to ensure that the implementation is smooth without any hitches…" (Abia KI)

"So one thing now which, TB across the country now, they've done this community intervention that's everywhere and we are hoping that it should saturate and we will have lesser and lesser of the misconceptions around TB…" (CARITAS KI)

"….we should also make sensitization, let people know that for every diagnosed TB patient, there is a therapy that can help the

contacts and prevent them from coming down with TB…." (Abia KI)

"*And also, in addition to creating awareness, we also need to engage religious leaders, engage traditional rulers. …"* (Abia KI)

"….I would also recommend that the ACSM unit of the National TB Programme should go a long way in engaging traditional rulers, religious rulers, so that they can be used as contact points in the communities to counter cultural barriers…" (Abia KI)

Training and retraining of workers, including DOT officers, were also recommended, given the high rate of attrition, as requested by a key informant. On-the-job training was also mentioned.

"…Yes! There should be more formal DOT trainings for DOT officers across board. What we have been having over the years is DOT expansion training and DOT expansion training focuses only on new DOT sites but there is no doubt that existing DOT sites have been affected by staff attrition over the years, most especially in the private sector…"(Abia KI)

On rating the TB standardized recording and reporting system as we have it now

I must tell you sincerely in terms of recording and reporting system we have, it is one of the best in the world, in the sense that anywhere you go in Nigeria, any facility you go, we have the standard way of recording and reporting TB interventions. The indicators are the same across the board. And the same tools, the same reporting, irrespective of who is supporting it and as a national programme, we try to ensure we bring all the partners together. (NTBCL KI)

Sensitization through outreaches to raise awareness of the signs and symptoms of TB among communities, using jingles with dedicated phone numbers for DOTS facilities to enable easy access

". So we need to be able to have those people talk about TB and increase the population's awareness and sensitize them about TB. ."(IHVN KI)

"…to know that, yeah, these are the signs, this is the number to call, this is where to go to and if somebody is positive, the contacts can as well take this medication and will not come down with TB…" (Abia KI)

"…We need to see that the…first, we are getting healthcare workers at the lowest level well-equipped with knowledge about TB and TB control, beginning from schools of health technology, schools of hygiene. All those should basically be able to understand symptoms of TB and other common illnesses…" (IHVN KI)

Advocates have called for greater political will and commitment from the government, including NHIA coverage of TB services. The government should also create an enabling environment for local production of TB medical consumables, such as diagnostics and drugs, to reduce costs for patients and the country.

*"…We need to see more than political will. We need to see commitment, action by government at all levels for TB control and for integrated healthcare service delivery in Nigeria…*we *need to see the National Health Insurance Agency that was formerly known as NHIS. We need to see TB integrated into that package of care. "* (IHVN KI)

"…Since we know we will need them for many years to come in a large number, in a large scale, why don't we have any medicine for TB prevention or TB treatment being produced in Nigeria? Those are areas where we should look into to unlock the value chain…" (IHVN KI)

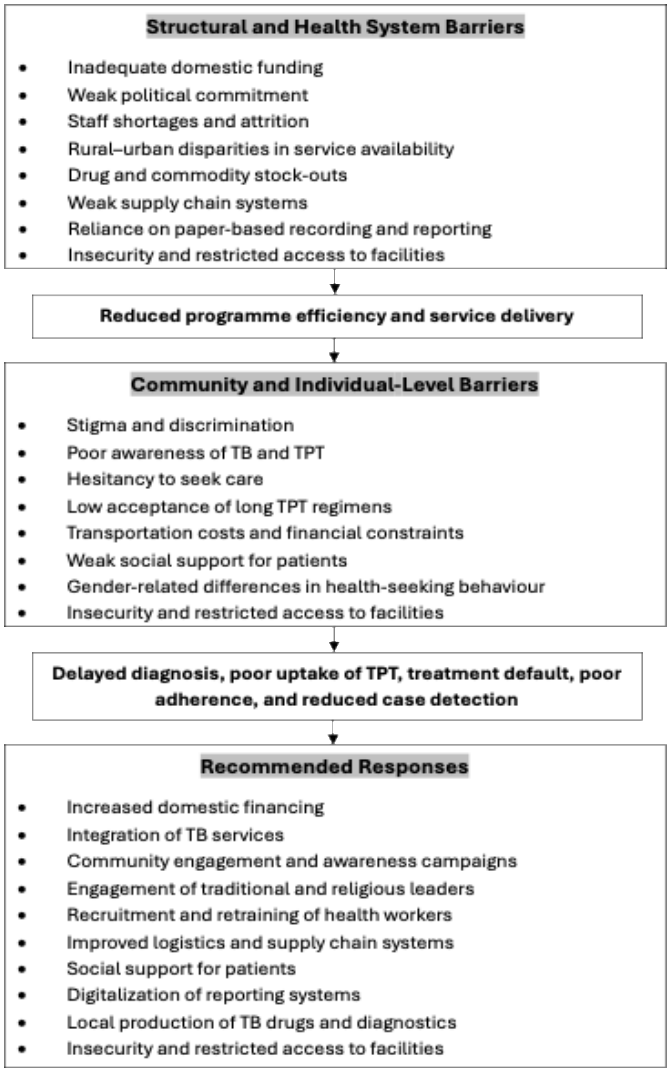


Figure 1. Conceptual Framework of Barriers to Tuberculosis Prevention and Control in Nigeria

Figure 1 illustrates the interrelationships among structural, health-system, community, and individual-level barriers to tuberculosis prevention and control in Nigeria, as well as the recommended strategies identified by policymakers and program managers.

The major themes, key findings, and illustrative issues raised by policymakers and programme managers are summarized in Table 1.

Table 1. Summary of Key Themes and Illustrative Findings from Interviews with Policymakers and Programme Managers on Tuberculosis Prevention and Control in Nigeria

Theme	**Key findings**	**Illustrative issues raised by participants**
Progress in TB control activities	Participants reported improvements in community-based case finding, diagnostics, TPT, DOTS, and monitoring systems.	Expansion of primary healthcare services, digital chest X-ray, AI-supported screening, and improved access to diagnostics.

Perceived benefits of TPT	TPT was viewed as an important preventive intervention, especially for household contacts and high-risk groups.	Respondents reported that shorter regimens such as 3HR and 3HP were more acceptable than 6-month isoniazid therapy.
Community-level barriers	Stigma, poor awareness, low risk perception, and poor counseling reduced uptake of preventive activities.	Fear of discrimination, delayed care-seeking, and low acceptance of TPT were commonly reported.
Financial barriers	Transportation costs, poverty, and weak social support limited access to TB services.	Patients often missed appointments because they could not afford transport to DOTS facilities.
Health-system barriers	Staff shortages, attrition, inadequate training, poor staff attitudes, and drug stock-outs reduced programme effectiveness.	Rural areas had fewer health facilities and trained personnel than urban areas.
Security and access barriers	Insecurity and movement restrictions disrupted case finding and service utilization.	Sit-at-home orders and insecurity reduced attendance at health facilities in some states.
Perceptions of DOTS	DOTS was widely regarded as beneficial for adherence, patient follow-up, and treatment completion.	Participants highlighted the importance of treatment supporters and contact tracing.
Service integration	Participants strongly supported integrating TB services into other health services.	Integration with maternal and child health, nutrition, and primary healthcare services was considered beneficial.
Recording and reporting systems	The standardized TB reporting system was viewed positively, but paper-based tools were considered inefficient.	Frequent shortages of reporting tools led to photocopying and concerns about data quality.
Recommendations for improvement	Respondents recommended stronger funding, digitization, training, social support, awareness campaigns, and local production of TB commodities.	Participants emphasized the need for political commitment, NHIA integration, and community engagement.

Source: Authors' fieldwork and thematic analysis of qualitative interviews with policymakers and programme managers on tuberculosis prevention and control in Nigeria, 2026.

Discussion

This study offers policy-level insight into the persistent gap between TB program implementation and optimal outcomes in a high-burden setting. It found that policymakers and program managers generally viewed ongoing tuberculosis (TB) control interventions in Nigeria as beneficial, particularly the expansion of community-based activities,

improved access to diagnostics, tuberculosis preventive therapy (TPT), and directly observed treatment short-course (DOTS). However, respondents consistently emphasized that sociocultural, financial, and health-system barriers continue to limit the full impact of these interventions. This pattern mirrors the broader global TB context, where progress in prevention, diagnosis, and treatment remains constrained by persistent system weaknesses and implementation gaps [1, 5, 9, 10].

A key finding was that respondents viewed recent improvements in diagnostic access and decentralized service delivery as key drivers of progress in case detection and linkage to care. Their emphasis on primary healthcare and community structures underscores the importance of decentralization in improving access to TB services in high-burden settings. This aligns with global TB guidance, which emphasizes early diagnosis, patient-centered care, and strong health systems as core pillars for reducing the TB burden [4, 5].

Respondents also regarded TPT as an essential preventive intervention, particularly for household contacts and other high-risk populations. However, they clearly distinguished between its theoretical benefits and the practical challenges of implementation. Low uptake, hesitancy, and delayed acceptance were linked to poor awareness, inadequate counseling, stigma, transportation costs, and the burden of long treatment duration. Participants consistently reported that shorter regimens, such as 3HR and 3HP, were more acceptable than the traditional 6-month isoniazid regimen. This aligns with WHO recommendations, which support shorter rifamycin-containing regimens for their improved acceptability and completion rates [3, 4, 11].

Stigma emerged as a major barrier to TB prevention and control. This finding is consistent with extensive evidence demonstrating that stigma remains a major determinant of delayed care-seeking, treatment interruption, and reduced uptake of preventive services in TB programmes [12, 13]. Respondents described self-stigma and community-level stigma as key drivers of delayed care-seeking, non-disclosure, and resistance to preventive therapy. They also highlighted low awareness and inadequate counseling as key contributors to poor service uptake. These findings reinforce the need for stronger community engagement, targeted health education, and the involvement of community, religious, and traditional leaders. Similar qualitative studies have identified stigma, delayed presentation, and operational barriers as persistent challenges in TB program implementation [7].

Another important theme was strong support for integrating TB services with other healthcare services. Integrating TB services into broader health systems has been shown to improve access, reduce fragmentation, and enhance efficiency in TB program delivery [14].

Respondents viewed integration as more patient-centered and more efficient, and potentially effective in reducing stigma. They also believed that integration could enhance case detection and program reach. However, they emphasized that integration should not compromise the quality of TB programmes. This highlights the need for careful implementation of integration strategies to ensure that infection control, diagnostic pathways, and reporting systems are maintained.

The findings also highlight major health-system constraints. Respondents repeatedly cited inadequate staffing, attrition of trained personnel, maldistribution of health workers, lack of ongoing training, and poor staff attitudes as key barriers to service quality and patient trust. Health workforce shortages and maldistribution have been widely documented as major constraints on TB service delivery in high-burden settings, affecting both the quality of care and program coverage [15]. These

findings align with existing evidence that workforce limitations and weak institutional readiness significantly undermine TB control in resource-constrained settings [16-18]. In addition, rural–urban disparities were noted, with rural populations facing greater barriers to accessing TB services.

Financial barriers were also prominent. Catastrophic costs for TB diagnosis and treatment remain a major barrier to access and adherence, particularly in low-income settings [19, 20]. Respondents cited transportation costs, limited social support, and insufficient domestic financing as key barriers to access and continuity of care. These findings reflect broader health system challenges in low- and middle-income countries, where indirect costs and weak financing structures continue to constrain program effectiveness [1, 5].

Respondents strongly emphasized the continued relevance of DOTS, describing it as a key strength in TB management, particularly for supporting adherence and reducing treatment defaults. However, they also highlighted the impact of drug stockouts and supply chain disruptions, which undermine program effectiveness. This underscores the importance of strengthening procurement, forecasting, and supply chain systems alongside service delivery interventions.

Another important finding concerns the recording and reporting system. Although respondents were satisfied with standardized tools, they consistently noted that reliance on paper-based systems is inefficient, costly, and prone to inconsistencies, especially when stock-outs require photocopying. Their strong call for digitization reflects a broader shift toward digital health systems to improve data quality, timeliness, and program monitoring. Digital health technologies are increasingly recognized as critical tools for improving TB surveillance, adherence monitoring, and program efficiency in resource-constrained settings [21].

This study has important strengths. It captures the perspectives of decision-makers and implementers directly involved in TB control, offering practical insights into program realities. However, it also has limitations. The small, purposively selected sample limits generalizability, and responses may have been influenced by social desirability bias. In addition, the findings are based on perceived experiences rather than on independently verified program data.

Overall, this study shows that although TB control efforts in Nigeria are progressing, their effectiveness remains constrained by structural and contextual barriers. Addressing these barriers will require coordinated, system-wide interventions that go beyond technical solutions to include community engagement, workforce strengthening, sustainable financing, and improved data systems.

Conclusion

TB control efforts in Nigeria are improving but remain constrained by persistent socio-cultural, financial, and health-system barriers. Strengthening workforce capacity, expanding service integration, improving financing, and accelerating digital transformation will be essential to improving program effectiveness and achieving TB control targets.

Competing Interest

The authors declare that they have no known competing financial or non-financial interests that could have influenced the work reported in this paper.

Consent for Publication

Not applicable. This manuscript does not contain any individual's data in any form (including individual details, images, or videos).

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Ethics Approval

Ethical approval was obtained from the Health Research Ethics Committee of the University of Nigeria Teaching Hospital, Enugu, Nigeria (Approval Number: NHREC/05/01/2008B-FWA00002458-1RB00002323). Written informed consent was obtained from all participants.

Author Contributions

EU conceptualized and designed the study. EU, AEC, AO, and JK contributed to data collection and to the development of the study methodology. EU and AEC conducted data analysis, statistical analysis, and data visualization. EU, AEC, AO, and JK drafted the manuscript. AEC, AO, and JK critically reviewed the initial draft. All authors contributed to interpreting the findings, revised the manuscript for important intellectual content, and approved the final version.

Data Availability

The datasets generated and analyzed in this study are not publicly available because the data are qualitative and participant confidentiality must be maintained. De-identified data may be provided by the corresponding author upon reasonable request, subject to ethical approval and institutional requirements.

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Healthcare Workers' Perspectives on Improving Patient Safety: A Thematic Analysis of Open-Ended Survey Responses from Public Hospitals in Tshwane District, South Africa

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Abstract

Resource constraints in the healthcare system environment present a serious encounter that impact negatively on patient safety. Although quantitative indicators provide measurable evidence of patient care outcomes, employees' suggestions provide perspectives from the lived experiences. This study explored healthcare workers' recommendations for strengthening the safety of patients within Tshwane District public hospitals. The methodology applied in the analysis of the open responses is qualitative and descriptive in nature. These responses are component of the answers of the questionnaire tool of the broader cross-sectional survey on service quality dimensions and safety in public hospitals within Tshwane district. The responses from 108 participants were examined through thematic analysis. The investigation encompassed coding, categorization including recuring themes identification. Eight themes emerged from the findings included the following constraints: staffing, infrastructure, accommodation space, equipment availability including supplies, governance including organizational weaknesses, professional skills proficiency, Hospital safety culture, Communication obstructions, patient overflow including high numbers, health information limitations. Personnel shortages, inadequate infrastructure, as well as insufficient resources were most frequently reported concerns. The findings indicate that safety challenges experienced in the public hospitals in Tshwane health district are fundamentally systemic in nature and require coordinated interventions focusing on workforce strengthening, improving infrastructure including positive safety culture enforcement.

Keywords *Communication, Health Systems, Hospital Safety, Risk Factors, Safety Culture, Thematic Analysis.*

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Introduction

The safety of patients is mainly regarded as an important dimension of healthcare service quality that poses distress globally and publicly. High mortality and morbidity rates found in low- and middle-income countries are mainly due to avoidable harm [1]. Despite the availability of patient safety and service quality guidelines, policies and regulations, the evidence of patient harm in the health facilities is escalating. The national guideline of patient safety indicates that many of these adverse events are associated with organizational including systemic weaknesses rather than isolated human error alone [2]. Public health institutions in South Africa continue to face operational pressures such as staff shortages, infrastructural inadequacy, overcrowding and resource deficiencies [3]. Although previous quantitative studies have examined the relationship between service quality and hospital safety outcomes, very few studies have identified the health professionals' personal suggestions for reinforcing best practices in health facilities [4].

Health professionals occupy a central position within the healthcare system; additionally, they are directly involved in patient care service delivery. Activities such as using equipment for patient procedures, along with daily interactions with multidisciplinary teams, put them in a unique position to identify operational gaps and inefficiencies, including potential risks. In addition, their standpoint may not only offer precise real-world perspectives but may also provide advance development of policy and enhancement in structural initiatives [5].

This investigation therefore examines the suggestions provided by health professionals about patient safety in public hospitals in the Tshwane district. The participants responded with qualitative suggestions planned to be used to quantify the broader numerical results linking safety in hospital setting and quality of service.

Methods

Study Design

A qualitative descriptive design is used to explore healthcare workers' perspectives regarding improving safety in the hospitals within Tshwane district.

The qualitative element is the section of the main cross-sectional design investigating relationships between the dimensions of service quality and hospital safety within the district.

The qualitative methods enable an in-depth exploration of participants' experiences, views, including suggestions regarding the safety of patients within the public hospitals. Additionally, the qualitative method afforded the contextual understanding that complements quantitative findings of the broader study [6].

Study Population and Site

This study took place in public hospitals in the metropolitan municipality of Pretoria, in the Gauteng province of South Africa. These hospitals serve a population of over 3.5 million. The area is mainly urban but also encompasses informal settlements including peri urban communities. The levels of care facilities include Primary Health Care clinics, Community Health Care Centres, Hospitals (5 district, 1 regional, 1 tertiary and 2 centrals academic). The academic hospitals also offer specialist health services to other provinces such as Limpopo, Northwest, and Mpumalanga, as they do not have central academic hospitals. Each academic hospital leads a cluster in its referral chain: one cluster composed of 2 tertiary hospitals, one regional hospital and 3 district hospitals, whilst another academic hospital leads a cluster composed of 2 district hospitals in its referral chain, which results in Primary Health Care clinics and Community Health care centres referring directly to central hospital. This academic hospital also receives direct walk-ins as a self-referral.

The accessible population consisted of all healthcare workers in public hospitals as mentioned above. The health professionals (managers, doctors, nurses, support staff), from these facilities were included in the study in order to capture the diverse views in advancing the care of patients. Different professional disciplines are important for encouraging relationships and organizational dynamics [7].

Participants Recruitment

Data collection was simplified by holding the planned meeting with the authorities of participating hospitals to provide information on the study purpose, clarify objectives, and explain the data-collection method. The person was nominated per each hospital during these sessions to be a liaison for support and dissemination of tools for collection of data. This stakeholder engagement procedure is crucial to increase participation rates and facilitate the execution of study activities in health facilities [8].

Data Collection

Self-administered Survey tool was developed through the University of Pretoria (UP) Qualtrics program. The last portion of the survey tool was an open-ended question, intended to gather the perspectives of health professionals in enhancing the hospital safety within their individual health facility. An anonymous survey link was created through the UP Qualtrics program and sent to the participants through internal messaging platforms such as WhatsApp groups and group emails that are managed by the hospital administration. The process was coordinated by the hospital contact person nominated in the contact session. 108 out of 476 participants who completed the survey, narrated their open-ended answers which shaped the qualitative data of this portion of the research. The answers of the participants were downloaded into an excel spreadsheet from University of Pretoria Qualtrics online platform where data were collected.

Data Analysis

Open-ended answers were analysed using reflexive thematic analysis as outlined by Virginia Braun and Victoria Clarke [9]. The appropriateness of this approach is in identification of patterns and themes within qualitative information derived from survey answers, mainly in healthcare research discovering health professionals' perceptions on hospital safety [10, 11]. Analytical technique includes the following six phases:

Data Familiarisation: All answers were read multiple times to ensure immersion in the data. The answers to the open-ended question were downloaded from the Qualtrics online platform into an Excel spreadsheet to ease the repeated readings.

Initial Coding: Inductive coding was applied, allowing themes to emerge from the data. The answers that had the similar meaning were identified and put together as codes as illustrated in column 3 & 4 of Table 1 to 4 below are developed to illustrate the codes derived from the responses per the level of hospital, where Table1 is for central hospital, 2 is for tertiary, 3 for regional and 4 is for district hospitals.

Themes Development: Codes that are similar and carry same interpretation were grouped into broader categories of themes reflecting main hospital safety issues as indicated in column 2, 3 & 4 of Table 1–4.

Themes Review: Themes were evaluated and refined to make sure that they are logic and distinct between categories to ensure consistency. The themes that have the same understanding from Table 1–4: column 2 were grouped together as main themes, depicted in Table 5: column 1 &2.

Theme definition and naming: Each theme was clearly defined, as well as assigning suitable name as accurately presented in the content. Table 5: column 1 illustrates the names of main themes and is defined in terms of categories as indicated in Table 5: column 2 and example of keywords or codes in column 3. Furthermore, the main themes are described in terms of the responses in the results section below.

Reporting: Findings were presented using anonymised participant quotations.

Table 1–4 below, indicates each code emerged from the responses (column 3), the names of themes emerged from codes (column 2), and the interpretation of each code according to the levels of hospitals.

Table 1. Represents Theme Names, Codes, and their Interpretations from Central Hospitals

Level of Hospital	Theme	Code	Code Interpretation
Central Hospital	Infrastructure and capacity	Overcrowding	The code indicates that high patient volumes affect patient safety. The pressure is felt in the wads, emergency, and specialized units in central hospitals. This results in difficulties for proper monitoring as well as providing care timeously
	Infrastructure, capacity	High patient volumes	The code indicates a high value because central hospitals serve extremely high volumes of more complex conditions. More non-complicated referrals add to the burden on the same level of care. A large number of patients leads to a heavy workload, which can delay care, cause missed care, and reduce the quality of patient monitoring.
	Infrastructure, capacity	Ageing infrastructure	This code refers to old or poorly maintained hospital buildings that endanger patient safety in areas such as hygiene, including infection prevention and control.
	Infrastructure, capacity	Theatre scarcity/ shortages	Inadequate theatre resources mean surgical procedures are delayed. Very urgent, including complex surgical cases, are referred to central hospitals. Theatre shortages may delay operations and diagnostic procedures.
	Infrastructure, capacity	Low bed capacity	This code shows that patient safety is compromised when hospitals lack sufficient beds to care for patients properly. Bed shortages can lead to patients being stuck in inappropriate areas, delayed admission, and a lack of continuity of care.
	Mental healthcare pressure	Insufficient psychiatric facilities	This code addresses the issue that users of mental healthcare are infrequently managed in appropriate facilities. Inadequate psychiatric wards in central hospitals can pose risks to the safety of other psychiatric patients, staff, as well as the patient him/herself.

	Referral approach	Referral bottlenecks	A code indicates that central hospitals are congested with patients referred from lower-level facilities. Weak referral flow leads to more congestion and undermines the hospital's efficiency, concentrating on specialized care.
	Patient flow	Long waiting times	This code means the patient safety risk is of waiting time. Prolonged waiting times could be linked to overcrowding, insufficient numbers of staff, inadequate theatre facilities, insufficient number of beds as well as patient-flow inefficiencies.
	Clinical systems	Electronic patient records	The code indicates that hospitals will have to introduce more advanced information systems. This code highlights the importance of strong information systems, such as electronic patient records, proper documentation, minimizing lost files, and promoting continuity of care and clinician decision-making.
	Governance	Executive responsibility/ Leadership accountability	The code indicates that the respondents consider patient safety as the responsibility of leadership and management. It emphasizes hospital leadership should focus on infrastructure, staffing, resource shortages, and problems of patient flow to avoid the fate of the frontline workers.

Table 2. Illustrates Theme Names, Codes, their Interpretations, from Tertiary Hospital

Level of Hospital	**Theme**	**Code**	**Code Interpretation**
Tertiary Hospital	Specialised clinical care	Specialist-care pressure	The code shows that tertiary hospitals face an added safety challenge because they manage more complex cases. Safety in care therefore comes down to the availability of skilled personnel, working equipment, quality clinical oversight, and trustworthy hospital processes.
	Equipment and resources	Specialist equipment shortages	This means that the lack of advanced equipment for specialized care can compromise the safety of care. In tertiary hospitals, insufficient equipment for specialist treatment can make diagnosis and specialist methods of treatment late.
	Equipment, resources	Broken equipment	The code shows how essential the maintenance of equipment is if the safety of patients is prioritized. Broken equipment can delay care, increase the level of clinical instability plus encourage staff to improvise. Such behaviour may not be considered safe for patients.
	Human resources	Staff training	The code describes the significance of continuing professional education. Based on surveys, it seems to be the case that the respondents appear to uphold that clinical competence, communication, infection control,

			safe practices and adherence to protocols, increased inpatient safety from regular training are supported by clinical competence as well as the prevention, control of infecting the environment and safety protocols.
	Human resources	Medical intern supervision	The code indicates that medical interns, including junior doctors, need oversight in reducing the proportion of clinical errors. In the higher education institutions, which are home for teaching and providing specialist care, little or no attention to safety might make patient welfare even less assured.
	Clinical governance	Incident reporting	These codes are indicative of the requirements of robust patient safety reporting systems. It sounds as if respondents agree on reporting mechanisms that notice dangers and systems failures but don't immediately place the blame on staff.
	Clinical communication	SBAR handover	This code demonstrates the role of structured communication among healthcare workers. Bad handover results in missed clinical details, medication errors, delayed treatment, and interruptions in care delivery. The word 'SBAR' stands for Situation, Background, Assessment, and Recommendation.
	Clinical documentation	Poor documentation	This code shows that incomplete or inaccurate documentation is a patient safety risk. Good documentation supports continuity of care, accountability, and decision-making in clinical practice.
	Medication safety	Availability of medication	A code indicates that constant access to medication is critical to safe care. An insufficient supply of drugs can stall treatment, delay healing, and put patients at risk of unnecessary harm.

Table 3. Reflect the Regional Hospital, Theme Names, Codes, and their Interpretations

Level of Hospital	**Theme**	**Code**	**Code Interpretation**
Regional Hospital	Referral coordination	Poor referral coordination	The code indicates that the weak management of either up or down referral due to insufficient referral pathways or poor referral systems may results in substantial risk of harm in regional hospitals. Good referral coordination can help with timeous treatment and care of patients at the correct level of care.
	Referral coordination	Delayed transfers	The code means that there can be prolonged waiting time before the patient can be transferred to the appropriate health facility. Delayed transfers may result in complications of patient conditions and further increase workload on the staff on regional hospital.

	Referral coordination	Down-referral challenges	The code indicates that the problems exist when coming to referring the patients back to district hospitals after completion of their care in regional hospital, this can affect the availability of beds for admission of new patients and results in overcrowding.
	Outreach and support	Outreach programmes	The code means that the support is needed between referring hospitals. Outreach programs is a strategy designed to assist lower-level hospitals to appropriately manage cases to minimise avoidable referrals to higher level hospitals.
	Resource distribution	Decentralised resources	The code means that the participants need the resource nearer to where patient care services are rendered. Decentralization of resources will reduce the time spent waiting for the resources and further enhance the speedy management of patients' conditions.
	Service capacity	Intermediate hospital capacity	The code means an adequate capacity is required in a regional hospital for the management of conditions that are difficult for district hospital but do not need to be referred to higher level of care. Without the intermediate hospital capacity, regional hospital may experience overcrowding, and increased risks to patient safety.
	Human resources	Staff shortages	The code reflects that there may be inadequate staffing to manage the demand of patient care in regional hospital. This may result in delays in treatment of patients, minimised monitoring of conditions and increased pressure in workload.
	Supply chain	Supply-chain delays	The code indicates the delays in getting equipment and consumables for rendering the safe care to patients in regional hospital. A reliable supply chain systems is required for the sustainability of safe hospital service and reduce the rate of complications.
	Communication	Communication between hospital levels	The code shows that communication between facilities is important for effective referrals, continuity of care and answerability. Poor communication may result in unsafe movement of patients throughout the health system.
	Referral coordination	Poor referral coordination	The code indicates that the weak management of either up or down referral due to insufficient referral pathways or poor referral systems may results in substantial risk of harm in regional hospitals. Good referral coordination can help with timeous treatment and care of patients at the correct level of care.

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Table 4. Reflects District Hospitals, Theme Names, Codes, and their Interpretations

Level of Hospital	Theme	Code	Code Interpretation
District Hospital	Basic operational readiness	Staff shortages	The code indicates that the safety of patients is seriously affected by inadequate staff in district hospitals. Low number of staff in hospitals can results in delays in patient care services such as monitoring of patients, delayed treatment, and poor infection prevention practices.
	Basic operational readiness	Poor staff-patient ratio	The code means that a smaller number of staff is allocated to high number of patients due to staff shortages. Poor staff-patient ratio results in overload of work, exhaustion and increase risk of missed care.
	Support services	Shortage of cleaners	The code indicates that support staff specifically cleaners are important part of patient safety. Cleaners' shortage can adversely affect hygiene and results in high infections rates.
	Infection prevention	Infection control	The code talks to the issue of prevention and control of acquired infections. Infection prevention and control is dependent on hygiene, supplies for cleaning, compliance by staff on procedures such as washing of hands accordingly, and appropriate monitoring.
	Infection prevention	Hand hygiene	The code talks to the participants concerns about the basics hygiene practices as it is central to patient care in the hospitals. Good hand hygiene practices may reduce the risks of infection transmission between patient and staff.
	Material resources	Medication shortages	The code shows that the district hospitals may experience some difficulties with accessing continuous supply of medication. Good and timeous supply of medication will reduce the treatment delays improve the quality of care.
	Material resources	Linen Shortages	The code reflects the importance of every material including linen for delivery of care that is dignified and safe. Adequate linen is essential for hygiene, comfort, and prevention of infection.
	Material resources	Consumables Shortage	The code indicates inaccessible daily supply of clinical supplies in district hospitals. Timeous access to clinical supplies will consistently safeguard routine care.
	Equipment	Basic equipment shortages	The code means that basic and reliable equipment are insufficient in district hospitals. Shortage of equipment may cause assessment delays, poor care, delayed treatment, and monitoring.

	Patient care process	Patient monitoring	This code reflects the importance of regular follow-ups and observations of patient care and safety. Hindrances in regular patient monitoring of the effect of treatment and change in patients' conditions, may escalate the risks of patient being missed or deteriorating.

The themes are summarized, categorized as well as coded and are demonstrated in Table 5 below, the frequency including the percentage score are demonstrated on both last columns, respectively.

Table 5. Reflects the Main Themes, Categories, as well as Response Frequency and Percentage Score

Main Themes	**Categories**	**Example Keywords / Codes**	**Frequency (n)**	**Percentage (%)**
1.Strengthening Staff establishment	Human resource shortages	Insufficient staffing, exhaustion, workload,	48	22%
	Capacity building & carrier pathing	On the job training, skills Continuous Professional Development (CPD)	35	16%
	Staff competence	Experience, knowledge gaps	18	8%
Theme 1 Sub-total			**101**	**46%**
2.Improving Communication plus Teamwork	Interprofessional communication	Handover, Poor communication	28	13%
	Team relationship	Teamwork, Provision	22	10%
	Reporting principles	Case recording, Transparency	14	6%
Theme 2 sub-total			**64**	**29%**
3.Systems improvement and Infrastructure	Equipment availability	Shortages, Malfunctioning	19	9%
	Infrastructure challenges	Overcrowding, Space	12	5%
	Technology structure	Digital records, Systems enhancement	9	4%
Theme 3 Sub-total			**40**	**18%**
4.Strengthening Leadership and Governance	Management support	Supervision, Leadership	15	7%
	Policy implementation	Guidelines, Compliance	10	5%
	Accountability	Monitoring, Reviews	6	3%
Theme 4 sub-total			**31**	**14%**

Results

The last portion of the survey tool comprised of two questions. The first one seeks to determine whether the participants had suggestions for improving patients' safety. Of the 476 participants who responded to the questions, 108 (22.7%) said yes. The second one was the follow-up question phrased as "if the answer in the above question is yes, please elaborate your

suggestions." All the 108 (100%) participants who responded by saying yes to having suggestions for improvement of safety, provided qualitative suggestions. Themes emerged from their suggestions and were summarised into 4 main themes with the categories, presented as follows:

Strengthening Staff Establishment

Human resources shortages were the mostly cited challenge mentioned by those who participated. The theme rating is forty six percent (46%) out of all the themes that emerged from the responses.

Employee shortages: Constraints in human resources were cited many times by a lot of participants touching equally the medical and the support services. Participants highlighted increased workload, fatigue, including reduced service quality because of inadequate staffing. Some respondents indicated what should be done to remedy the situation. Participant quote: "hire more staff so that patient can receive better care they need."

Training and Professional Development: Skills development as well as continuous training in particular safety practices, including clinical competencies' needs were emphasized. Personal protective equipment (PPE) use should also be included in the training program, was indicated by one of the participants.

Staff competency: lack of speciality skills, experiences and knowledge gap were examples of highlighted gaps.

Improving Communication plus Teamwork

Communication and teamwork issues were the second most common factors that affect the safety of patients in the hospitals within Tshwane district. The theme rated 29% of the total themes.

Interprofessional Communication: Challenges with handover reporting and, poor communication, Team relationship, teamwork, provision of clinical care and documentation were some of the highlighted gaps. Reporting principles such as case recording including poor record keeping and transparency, were some of the responses. Referral coordination, poor communication between facilities and communication breakdown, were examples of challenges identified. One of the respondents recommended 'SBAR' (Situation Background Assessment and Recommendation) as a strategy that can be used during handover.

Systems Improvement and Infrastructure

This theme was third of all the themes with 18% of factors affecting patient safety in hospitals within Tshwane district.

Health Information and Technology: Better electronic system is highlighted to improve record management, patient tracing, as well as medication safety.

Inadequate space and infrastructure limitation: Participants indicated that infrastructure is aging and insufficient, as well as theatres, wards including specialized facilities particularly for mental health services.

Overcrowding as well as Patient flow challenges: Emergency unit including psychiatric wards overcrowding, as well as referral systems inefficiencies result in high safety risks, cited by participants. The following is one of the participants' answers: "Mixing psyche patients with internal medicine patients is haphazardous as it creates an uncomfortable environment for patient care."

Resources including equipment insufficiency: Consumables, equipment plus medications are essential resources that were reported to be frequently lacking. Safety risks such as shortages in supply as well as damaged equipment were also mentioned.

Governance, Leadership, System Failure

These issues were the fourth with the rating of 14% on factors contributing to poor patient

safety outcomes, Participants expressed concerns about poor leadership, liability as well as supply chain management lack. Blame culture instead of system enhancement was also cited. lack of a non-punitive reporting culture was identified as hospital safety barriers by those who participated. Participants Quote: "promote a culture of transparency and reporting incidents without fear of blame."

Management support: Participants indicated that there is lack of supervision and leadership. Guidelines are unavailable if not implemented. There is lack of monitoring or reviews of patient conditions, system failures and accountability thereof, mentioned by those who participated.

Discussion

This investigation adds to findings from other studies exploring how healthcare workers perceive patient safety quality at public hospitals in Tshwane District. Participants perceived patient safety issues as primarily a system-level problem, not necessarily individual clinical negligence or error [12]. Key problems were inadequately staffed facilities with unaddressed staff dissatisfaction. Key problems were inadequately staffed facilities, physical limitations on the ground, equipment unavailability and infrastructure, consumable shortages, infrastructure management, communications challenges, and overcrowding. Leadership as well as governance challenges.

The challenges in human resources were also area that is mostly discussed. Health professionals noted that staffing shortages increased clinical workload, fatigue, and burnout, and undermined continuity of patient care. Low levels of staff were noted as delays in the treatment process, monitoring patients' well-being, and as a stressor for health care professionals in the context of Tshwane district. Prior studies equally illustrated that shortage of human resources have a say in bad service outcomes, high risks of infections, medication faults, and increased mortality rate [13]. Workforce design and retention plans are necessary to address the problems underscored by this study's findings.

The main issues pinpointed by the participants were infrastructure-related challenges: the overcrowded wards, lack of clinical space, ageing facilities, and inadequate specialised services. There were strong concerns about the mental health infrastructure. Such limitations could be seen as having negative impact on infection control, patient privacy, responsiveness of emergency services, and quality care. Overcrowding in hospitals as well as inadequate infrastructure have been recorded to have contributed to avoidable harm in some low- and middle-income countries [14]. Hospital infrastructure discrepancies remain a prolonged challenge that puts a significant burden on South African public health service delivery [15].

The risks of safety in hospitals are broadened when the equipment together with the resources are inadequate. Critical supplies scarcity, damaged equipment, supply chain ineffectiveness was cited by those who participated. Previous studies agree that insufficiencies in essential curative resources disrupt hospital service delivery and increase avoidable injuries [7]. Supply chain issues and fraud underscore governance and systems problems that should insistently be addressed.

Critical contributors to hospital safety risks, such as structural leadership and governance problems, were recognized. Poor accountability methods, delayed decision-making, ineffective supervision and a culture of blame instead of openness to learning from errors were some of the concerns expressed by those who participated. Hospital culture symbolized by weak communication as well as fear, may compromise the reporting of incidents and result in reduced chances for continuous learning and improvement. Adopting system-oriented hospital safety approaches that critically prioritize organization learning,

compassionate leadership guidance as well as answerability, is reinforced by the findings [16].

Professional training and skills development were indicated as key enablers of hospital safety in the hospitals withing Tshwane health district. Continuous training, especially in clinical skills development, best care practices as well as infection prevention and control were emphasized by those who participated to improve the safety of care. Capacity building strategies as well as continuous training are evidenced by researchers as an impotent aspect of health professional competency building initiative that will bringdown the chances of mistakes [17].

The study also emphasized the importance of a safe culture, including effective communication, for health service delivery. Ineffective teamwork, breakdowns in communication, as well as the lack of a non-blame reporting environment were identified as barriers in hospital service delivery. The researchers highlight the significance in communication, teamwork as well organizational learning in minimizing mistakes to enhance better outcomes [18]. This hospital safety culture framework is in alignment with the findings of this study.

The challenges in the flow of patients as well as congestion were cited as important contributory factors to risks in hospital service delivery. The report of overcrowding in emergency departments and psychiatric units as well as inefficiencies in referral systems were also indicated by those who participated in the study. There is consistency with the results of other investigations indicating that overcrowding leads to delays in care, increased medical errors as well as reduction in quality of care [19].

Some of the important solutions to a lot of issues mentioned were the use of information systems and health technologies in the health institutions within Tshwane district. Electronic record managements system such as system barcodes as well as digital tracking tools are some of participants' suggestions to improve safety of care in hospitals. Studies indicate that the use of information technologies in health sector can evidently minimize medication mistakes, enhance documentation accuracy as well as increase harmonization of care [20]. It will save time to use electronic system to capture the ward and the bed in which the patient is sleeping, than physically look for the beds for the new patients that are admitted.

The results of this investigation highlight the need for system-based methods that address challenges in human resources, governance and leadership, infrastructure, and safety culture to achieve sustainable safety.

Conclusion

This study shows that the safety challenges faced by hospitals in the Tshwane district are mainly driven by organizational and systemic factors. The key factors contributing to harm of patients in the health facilities were highlighted to be the shortages in human resources, insufficiencies in infrastructure, inadequacy in resources, communication obstructions, and governance flaws. To address these issues, the coordinated sustainable methods of interventions that strengthen workforce capacity, enhance infrastructure, make the equipment plus resources available, improve leadership and governance as well as elevation of supportive culture of safety in the hospitals. The findings of this study may assist policymakers, leaders as well as mangers of the hospitals, to develop a proper approach aiming to enhance improvement of safety within the budgetary constraints health sector.

Recommendations

Recommendations are based on themes emerged from data analysis.

Strengthening Staff Establishment

Health professionals highlighted that addressing this issue can minimise hospital safety challenges. This is supported by the literature, which shows that sufficiently skilled

and adequate health professionals enable continuous care and better outcomes, such as reduced avoidable morbidity and mortality rates [7, 13]. The following strategies are recommended:

Enhance Planned Strategic Hiring

Directed Staffing Plan: Establish a human resource plan at the beginning of each financial year. This plan should be aligned with the operational plan. Guidance for this plan includes identifying areas of staff shortages, including high risks, the skills needed, and the future expertise required for that area; consider the level of acuity for the type of care in the areas identified [7].

Recruit Competent and Safety-Oriented Staff: Prioritization should focus on candidates with ability to deliver high quality and safe care, clinical care competencies, commitment and skilled in communication, safe culture, teamwork, ethics as well as patient focussed [21].

Improving Recruitment Process: Recruitment process should have the time frame targets with adherence. The process should be decentralised to the hospitals as indicated by the participants. Decentralization will reduce the duration of recruitment process [7].

Rural Allowance: Consider incentives and scarce-skills recognition to support staff retention. Consider international recruitment where there is a scarce skills shortage in the country; staff shortages can also be reduced by offering salaries and benefits that are reasonable and can be used to attract health professionals [22].

Build partnerships with colleges and universities that train health professionals. Workers on contract may be employed permanently at the end of community service to minimise staff turnover [7].

Promote Workforce Diversity: a diverse health care workforce improves cultural competence, engagements as well as openness to the proper requirements of care [23].

Improve Retention through Positive Work Environment: Ensure safe staffing levels: sufficient staffing may decrease issues of staff exhaustion, weariness, medication mistakes, and hospital-acquired infections. Studies have associated the accurate staff patient ratios with the minimal preventable mortality and morbidity rate [13].

Use Recognition and Incentives System: Employee recognition helps improve morale, job satisfaction as well as commitment within organizations. Hospitals can reduce staff turnover by rewarding outstanding performance, appreciating with incentives those who have long service as well as programs that award safety. Recognition has been associated with lower turnover intentions among workers [24].

Strengthening Leadership and Governance

Enhance supervision and organizational support: supportive leadership plays a critical role in retaining healthcare staff by fostering a positive, inclusive work environment. Hospital managers can strengthen staff commitment by promoting open communication, acknowledging contributions, providing constructive feedback, involving staff in decision-making, as well as a non-punitive hospital culture. Increased staff satisfaction level as well as the culture that promote the better outcomes, are associated with transformational leadership [25].

Promote employee wellness: introduction of wellness programs focussing on reduction of stress associated with work, promoting mental health, avoiding emotional fatigue, addressing brutality in the workplace including enhancing the balance in work-life by way of flexibility in work schedule. These programs are critical to

reduce work stress thereby minimising mistakes in service delivery [26].

Enhance continuous professional development: Capacity building and in-service training play an important role in providing a required competencies in hospitals. Participants cited training and professional development as critical to minimising avoidable harm in hospitals. The areas of focus may include training on emergency preparedness, teamwork and communication workshops, safety management as well as prevention and control of infections. Uninterrupted training including professional growth uplift quality thereby assuring the better outcomes in care delivery [7].

Offer opportunities for career growth: staff retention may be enhanced by knowledge of career opportunities, such as advancement, speciality training, leadership and management courses, and mentorship for newly qualified professionals to help them adjust to the clinical setting [27].

Adopt safety culture that is persuasive and non-punitive. The environment that supports reporting of safety incidents, errors as well as near misses, without fear of punishment or blame, should be created. Respondents indicated that systems should be corrected rather than punitive outcome of reporting and investigations. The culture that encourages openness, knowledge from previous mistakes, working harmoniously, mutual obligations are positive and important to enhance expected service delivery in the hospitals [7, 24].

1. Apply the principle of Just culture on the management of patient safety incidents. This principle guides on how the behaviour of employees needs to be managed when dealing with patient safety incidents, as the main aim of identifying and managing patient harm incidents is to prevent the further occurrence of the same nature in future. This underscores the critical aspect of learning from the investigated safety incidents. The punitive culture environment defeats the whole aim of identifying gaps in order to learn and improve as staff became afraid of reporting the safety incidents [2, 24]. Therefore, organizations should shift from a culture of blame to a culture of learning by encouraging transparency in identifying system weaknesses rather than capitalising on individual imperfections; root cause analysis, reflective learning, and problem resolution should be promoted. Ultimately, disseminate the acquired knowledge throughout the entire hospital to prevent future occurrences of the same nature, including system safety [16].
2. Strengthening Leadership Commitment to Patient Safety: Supportive leadership promote trustfulness and fairness, as well as accountability, through open communication of safety significance, supporting personnel in reporting harm incidents. Fairness in investigations, as well as providing the resources needed for care initiatives. Supportive leadership enhance personnel confidence as well as participation in patient safety [28].
3. Supporting Healthcare Workers after Adverse Events: Health professionals implicated in safety incidents may encounter touching difficulties that may reduce their confidence at work and in their social lives; this is known as the ‘second victim' phenomenon. The affected professionals can be supported through psychological support services, employee wellness program such as counselling and debriefing sessions as well as non-judgemental supervision. These supports can promote openness and wellbeing, including resilience following an incident of harm [29].
4. Human resource policy indicators such as turnover rate, vacancy rate, burnout rate, absenteeism rate, as well as safety incident rate should be monitored. The resulting data and analytics can help identify

retention problems sooner and guide approaches to improve quality of care and safety [22].

Systems Improvement and Infrastructure

Health Infrastructure Investment and Conservation

Conservation, including investing in infrastructure, can enhance safety in hospitals by creating a safer as well as more efficient hospital environment. In the areas of Tshwane district as well as the South Africa where resources are limited, Improved infrastructure can assist in reducing medical errors, health acquired infections, equipment breakdown including delays in treatment [7]. Equipment unavailability, infrastructural issues, and technology system challenges were the third most common factors affecting the safety in the hospitals within Tshwane district according to this study. The following are recommended strategies:

Consistent servicing and modernization of medical equipment are critical for accuracy in examining, diagnosing, and prescribing treatment for the patients. Contributory factor to treatment delays, mistakes in medication, wrong diagnosis as including patient injury, may be the results of inadequate maintenance or equipment that is outdated. Regular servicing of diagnostic equipment, replacing outdated technologies including implementation of preventative conservation programs to reduce technical failures for improved outcomes in hospitals [7].

Improved infrastructure for prevention and control of infections is critical for reducing hospital acquired infections as well as improving outcomes of care. Hospitals should invest in proper sanitation and handwashing facilities; ventilation, water, and waste management systems should be reliable. The units such as theatres and wards should be clean and well maintained. Poorly maintained infrastructure can increase infection transmission and place patient safety at risk [7, 9].

Accessible and reliable fresh water and electricity are vital for the safety of service delivery in hospitals. Disruptions and interference in these utilities is capable of disturbing surgeries, equipment sterilization, storage of medicine including care in emergency departments. Back-up supply of power, storage of water and system for purification, plumbing and electrical system testing will all ensure reliable infrastructure for safe patient care [30].

Minimising patient overflow and improving hospital design can enhance patient safety by reducing the risk of infections, medication errors, patient falls, and poor-quality care. Hospitals can improve safety by expanding wards and waiting areas, redesigning emergency departments, separating high-risk patients, and creating accessible, patient-friendly environments. Adequate space also supports better privacy, communication, and staff efficiency [13].

Strengthen Health Information and Communication Systems

Capitalize on digital infrastructure for health to reduce documentation errors as well as enhancing continuity of care. Electronic medical records, programmed medication systems, systems for reporting safety incidents as well as electronic tools for monitoring patient can reduce the communication errors and avoid preventable safety incidents. [19, 31].

Data Analytics and Monitoring for Patient Safety: computer programs can be used to provide continuous support and monitoring of safety indicators such as infection and mortality rates, the rate of mistakes when administering medication as well complications acquired in the hospital. Managers can use data analytics to categorise trends, risks evaluation, including implementation of targeted improvement strategies [18].

Reinforce Good Communication and Effective Teamwork

Support a multidisciplinary team approach, efficient operative handover, dispute resolution skills, and a mutually agreed model of care. These will improve care quality and reduce the likelihood of adverse outcomes [32]. A framework designed for communication such as Situation, Background, Assessment, and Recommendation (SBAR) can be used for sharing patient information with teams during handover reporting.

Systems Improvement

Strengthen security and emergency preparedness through usable emergency response systems, fire-detection devices, evacuation procedures, CCTV cameras, and disaster-readiness infrastructure. These measures improve organizational resilience and support effective emergency management [7].

Constant supply of pharmaceuticals, including consumables, helps ensure the continuous availability of essential medicines, vaccines, and personal protective equipment (PPE). Shortages can be managed through monitoring stock levels and accurate forecasting, inventory execution, and emergency ordering to reduce delays [33]. The use of digital inventory systems such as barcode tracking. Avoid using expired stock as they can compromise the treatment of patients and their safety. Minimise medication harm by inspecting stock regularly implementing first expiry- first out systems and removing the expired stock from the shelves [34].

Improve Supply Chain Management systems: Enhancing supply chain management helps ensure healthcare workers have timely access to the correct products in safe and adequate quantities. Build competencies of Supply chain Management staff on procedures such as inventory control, procurement, material preservation, and effectiveness, as well as systems for monitoring that can enhance efficiency and decrease safety risks in the supply chain department [35].

Implement systems such as a computerised health record system and a medication management system, while safeguarding data security and privacy. These systems will ensure accurate information and minimise patient treatment errors, reduce illegible handwriting and lost files, and reduce duplication of tests and coordination failures, ultimately reducing harm [19, 36].

Provide interoperability between health care systems: design electronic systems that enable communication across health facilities and disciplines to enhance continuity of care. These systems assure the safe sharing of patient information between, hospitals. Clinics, laboratories as well as pharmacies, thereby reducing fragmentation of care and mistakes [28].

Improve the referral pathways and minimise overcrowding. This can be done in different ways such as:

Supporting the primary health services through outreach programs and reducing avoidable referrals to hospitals, thereby minimising the burden of overcrowding in higher-level hospitals.

A standardised referral guidelines and protocols to improve coordination between different hospitals to ensure that patients receive care at the appropriate level of care. Improve communication between health facilities by providing an effective referral system, phones, forms, and sharing patient information to prevent repeated tests, discontinuity of care, and treatment failures [36-38].

Trustworthiness

The trustworthiness model used includes 4 pillars: credibility (staff from different public hospitals participated in the study). The use of thematic analysis approach to analyse a qualitative response. Transferability: an in-depth description of the study setting and

research procedures were provided. Dependability: the detailed process of data collection and thematic analysis procedure of participants responses were maintained. Confirmability: Audit trail and direct verbatim of participants quotes were used to demonstrate the support of the themes identified to make sure that findings were built on participants' views and not researchers' bias [39, 40].

Limitations

A major strength of this study was its ability to complement quantitative findings with qualitative insights obtained directly from healthcare workers across multiple public hospitals. The inclusion of an open-ended survey question enabled participants to share diverse experiences and recommendations relating to patient safety improvement.

However, several limitations should be considered when interpreting the findings. The qualitative analysis process may have been influenced by researcher interpretation during coding and theme development. Furthermore, only 108 (22,7%) of the 476 survey participants provided narrative responses, which may have introduced response bias and limited the representativeness of the qualitative findings. Because the study was conducted in public hospitals in Tshwane District, the findings may not be transferable to other healthcare settings or provinces.

Conflict of Interest

The author declares no conflicts of interest regarding the publication of this article. The author has no financial or personal relationships that could have inappropriately influenced the work reported in this study.

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Ethical Approval

The University of Pretoria Faculty of Health Sciences Research Ethics Committee granted ethical approval for the study (Protocol number: 598/2025). The National Health Research Database (Reference number: GP2025-10-110) and relevant institutional authorities also approved the study.

Participants received information explaining the study's purpose, the expected duration of participation, and their right to decline participation or withdraw at any stage without penalty. Participation was voluntary, and informed consent was obtained electronically before completing the questionnaire. To maintain confidentiality and anonymity, no identifying information were collected, and de-identified all responses during data management and analysis.

Author Contributions

The authors contributed to the study as follows: Conceptualization, methodology, formal analysis, investigation, data curation, and writing original draft preparation was performed by the author 1. Editing, as well as final approval of the manuscript and supervision, were completed by author 2. Author 3 assisted as a co-supervisor, edited and approved the study. All authors agree to be accountable for all aspects of the research work.

Data Availability

Datasets are downloaded from Qualtrics online platform and is available upon justifiable request from the corresponding investigator.

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Institutionalising Social and Behaviour Change Systems for Universal Health Coverage in Fragile and Humanitarian Settings: Evidence from the South Sudan Social and Behaviour Change Strategic Framework (2026–2030)

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Abstract *Social and Behaviour Change (SBC) is increasingly recognised as an important health systems function for strengthening Primary Health Care (PHC), health security, community resilience, and progress toward Universal Health Coverage (UHC), particularly in fragile and humanitarian settings. However, SBC implementation in many settings remains fragmented across disease-specific programmes, limiting coordination, institutional learning, sustainability, and national ownership. This study examines the South Sudan Social and Behaviour Change Strategic Framework (2026–2030) as a national health systems reform for institutionalising SBC. This study used a qualitative Health Policy and Systems Research approach, drawing on a documentary review and thematic analysis of national policies, strategic frameworks, programme documents, stakeholder consultation reports, international guidance, and peer-reviewed literature. The analysis identified governance and leadership; behavioural and social insights; community engagement and service experience; strategic communication and digital innovation; monitoring, evaluation, and adaptive learning; and sustainable financing and multisectoral coordination as interrelated institutional functions. Building on these findings, the study proposes the Integrated Social and Behaviour Change Systems Institutionalisation Framework (ISBCS-IF), illustrating how institutionalised SBC can strengthen health system performance, service utilisation, community trust, emergency preparedness, and progress toward UHC. South Sudan's experience provides an adaptable systems model for governments and development partners seeking to institutionalise SBC within routine health systems in fragile and resource-constrained settings.*

Keywords *Behavioural Science, Fragile Settings, Health Systems Strengthening, Health Policy and Systems Research, Primary Health Care, Social and Behaviour Change, Universal Health Coverage.*

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Introduction

Universal Health Coverage (UHC) remains a global health priority under Sustainable Development Goal 3, requiring health systems that provide equitable, accessible, and quality services while responding effectively to population needs [1-5]. Although investments in infrastructure, workforce, medicines, and technologies are essential, health outcomes are also influenced by individual behaviours, social norms, community participation, trust, service experience and enabling environments [3, 6-12]. These behavioural and social determinants influence service utilisation, prevention practices, treatment adherence, and public responses during health emergencies.

The Declaration of Astana reaffirmed Primary Health Care (PHC) as the foundation for achieving UHC and emphasised community empowerment, multisectoral action, and people-centred care [1, 3]. Within this context, Social and Behaviour Change (SBC) has evolved beyond conventional health education and communication to incorporate behavioural and social insights, community engagement, strategic communication, policy advocacy, implementation research and systems strengthening [7, 10-16]. Evidence across immunisation, maternal and child health, infectious diseases, and emergency response further demonstrates the importance of integrating behavioural and community-centred approaches into health programming [17-25].

However, SBC remains fragmented in many low- and middle-income and humanitarian settings, where disease-specific programmes frequently operate through separate governance, financing, coordination, and monitoring arrangements [10, 12, 20-22, 26]. Such fragmentation can constrain institutional learning, government ownership, resource efficiency, and long-term sustainability.

South Sudan illustrates these challenges. Recurrent humanitarian emergencies, population displacement, disease outbreaks, climate-related shocks, and limited health-system capacity have increased reliance on community-centred approaches and external support [27-31]. Over time, multiple government institutions and partners have implemented SBC interventions across immunisation, nutrition, maternal and child health, HIV, tuberculosis, malaria, and emergency preparedness, but often through programme-specific approaches and parallel coordination mechanisms [29, 32-34].

In response, the Ministry of Health, with technical support from UNICEF and partners, developed the South Sudan Social and Behaviour Change Strategic Framework (2026–2030) and its Operational Framework [35, 36]. These frameworks reposition SBC as a cross-cutting health systems function by integrating governance, behavioural and social insights, community engagement, strategic communication, workforce capacity, digital innovation, monitoring and evaluation, adaptive learning, and sustainable financing within routine health-sector structures [35, 36].

Despite increasing international recognition of behavioural and social sciences within health systems [3, 7, 10, 11, 37], relatively limited literature examines the institutionalisation of SBC as a national health systems function, particularly in fragile and humanitarian contexts. This study addresses this gap by analysing South Sudan's SBC Strategic Framework from a Health Policy and Systems Research (HPSR) perspective and developing the Integrated Social and Behaviour Change Systems Institutionalisation Framework (ISBCS-IF) as a systems model for strengthening PHC, health-system resilience, and progress towards UHC.

Background and Policy Context

Evolution of Social and Behaviour Change within Health Systems

Social and Behaviour Change (SBC) has evolved from traditional health education and

information dissemination into a multidisciplinary, evidence-informed approach that incorporates behavioural and social sciences, strategic communication, community engagement, policy advocacy, implementation research and systems thinking [7, 10-16]. This evolution reflects growing recognition that knowledge alone does not necessarily produce sustained behaviour change because health decisions are shaped by interactions among individual capability and motivation, social norms, family and community influences, service experiences, institutional arrangements, and broader enabling environments [13-16].

Contemporary SBC therefore draws on complementary behavioural frameworks, including the COM-B Model and Behaviour Change Wheel, the Socio-Ecological Model, and Diffusion of Innovations, to understand how capability, opportunity, motivation, interpersonal relationships, social norms, and environmental conditions influence behaviour [13-16]. Behavioural and Social Insights (BSI), human-centred design, social listening, implementation research, and digital technologies have further strengthened health systems' capacity to identify behavioural barriers and adapt interventions to community needs [7, 11, 12].

Within Primary Health Care (PHC), SBC provides an important mechanism for linking communities with services by strengthening health literacy, trust, demand, community participation, and service responsiveness. The Declaration of Astana and WHO PHC guidance emphasise people-centred care, community empowerment, multisectoral collaboration, and integrated service delivery as foundations for Universal Health Coverage (UHC) [1, 3, 9, 37]. Community Health Workers and community-based structures are particularly important in extending these functions to underserved populations [17, 20-22].

SBC, Community Engagement and Health Emergency Preparedness

Risk Communication and Community Engagement (RCCE) represents one of the most visible applications of SBC during public health emergencies. Experience from Ebola, COVID-19, and other outbreaks demonstrates that effective response depends not only on biomedical interventions but also on public trust, credible communication, community participation, social listening, and rapid response to misinformation [18, 19, 23, 26].

Institutionalising these functions within routine health systems can strengthen preparedness between emergencies rather than activating communication structures only during crises. WHO, Africa CDC, and UNICEF guidance increasingly emphasise sustained community engagement, behavioural evidence, and accountability as integral components of emergency preparedness and health-system resilience [18, 19, 23, 26].

Similar principles apply beyond emergency response. Evidence from immunisation and community health programmes indicates that behavioural interventions are more sustainable when combined with strong community systems, supportive service environments, appropriate health-worker capacity, and coordinated implementation [17, 20-22, 24, 25]. Accordingly, SBC should be understood as a health-system function that influences both demand for services and the quality of interaction between people, communities, and health institutions.

Institutionalisation and the South Sudan Policy Context

Despite increasing recognition of SBC, implementation in many low- and middle-income and humanitarian settings remains fragmented across disease-specific programmes. Separate governance, financing, monitoring, and reporting arrangements can reduce efficiency, weaken institutional

learning, constrain government ownership, and undermine sustainability [10, 12, 20-22, 26].

South Sudan faces these challenges within a health system affected by recurrent humanitarian crises, displacement, disease outbreaks, climate-related shocks, limited infrastructure and constrained financing [27, 28, 30, 31]. National health policies and strategies have progressively emphasised PHC, community health and community participation, including the National Health Policy, Health Sector Strategic Plan II, National Health Promotion Strategy, National RCCE Strategy and Revised Boma Health Initiative [27-29, 32, 33].

Building on these reforms, the Ministry of Health developed the South Sudan Social and Behaviour Change Strategic Framework (2026–2030) and associated Operational Framework [35, 36]. The Strategic Framework establishes a national approach for integrating governance, behavioural and social insights, community engagement, service experience, strategic communication, digital innovation, workforce capacity, monitoring and evaluation, adaptive learning, multisectoral coordination and sustainable financing within routine health-sector planning and implementation [35, 36].

The framework also complements South Sudan's Community-Based Networks Integration Strategy, which seeks to harmonise community structures within national community-health governance and service-delivery arrangements [29, 34]. Together, these reforms provide an institutional foundation for shifting SBC from fragmented, programme-specific communication activities toward a coordinated national health-systems function.

Knowledge Gap and Study Contribution

Although substantial literature examines behavioural interventions and programme-specific outcomes, fewer studies analyse the institutional arrangements required to sustain SBC within national health systems, particularly in fragile and humanitarian contexts. Existing evidence is stronger on individual behaviour change, community health-worker performance and emergency communication than on the governance, financing, coordination and organisational reforms required to institutionalise SBC [12-16, 20-22, 38, 39].

Health Policy and Systems Research (HPSR) provides an appropriate perspective for addressing this gap because it examines interactions among institutions, governance, actors, policies, implementation processes and health-system performance [38, 39]. From this perspective, South Sudan's SBC Strategic Framework can be examined not merely as a communication strategy but as a national institutional reform.

This study therefore analyses the South Sudan SBC Strategic Framework (2026–2030) and develops the Integrated Social and Behaviour Change Systems Institutionalisation Framework (ISBCS-IF) to explain how SBC functions can be embedded within routine health systems to strengthen PHC, community trust, health security, resilience and progress towards UHC.

Materials and Methods

Study Design and Setting

This study employed a qualitative Health Policy and Systems Research (HPSR) approach to examine the institutionalisation of Social and Behaviour Change (SBC) within South Sudan's national health system. HPSR was selected because it enables analysis of interactions among policies, institutions, governance arrangements, health-system actors, and implementation processes within complex health systems [38, 39].

The analysis focused on South Sudan, a fragile and humanitarian setting characterised by recurrent emergencies, population displacement, disease outbreaks, resource constraints, and substantial dependence on

external health-sector support [27, 28, 30, 31]. Particular attention was given to the South Sudan Social and Behaviour Change Strategic Framework (2026–2030) and its associated Operational Framework as national instruments for integrating SBC within routine health-system functions [35, 36].

Analytical and Conceptual Orientation

The analysis drew on complementary health systems and behavioural perspectives. The WHO health systems framework and PHC operational guidance provided the systems lens for examining governance, workforce, information, financing, service delivery, and community participation [3, 6, 8, 9]. Behavioural and social science perspectives were informed by WHO and UNICEF SBC guidance and established behaviour-change theories, including the Behaviour Change Wheel/COM-B, Diffusion of Innovations, and socio-ecological approaches [7, 10, 11, 13-16].

HPSR principles were applied to examine how institutional arrangements, actors, policies, implementation processes, and contextual factors influence the integration and sustainability of SBC within the national health system [38, 39].

Data Sources and Document Selection

The study drew on national policy and strategy documents, programme and technical reports, stakeholder consultation outputs, international normative guidance, and peer-reviewed literature relevant to SBC, PHC, community health, health-system strengthening, behavioural science, and institutionalisation.

Key national documents included the National Health Policy 2016–2026 [27], Health Sector Strategic Plan II 2023–2027 [28], National Health Promotion Strategy [32], National Risk Communication and Community Engagement Strategy [33], South Sudan Social and Behaviour Change Strategic Framework 2026–2030 [35], South Sudan Social and Behaviour Change Operational Framework 2026–2030 [36], Revised Community Health Strategy: Boma Health Initiative 2024–2028 [29], and Community-Based Networks Integration Strategy [34].

International sources included WHO and UNICEF guidance on PHC, health systems, behavioural and social sciences, SBC, RCCE, and community health [1, 3, 6-11, 17-19, 23, 26, 37], together with peer-reviewed literature on behavioural change, community health systems and HPSR [13-16, 20-22, 38, 39].

Documents were purposively selected according to their relevance to SBC institutionalisation, health-system governance, behavioural and social insights, community engagement, strategic communication, workforce capacity, monitoring and evaluation, financing, PHC, and UHC. Documents without substantive relevance to these analytical areas were excluded.

Data Extraction and Analysis

Relevant information was extracted from the selected documents and organised around recurrent institutional and health-system themes. The analysis examined: (1) governance and leadership; (2) behavioural and social insights; (3) community engagement and service experience; (4) strategic communication and digital innovation; (5) monitoring, evaluation, learning, and adaptive management; and (6) sustainable financing and multisectoral coordination.

Thematic content analysis identified recurring patterns, institutional gaps, enabling factors, and relationships across the reviewed sources, informed by established HPSR methodological approaches [38, 39]. We compared findings from national documents with international guidance and peer-reviewed evidence to identify areas of convergence, contextual adaptation, and potential systems-level contribution.

The resulting themes informed development of the Integrated Social and Behaviour Change

Systems Institutionalisation Framework (ISBCS-IF), which synthesises the institutional functions and pathways through which SBC may contribute to PHC, health-system resilience and UHC.

Rigour and Trustworthiness

Credibility was strengthened through triangulation across multiple categories of evidence, including national policy and strategy documents, technical guidance, stakeholder consultation outputs and peer-reviewed literature. The study compared sources to assess the consistency of emerging themes and reduce reliance on any single document. The analysis maintained an audit trail linking the principal analytical themes to their supporting documentary sources.

Ethical Considerations

The study involved analysis of publicly available policies, strategic frameworks, technical documents and published literature and did not involve direct interaction with human participants or collection of identifiable personal information. Formal ethical approval and informed consent were therefore not required. The analysis followed principles of scientific integrity, appropriate attribution and accurate representation of documentary evidence.

Results

Overview of Findings

The documentary analysis identified six interrelated institutional themes underpinning the institutionalisation of Social and Behaviour Change (SBC) in South Sudan: (1) governance and leadership; (2) behavioural and social insights; (3) community engagement and service experience; (4) strategic communication and digital innovation; (5) monitoring, evaluation, learning, and adaptive management; and (6) sustainable financing and multisectoral coordination. Together, these functions reposition SBC from fragmented, programme-based communication activities towards an integrated national health-systems function embedded within routine planning, implementation, monitoring, and accountability structures [35, 36].

Institutionalising SBC within the Health System

A key finding is that the South Sudan SBC Strategic Framework establishes an institutional architecture to integrate SBC within national health-sector governance, rather than maintaining it primarily as a disease-specific communication function [35, 36]. The framework promotes coordinated leadership, planning, supervision, behavioural evidence generation, monitoring, partner alignment, and accountability across national and subnational levels. This approach is consistent with national reforms promoting PHC, community health, and integrated community-based systems [27-29, 32-36].

The analysis further indicates that institutionalisation requires interaction among governance, behavioural evidence, community participation, workforce capacity, financing, partnerships, research and digital systems rather than isolated communication interventions. These relationships are summarised in Figure 1.

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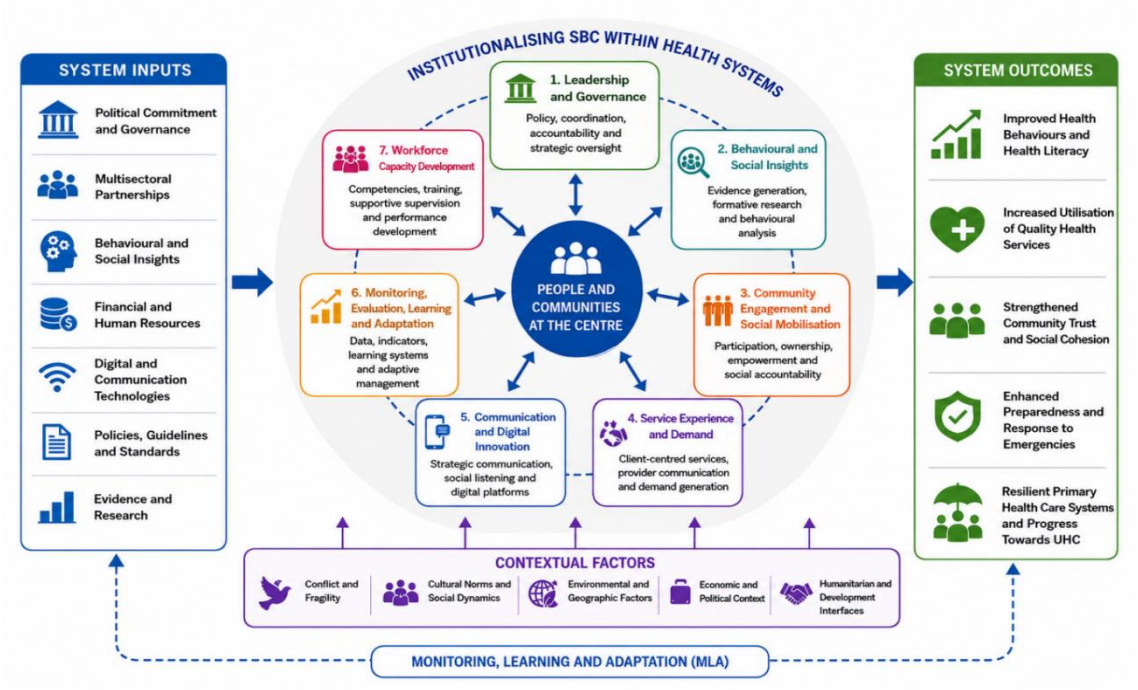


Figure 1. Analytical Framework for Institutionalising Social and Behaviour Change as a Health Systems Strengthening Function

Source: *Developed by the author based on the findings of this study and informed by the South Sudan Social and Behaviour Change Strategic Framework (2026–2030) [35], WHO Primary Health Care guidance [3], the WHO Health Systems Framework [6,8], UNICEF Social and Behaviour Change Strategy (2022–2030) [10], and HPSR literature [38, 39].*

Interpretation: Figure 1 illustrates how institutional functions interact to embed SBC within the health system. Together, they can strengthen health behaviours, service utilisation, community trust, emergency preparedness, and progress towards UHC.

Behavioural and Social Insights

The Strategic Framework institutionalises Behavioural and Social Insights (BSI) as a foundation for evidence-informed planning and implementation [35, 36]. Rather than relying primarily on assumptions or message dissemination, it promotes behavioural research, Knowledge, Attitudes and Practices surveys, social listening, human-centred design, behavioural barrier analysis, implementation research and community feedback. This approach is consistent with contemporary behavioural science guidance emphasising systematic diagnosis of behavioural determinants before intervention design [7, 11-14].

BSI therefore provides a mechanism to shift SBC from message-driven communication to evidence-informed, adaptive programming responsive to behavioural, social, and contextual determinants.

Community Engagement, Service Experience and Institutional Architecture

The analysis indicates that service utilisation is influenced by both community demand and people's experiences of health services. The Strategic Framework consequently links interpersonal communication, respectful and people-centred care, community participation, supportive supervision, and accountability mechanisms [35, 36]. Community structures, including Boma Health Workers, community leaders, faith-based organisations, civil society organisations, women's and youth groups, schools, and local media, provide platforms for

community engagement, mobilisation and feedback [29, 34, 35].

These arrangements are reinforced through community dialogue, participatory planning, social listening, and Accountability to affected populations, consistent with international guidance on community engagement and people-centred health systems [18, 19, 26, 37]. Figure 2 illustrates the multi-level institutional architecture supporting these functions.

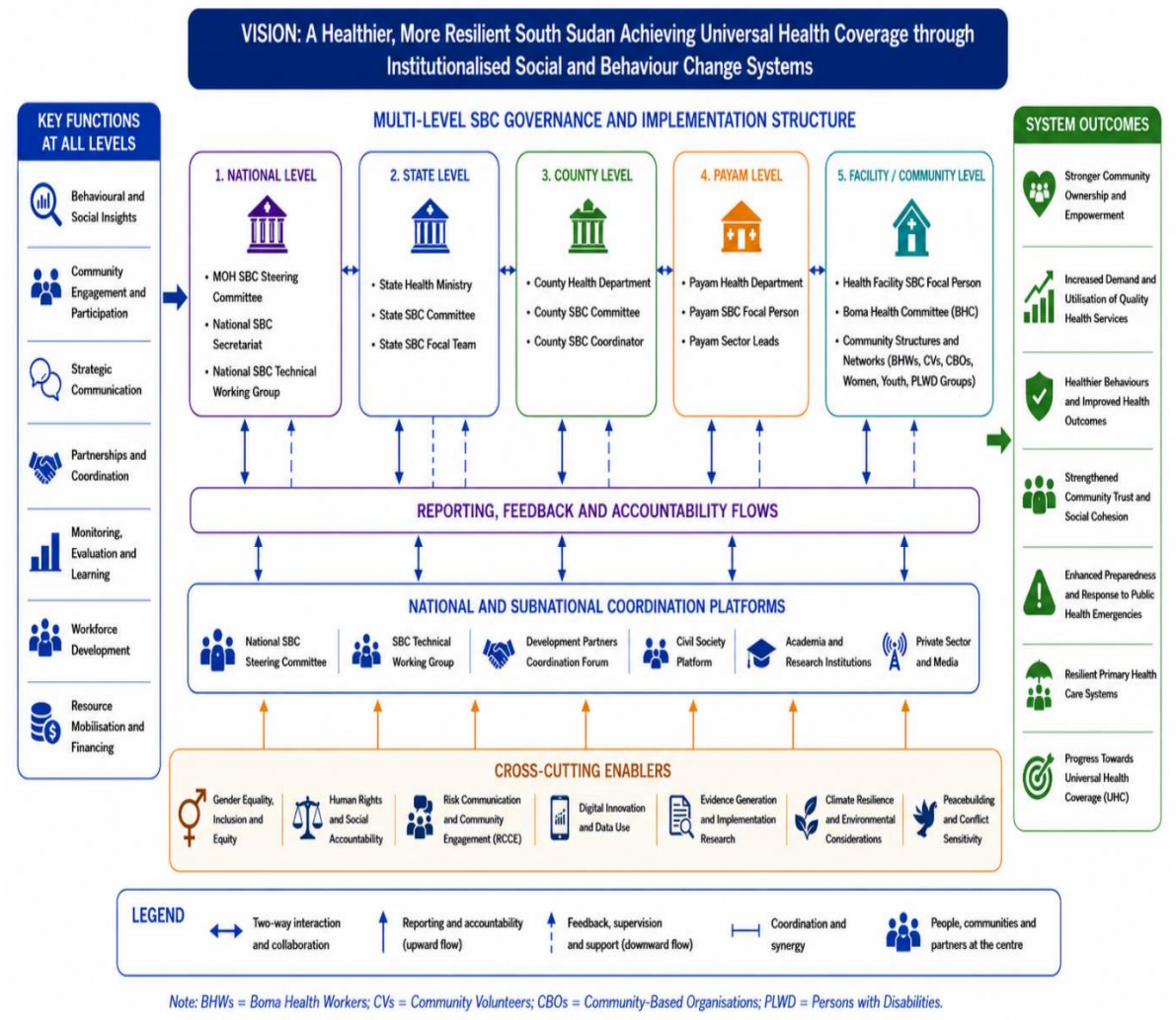


Figure 2. Institutional Architecture for Institutionalising Social and Behaviour Change Systems within the South Sudan Health System

Source: *Developed by the author based on the findings of this study and informed by the South Sudan Social and Behaviour Change Strategic Framework (2026–2030) [35], South Sudan Social and Behaviour Change Operational Framework (2026–2030) [36], WHO Primary Health Care guidance [3], the WHO Health Systems Framework [6, 8], and WHO community health-worker guidance [17].*

Interpretation: Figure 2 illustrates how SBC functions are coordinated across national, state, county, Payam, health-facility, and community levels. Vertical coordination and community feedback connect governance, behavioural evidence, communication, and accountability within one institutional system.

Strategic Communication, Digital Innovation, Monitoring, and Sustainable Financing

The Strategic Framework expands communication beyond conventional mass media by incorporating digital platforms for social listening, community feedback,

emergency communication, and programme monitoring [35, 36]. These include RapidPro, U-Report, Interactive Voice Response, social media, digital dashboards, and mobile messaging platforms.

Monitoring, Evaluation, Learning, and Adaptation (MELA) are integrated through standardised indicators, behavioural monitoring, implementation research, performance review, and continuous learning [35, 36]. Sustainable implementation is linked to government stewardship, partner harmonisation, domestic resource mobilisation and integration of SBC into routine health-sector planning and financing. These elements collectively support institutional continuity beyond short-term campaigns and externally financed programmes. Figure 3 summarizes the implementation relationships.

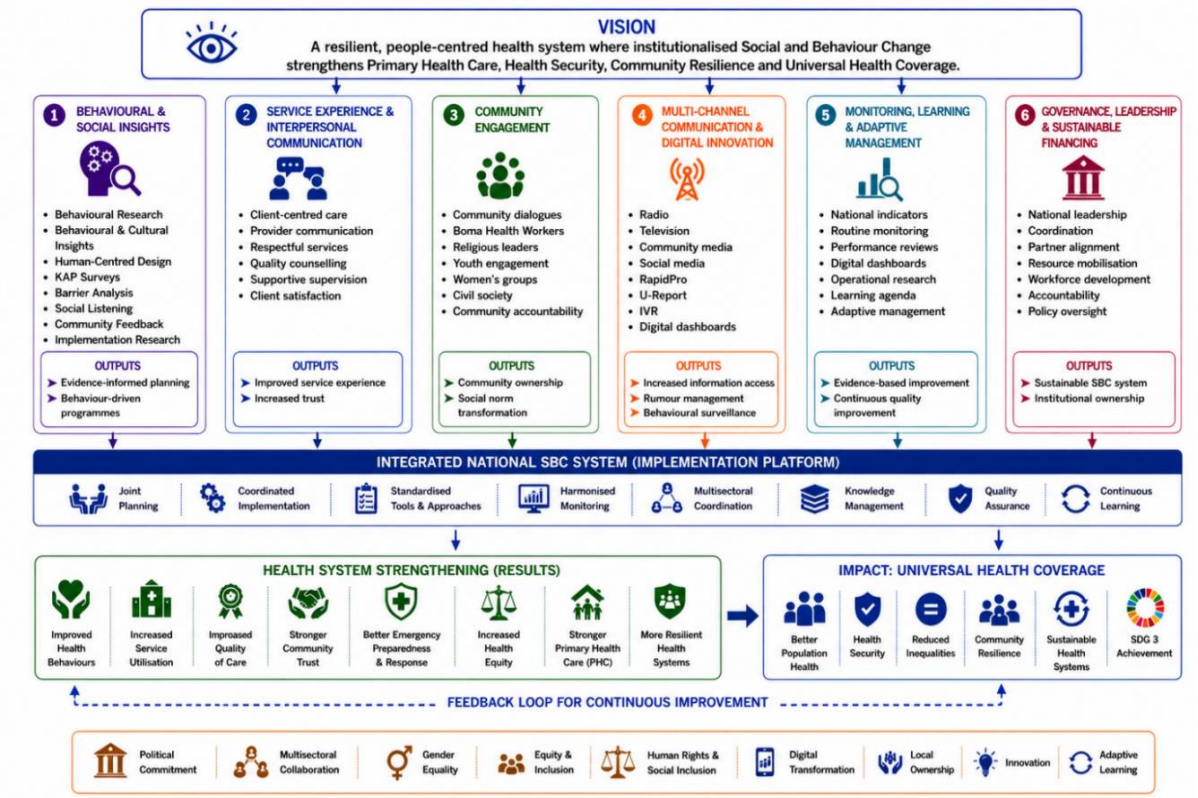


Figure 3. Strategic Implementation Framework for the South Sudan Social and Behaviour Change Strategic Framework (2026–2030).

Source: *Developed by the author based on the findings of this study and informed by the South Sudan Social and Behaviour Change Strategic Framework (2026–2030) [35], WHO Primary Health Care guidance [3], WHO Health Systems Framework [6, 8], UNICEF Social and Behaviour Change Strategy (2022–2030) [10], and WHO behavioural and social sciences guidance [7, 11].*

Interpretation: Figure 3 shows how governance, evidence, community engagement, communication, workforce capacity, monitoring, and financing interact during implementation. Continuous learning provides feedback for adapting interventions and strengthening institutional performance.

Theory of Change for Institutionalising Social and Behaviour Change

The analysis indicates that sustainable SBC institutionalisation requires progression from enabling inputs and institutional arrangements to coordinated implementation, measurable outputs, and health-system outcomes. The resulting Theory of Change links government

leadership, financing, workforce capacity, behavioural evidence, community structures, partnerships, and digital systems with coordinated SBC interventions and improved behavioural and health-system outcomes [3, 10, 35, 36, 38, 39].



Figure 4. Theory of Change for Institutionalising Social and Behaviour Change Systems in South Sudan

Source: *Developed by the author based on the findings of this study and informed by the South Sudan Social and Behaviour Change Strategic Framework (2026–2030) [35], South Sudan Social and Behaviour Change Operational Framework (2026–2030) [36], WHO PHC and Health Systems Strengthening guidance [3, 6, 8], UNICEF Social and Behaviour Change Strategy (2022–2030) [10], and HPSR literature [38, 39].*

Interpretation: Figure 4 demonstrates the pathway through which institutional inputs and coordinated SBC interventions are expected to generate outputs, behavioural and health-system outcomes, and longer-term contributions to resilient PHC and UHC.

Integrated Social and Behaviour Change Systems Institutionalisation Framework

Synthesising the six themes, this study proposes the Integrated Social and Behaviour Change Systems Institutionalisation Framework (ISBCS-IF) as its principal conceptual contribution. The framework integrates governance and leadership, behavioural and social insights, community engagement, strategic communication and digital innovation, workforce capacity, monitoring and adaptive learning, partnerships, and sustainable financing within a unified systems model.

The ISBCS-IF conceptualises institutionalisation as a dynamic process in which these functions interact rather than operate as independent programme

components. It proposes that embedding them within routine health-system structures can strengthen PHC, community trust, service utilisation, emergency preparedness, institutional resilience, and progress towards UHC [3, 6, 7, 10, 35, 36, 38, 39].



Figure 5. Integrated Social and Behaviour Change Systems Institutionalisation Framework (ISBCS-IF)

Source: *Developed by the author based on the findings of this study and informed by the South Sudan Social and Behaviour Change Strategic Framework (2026–2030) [35], the WHO Primary Health Care Operational Framework [3], the WHO Health Systems Framework [6, 8], the UNICEF Social and Behaviour Change Strategy (2022–2030) [10], the WHO behavioural and social sciences guidance [7, 11], and HPSR literature [38, 39].*

Interpretation: Figure 5 presents the ISBCS-IF as an integrated systems model linking institutional SBC functions with strengthened PHC, community trust, health-system resilience, and UHC. The framework emphasises continuous interaction among governance, behavioural evidence, communities, workforce, financing, partnerships, communication, and learning rather than a linear communication model.

Discussion

Institutionalising SBC as a Health Systems Function

This study demonstrates that the South Sudan Social and Behaviour Change Strategic Framework (2026–2030) represents an important shift from fragmented, programme-specific communication towards institutionalising SBC as a routine health-systems function. This transition is consistent with international approaches that increasingly recognise behavioural and social determinants,

community participation, and people-centred services as integral to PHC and UHC [1, 3, 7, 9-11, 37].

The significance of this reform lies not simply in expanding SBC activities but in embedding them within governance, planning, financing, workforce development, information systems, implementation, and accountability structures [35, 36]. This systems orientation addresses a common weakness of programme-specific behavioural interventions, which may achieve short-term results but remain vulnerable when external funding, emergency response structures, or vertical programme support decline [10, 12, 20-22, 26].

South Sudan's approach therefore extends the concept of SBC beyond communication and demand generation. It positions institutionalisation as a health-system reform requiring sustained government stewardship, institutional capacity, and integration with routine PHC structures.

Governance, Coordination and Sustainable Institutionalisation

Governance emerged as a central requirement for SBC institutionalisation. The Strategic and Operational Frameworks establish coordinated structures linking national, state, county, Payam, health-facility, and community levels [35, 36]. These arrangements are aligned with wider national reforms promoting decentralised PHC, community health, and integration of community-based networks [27-29, 32-36].

This finding is consistent with HPSR literature emphasising that sustainable reforms depend on interactions among institutions, actors, implementation processes, and contextual factors rather than technical interventions alone [38, 39]. Evidence from community health programmes similarly demonstrates that performance is strengthened when community-based actors are supported through clear governance, supervision, integration, and accountability arrangements [17, 20-22].

For fragile health systems, institutional governance is particularly important because multiple humanitarian and development actors may operate simultaneously. Strong government-led coordination can therefore reduce duplication, align partner investments with national priorities, and strengthen institutional continuity during and between emergencies [26, 30, 35, 36].

Behavioural and Social Insights and Adaptive Programming

A major feature of the Strategic Framework is the institutionalisation of Behavioural and Social Insights (BSI) within routine planning and decision-making [35, 36]. Behaviour-change theory demonstrates that behaviours are influenced by interacting individual, social, and environmental determinants; effective interventions therefore require diagnosis of behavioural barriers rather than reliance on information provision alone [13-16].

The framework's emphasis on behavioural research, social listening, community feedback, human-centred design, and implementation research is consistent with WHO and broader SBC guidance promoting evidence-informed and adaptive approaches [7, 11, 12]. Institutionalising these functions can enable programmes to identify emerging behavioural barriers, misinformation, service-experience problems, and changing community priorities and to adapt interventions accordingly.

This is particularly relevant in humanitarian and outbreak settings, where perceptions, trust, and information environments can change rapidly. Routine BSI capacity may therefore strengthen both long-term PHC programming and emergency preparedness [18, 19, 23, 26].

Community Engagement, Service Experience and Trust

The findings reinforce the importance of connecting community demand with service

experience. Community engagement alone may have limited impact when services are inaccessible, disrespectful, or unresponsive, while technically available services may remain underused when communities lack trust, information, or meaningful participation [3, 9, 10, 37].

South Sudan's framework addresses this relationship by combining community engagement, interpersonal communication, community feedback, accountability, and people-centred service delivery [35, 36]. Boma Health Workers, community leaders, faith-based organisations, civil society organisations, women's and youth groups, and other community structures provide potential platforms for sustained engagement within the national system [29, 34].

This approach is consistent with evidence showing that community health interventions perform better when community-based actors are linked to formal health systems through supportive supervision, institutional recognition, and functional referral and accountability mechanisms [17, 20-22]. It also strengthens the relevance of SBC to immunisation and other essential services where confidence, service experience and community engagement influence uptake [24, 25].

Digital Innovation, Learning, and Sustainable Financing

Institutionalisation also requires mechanisms for continuous monitoring, learning, and adaptation. The Strategic Framework's integration of digital platforms, social listening, behavioural monitoring, community feedback, and routine performance review provides opportunities for more responsive SBC implementation [35, 36]. These mechanisms can strengthen the feedback loop between evidence generation, programme adaptation, and decision-making.

However, institutionalisation is unlikely to be sustainable without predictable financing and workforce capacity. Reliance on short-term, disease-specific, or emergency funding can reproduce the fragmentation that the framework seeks to address. Integrating SBC into government planning, budgeting, workforce development and routine monitoring is therefore essential for long-term sustainability [6, 8, 10, 12, 35, 36].

Development partners remain important in fragile settings, but external support should progressively reinforce nationally led systems rather than create parallel structures. This requires alignment of financing, technical assistance, indicators, and implementation arrangements with national SBC priorities.

Contribution of the ISBCS-IF

The principal conceptual contribution of this study is the Integrated Social and Behaviour Change Systems Institutionalisation Framework (ISBCS-IF). Unlike approaches that conceptualise SBC primarily as communication or individual behaviour-change programming, the ISBCS-IF positions behavioural and social functions within the broader institutional architecture of the health system.

The framework integrates governance, BSI, community engagement, strategic communication, and digital innovation, workforce capacity, monitoring, adaptive learning, partnerships, and financing as mutually reinforcing institutional functions. This interpretation builds on behavioural science [13-16], health-systems thinking [3, 6, 8], community-health evidence [4, 16-18], and HPSR [38, 39], while adapting these perspectives to the institutional realities described in South Sudan's national frameworks [29, 34-36].

The ISBCS-IF therefore provides a testable systems model rather than evidence of effectiveness in itself. Its proposed relationships should be assessed prospectively as the Strategic Framework is implemented.

Implications for Fragile and Humanitarian Settings

South Sudan's experience has relevance beyond the national context. Fragile and humanitarian health systems commonly face disrupted services, constrained institutional capacity, multiple implementing actors, and dependence on external financing [26, 30, 31]. Under these conditions, maintaining separate SBC structures for individual diseases or emergencies can further fragment already constrained systems.

Institutionalising SBC within routine PHC offers an alternative approach by maintaining governance, behavioural evidence, community engagement, communication, monitoring, and workforce functions that can serve both routine programmes and emergency response. This may strengthen institutional continuity and adaptability while supporting more integrated, people-centred services [3, 9, 10, 18, 19, 26, 37].

However, transferability should not be assumed. Governance arrangements, financing capacity, decentralisation, community structures, and humanitarian conditions vary across countries. The ISBCS-IF should therefore be adapted and empirically evaluated within each implementation context.

Strengths, Limitations and Future Research

A key strength of this study is its application of an HPSR perspective to SBC institutionalisation, moving analysis beyond individual interventions towards governance, institutional arrangements, and system functions. Triangulation across national policies, strategic frameworks, international guidance, and peer-reviewed literature also strengthened the policy relevance of the analysis.

The study nevertheless has limitations. It is based primarily on documentary analysis and does not include primary empirical data from policymakers, health workers, community members, or development partners. In addition, because the South Sudan SBC Strategic Framework (2026–2030) is newly developed, implementation fidelity, behavioural outcomes, health-service effects, cost-effectiveness, and long-term institutional sustainability could not yet be assessed.

Future research should therefore evaluate implementation fidelity, institutional capacity, financing, behavioural outcomes, service utilisation and community experiences as implementation progresses. Comparative research across other fragile and humanitarian settings would further test the applicability and transferability of the ISBCS-IF.

Conclusion

This study demonstrates that the South Sudan Social and Behaviour Change Strategic Framework (2026–2030) represents an important shift from fragmented, programme-specific communication towards institutionalising SBC as a cross-cutting national health-systems function [35, 36]. The analysis shows that sustainable institutionalisation requires coordinated governance, behavioural and social insights, community engagement and service experience, strategic communication and digital innovation, workforce capacity, monitoring and adaptive learning, multisectoral partnerships, and sustainable financing.

The proposed Integrated Social and Behaviour Change Systems Institutionalisation Framework (ISBCS-IF) synthesises these functions into a systems model illustrating how institutionalised SBC may strengthen PHC, community trust, service utilisation, emergency preparedness, health-system resilience, and progress towards UHC. The framework complements international approaches to integrated, people-centred PHC and behavioural science while adapting them to South Sudan's fragile and humanitarian context [3, 7, 9-11, 35-37].

The findings support recognising SBC not merely as communication or demand generation but as a strategic health-systems function requiring sustained government leadership, institutional capacity, financing, and integration into routine planning and accountability. However, because the framework has not yet been prospectively evaluated, future implementation research should assess its feasibility, effectiveness, sustainability, and transferability to other fragile and humanitarian settings.

Policy Recommendations

Based on the findings, the following priority actions are recommended:

- Institutionalise SBC within national health systems. Governments should formally integrate SBC into health policies, PHC strategies, governance structures, annual plans, budgets, routine information systems and performance frameworks [3, 6, 8, 10].
- Operationalise South Sudan's national SBC frameworks. The Ministry of Health should translate the Strategic and Operational Frameworks into costed implementation plans with clearly defined responsibilities across national, state, county, Payam, health-facility, and community levels [35, 36].
- Strengthen behavioural evidence and community accountability. BSI, social listening, implementation research, community feedback, and participatory approaches should inform routine programme design, adaptation, and decision-making [7, 11, 12, 18, 19, 26].
- Strengthen and integrate community systems. Boma Health Workers, Community-Based Networks, faith-based organisations, civil society, and other community structures should be linked with formal PHC governance, supervision, referral, and accountability mechanisms [17, 20-22, 29, 34].
- Invest in institutional capacity and sustainable financing. Government and development partners should strengthen SBC workforce competencies, digital systems, monitoring, and learning while progressively integrating SBC financing into routine health-sector budgets [8, 10, 35, 36].
- Align partner investments with national systems. Development partners should reduce parallel, disease-specific SBC structures and align technical and financial assistance with nationally led governance, implementation, and monitoring arrangements [26, 35, 36].
- Generate implementation evidence. Prospective research should assess implementation fidelity, financing, institutional capacity, behavioural outcomes, service utilisation, cost-effectiveness, and community experiences and test the ISBCS-IF in other fragile and humanitarian contexts.

This condensed version replaces the longer current recommendation lists for national governments, the Ministry of Health, development partners and future research.

Study Contribution to Knowledge

This study contributes to Health Policy and Systems Research in three principal ways. First, it reconceptualises SBC as an institutional health-systems function rather than primarily a programme-specific communication intervention. Second, it introduces the ISBCS-IF, integrating governance, behavioural and social insights, community engagement, strategic communication and digital innovation, workforce capacity, monitoring and learning, partnerships, and sustainable financing within a unified systems model. Third, it extends the application of behavioural science from individual behaviour-change programming towards institutional governance and

organisational performance in a fragile and humanitarian health system.

The framework therefore provides a conceptual and policy contribution that can guide implementation and future empirical evaluation in South Sudan and comparable settings. Its effectiveness and transferability should, however, be established through prospective implementation research.

Competing Interests

The author declares no competing interests.

Consent for Publication

Not applicable.

Author Contributions

Okello David Omwony conceived and designed the study, conducted the documentary review and analysis, developed the conceptual framework and figures, interpreted the findings, and drafted, reviewed, and approved the final manuscript.

Ethical Approval

The study analysed publicly available policy documents, strategic frameworks, technical reports, and peer-reviewed literature. No human participants or identifiable personal data were involved; therefore, formal ethical approval and informed consent were not required.

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Data Availability

Documents analysed in this study are available from the Ministry of Health, WHO, UNICEF, and other sources cited in the manuscript. Additional information supporting the analysis is available from the corresponding author upon reasonable request.

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From Training to Competency: An Operations Research Evaluation of Family Planning and Post-Abortion Care Capacity Building in Sierra Leone

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Abstract *Sierra Leone faces persistent reproductive health challenges, including unmet need for family planning, unsafe abortion-related morbidity, and limited public-sector capacity to provide quality family planning and post-abortion care services. This retrospective mixed-methods operations research evaluation assessed whether a competency-based training, mentorship, and supportive supervision model implemented under the Saving Lives Phase 2 project was associated with improvements in provider knowledge, clinical competency, quality-of-care indicators, and post-abortion care service delivery in selected public-sector facilities in Sierra Leone. Kirkpatrick's four-level model and a programme theory linking training inputs to learning, workplace competency, service readiness, and service outputs guided the evaluation. The evaluation reviewed routine programme data from 2019 to 2020, including trainee reaction forms, pre- and post-test scores, competency assessment records, supervision and mentorship records, quality-of-care assessments, service statistics, programme reports, and exploratory financial and modelled impact estimates. Descriptive analysis summarised changes over time. Trainee reaction was highly positive. Mean knowledge scores increased from 28% at pre-test to 81% at post-test. The share of providers attaining Level 1 competency increased from 59% in Q3 2019 to 97% in Q4 2020. Model-site quality-of-care status increased from 3% in 2019 to 33% in 2020, while model-area status increased from 8% to 22%. Post-abortion care service volume increased from 442 in 2019 to 1,950 in 2020. The findings suggest programme-associated improvements across the training-to-practice pathway, but causal inference is limited by the retrospective descriptive design and absence of a comparison group.*

Keywords *Competency-Based Training, Family Planning, Operations Research, Post-Abortion Care, Supportive Supervision, Sierra Leone.*

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Introduction

Sierra Leone continues to face substantial reproductive health challenges, including high fertility, unmet need for family planning, adolescent pregnancy, unsafe abortion-related morbidity, and persistent gaps in access to quality reproductive health services. The 2019 Sierra Leone Demographic and Health Survey remains a key reference point because it reflects the reproductive health context during the 2019–2020 implementation period and documents continuing needs in family planning, maternal health, adolescent health, and service access [1]. More recent secondary analysis of the same dataset has highlighted deficiencies in the quality of contraceptive counselling received by young women, underscoring that improving service quality and client-centred counselling, not commodity availability alone, remains a critical priority [2]. These findings collectively indicate that strengthening provider competence and service readiness is essential for improving reproductive health outcomes in Sierra Leone.

Access to high-quality family planning and post-abortion care services is central to reducing unintended pregnancy, unsafe abortion-related morbidity, and preventable maternal deaths. Unsafe abortion continues to impose a clinical and economic burden on Sierra Leone's health system [3]. WHO guidance emphasises that abortion-related care, including post-abortion care, should be safe, timely, respectful, effective, accessible, acceptable, equitable, and efficient [4]. WHO recommendations on post-abortion contraception further emphasise that contraceptive options should be available as part of comprehensive care when desired by the client [19]. Despite these global standards, many health systems in low-resource settings struggle to translate guidelines into consistent, high-quality service delivery because of gaps in provider competence, facility readiness, commodities, equipment, documentation, and supportive supervision.

Training health workers is a widely used strategy for improving reproductive health service delivery; however, evidence increasingly shows that classroom-based training alone rarely produces sustained improvements in clinical performance. Studies from low- and middle-income countries suggest that knowledge acquisition does not automatically translate into competent practice when providers face limited equipment, weak supervision, inadequate mentorship, poor documentation systems, commodity constraints, or few opportunities to practise newly acquired skills [21, 24]. These limitations highlight the need for training models that extend beyond didactic instruction. For clinical training to influence service quality, it must be linked to competency assessment, workplace mentorship, supportive supervision, action planning, and continuous quality improvement [11, 12, 20, 21].

Competency-based training offers a practice-oriented approach by focusing not only on what providers know, but also on what they can safely and consistently perform in routine service-delivery settings. WHO's global competency and outcomes framework for universal health coverage emphasises integrating the knowledge, skills, attitudes, and behaviours required for people-centred health service delivery [23]. In family planning and post-abortion care, this is particularly important because counselling, informed choice, implant and intrauterine contraceptive device provision, manual vacuum aspiration, infection prevention, emergency preparedness, documentation, consent, and incident reporting require both technical competence and clinical judgement. Recent evidence from low- and middle-income countries also shows that simulation-based and practice-based education can strengthen health-worker performance, especially when combined with contextualised mentorship and supervision [24].

What is already known is that family planning and post-abortion care quality depends on trained providers, informed choice, method-specific counselling, respectful care, technical competence, continuity, and appropriate service organisation [9, 13-18]. Supportive supervision and performance-enhancing approaches can also strengthen health-worker performance when they are collaborative, problem-solving oriented, and linked to service-delivery improvement [20, 21]. However, existing studies have several limitations. First, much of the published evidence on family planning and post-abortion care training in low- and middle-income countries comes from small-scale pilot projects, NGO-led interventions, or health-worker training studies with limited documentation of outcomes within public-sector systems [21, 24]. Second, many studies assess immediate post-training knowledge gain but do not measure competency progression over time, despite global recognition that competency requires longitudinal assessment and workplace-based practice [10, 23]. Third, fewer studies examine how competency-based models influence facility-level quality-of-care indicators or service-delivery outputs, which remain under-reported in reproductive health implementation literature [22, 25]. Fourth, published evidence from Sierra Leone remains limited on whether competency-based family planning and post-abortion care training, when combined with mentorship and supportive supervision, yields measurable improvements beyond knowledge acquisition. Existing Sierra Leone evidence has focused more on counselling quality or abortion-related morbidity than on provider competency, facility readiness, or quality-performance indicators [2, 3].

The Saving Lives Phase 2 project provided an opportunity to address this gap. Marie Stopes Sierra Leone, in collaboration with the Ministry of Health and Sanitation and programme partners, implemented a public-sector capacity-building intervention focused on family planning and post-abortion care services between 2019 and 2020. The model included a 10-day training programme, competency assessment, mentorship, workplace observation, supportive supervision, facility action planning, and quality-of-care monitoring. The original programme evaluation report documented trainee reaction, pre-test and post-test performance, competency progression, quality-of-care indicators, service-output trends, and exploratory return-on-training investment estimates [5]. However, these findings had not been synthesised into a peer-reviewed analysis, nor had they been critically examined within the broader evidence base.

This manuscript's conceptual framework combines Kirkpatrick's four-level training evaluation model with an implementation pathway linking training inputs to learning, workplace behaviour, facility readiness, and programme results. Kirkpatrick's model remains useful because it assesses reaction, learning, behaviour, and results [6]. At the same time, critiques of the model caution against assuming a simple linear causal chain between these levels and highlight the need to consider contextual and organisational factors [7]. Therefore, this evaluation interpreted findings as programme-associated changes across a training-to-practice pathway rather than as definitive causal effects.

This study aimed to evaluate whether a competency-based family planning and post-abortion care training and supportive supervision model was associated with improvements in provider knowledge, clinical competency, quality-of-care indicators, and post-abortion care service delivery in selected public-sector facilities in Sierra Leone between 2019 and 2020. The study hypothesis was that a combined training, mentorship, and supportive supervision model would be associated with improvement across multiple levels of the evaluation pathway: trainee reaction, provider learning, workplace

competency, quality-of-care status, and service-delivery outputs.

Materials and Methods

Study Design

This study was a retrospective operations research evaluation of a competency-based family planning and post-abortion care training and supportive supervision model implemented under the Saving Lives Phase 2 project in Sierra Leone. The retrospective design was appropriate because the purpose was to analyse existing routine programme data generated during implementation and to determine whether the capacity-building model was associated with changes in knowledge, competency, quality-of-care indicators, and service delivery over time.

An operations research design was also appropriate because the evaluation addressed a practical service-delivery question: how a real-world public-sector capacity-building model functioned under routine programme conditions. The evaluation was not designed as a clinical trial or controlled effectiveness study. Findings were therefore interpreted as descriptive programme-associated changes rather than causal estimates of intervention effect.

Study Setting

The evaluation was conducted in Sierra Leone within selected public-sector health facilities supported under the Saving Lives Phase 2 project. Marie Stopes Sierra Leone implemented the project in collaboration with the Ministry of Health and Sanitation as part of a broader public-sector reproductive health system-strengthening initiative. The intervention focused on strengthening the capacity of public-sector providers to deliver long-acting reversible contraception and post-abortion care services. Facility selection was conducted in consultation with government and implementing partners, prioritizing sites such as Emergency Obstetric and Neonatal Care facilities, high-catchment-population sites, border-town community health centres, and hard-to-reach locations [5].

In addition to training, the intervention sought to strengthen service readiness at supported facilities. The intervention issued training materials and practical job aids, including family planning manuals, family planning and post-abortion care flipcharts, and other provider-support tools, to participating facilities. Essential equipment and commodities were also supplied to help newly trained providers begin applying their skills under supervision after training. Providers were expected to practise under mentorship and supportive supervision until they were assessed as Level 1 competent, after which they could provide services independently, subject to periodic reassessment and ongoing quality monitoring [5]. This approach is consistent with current guidance that reproductive health service quality depends not only on provider knowledge, but also on method-specific guidance, appropriate commodities, equipment readiness, supervision, referral capacity, and client-centred counselling [4, 9].

Programme Description

The programme consisted of a competency-based training and post-training support model for public-sector providers. The intervention included a 10-day training programme on family planning and post-abortion care, followed by competency assessment, mentorship, workplace observation, supportive supervision, facility action planning, and quality-of-care monitoring. Training content covered long-acting reversible contraceptive methods, post-abortion care, clinical governance, medical emergency management, clinical documentation, consent, infection prevention, and incident reporting.

Before the cascade training, Marie Stopes Sierra Leone, through its Medical Development Team, worked closely with the Reproductive Health/Family Planning Department of the

Ministry of Health and Sanitation to strengthen national training capacity. This included facilitating the establishment of a core group of National Master Trainers made up of experienced reproductive health trainers selected across districts in Sierra Leone. These master trainers worked with the Marie Stopes Sierra Leone Medical Development Team to adapt training materials from existing government family planning and post-abortion care manuals, ensuring cascade training aligned with national standards and implementation needs.

In January 2019, Marie Stopes Sierra Leone and the Ministry of Health and Sanitation conducted a national master trainers' meeting in Bo District [5]. Master trainers from the Ministry of Health and Sanitation and Marie Stopes Sierra Leone received refresher training and competency assessment using standardised competency assessment checklists. They reviewed and adapted training materials and presentations for the national cascade. The Ministry of Health and Sanitation approved the training strategy, which separated implant and post-abortion care training from intrauterine contraceptive device training.

Training was delivered simultaneously across multiple districts using a low trainer-to-trainee ratio of approximately one trainer to four or five trainees [5]. Each training unit included approximately 8–12 trainees and 2–3 trainers. Training methods included presentations, group work, practical sessions, plenary discussions, experience sharing, feedback sessions, pre-tests, post-tests, and action planning.

Demand creation and community mobilisation around supported facilities were undertaken through a combined effort involving Marie Stopes Sierra Leone community-based mobilisers and consortium-supported community mobilisation structures, including Restless Development where applicable. These activities helped prepare communities and supported facilities ahead of mentorship, supportive supervision, competency assessment, and service-delivery follow-up visits by informing communities, mobilising eligible clients, and facilitating client flow around supported sites. This mobilisation component was important because newly trained providers required supervised opportunities to apply their skills in real service-delivery settings before being assessed as competent to provide services independently.

The programme also included practical service-readiness support to enable providers to translate classroom learning into supervised clinical practice. Participating facilities received family planning manuals, family planning and post-abortion care flipcharts, and other job aids to support counselling, clinical decision-making, documentation, and service delivery. Essential equipment and commodities were also supplied to supported facilities to enable newly trained providers to begin applying their skills after training. Providers practised under mentorship and supportive supervision until they were assessed as Level 1 competent, after which they could provide services independently, subject to periodic reassessment and ongoing quality monitoring [5].

Post-training mentorship and supportive supervision reinforced learning, assessed competency, monitored facility action plans, and addressed implementation barriers such as equipment, consumables, documentation, and stock-management gaps. This combined approach reflected a training-to-practice model that linked classroom instruction to national training capacity, standardised training materials, service readiness, supervised practice, competency assessment, facility action planning, and continuous quality improvement. This is consistent with guidance that quality family planning and post-abortion care require not only trained providers, but also appropriate commodities, equipment, method-specific counselling tools, supervision, referral

readiness, and client-centred service delivery [4, 9].

Participants, Facilities, and Sampling

The programme targeted public-sector providers selected from supported public-sector health facilities in Sierra Leone. In 2019, Marie Stopes Sierra Leone, in collaboration with the Ministry of Health and Sanitation, trained more than 180 public-sector providers from 90 public-sector sites [5]. Participant selection involved consultation with national and District Health Management Teams to identify eligible public-sector providers from supported facilities.

The sampling approach was purposive and programme-based rather than probability-based. Providers and facilities were selected because they were part of the Saving Lives Phase 2 public-sector capacity-building programme, not because they represented all public-sector providers or facilities in Sierra Leone. Inclusion criteria for providers included selection by relevant programme and government structures, participation in the training or mentorship process, and availability of programme records. Facilities were included if they were supported public-sector sites with relevant programme data. We excluded facilities when required programme data were unavailable or not included in the final evaluation dataset.

A formal sample size calculation was not conducted because the evaluation used routinely collected programme data from all available eligible training and implementation records. The sample size was therefore determined by programme reach and data availability rather than by statistical power calculation. This limits generalisability but is appropriate for a retrospective operations research evaluation focused on programme learning.

Evaluation Framework and Conceptual Model

The evaluation used Kirkpatrick's four-level model of training evaluation, which assesses training outcomes across reaction, learning, behaviour, and results [6, 7]. Level 1 assessed trainee reaction to the training, including satisfaction with objectives, content, materials, facilitation, timeframe, participation opportunities, and opportunities to practise and apply learning. Level 2 assessed learning through pre-test and post-test scores. Level 3 assessed behaviour change through workplace observation, competency assessment, mentorship records, and supportive supervision findings. Level 4 assessed programme-level results using quality-of-care indicators, competency progression, service delivery outputs, and exploratory financial and modelled impact estimates.

The programme theory assumed that training would improve knowledge; mentorship, supervised practice, and workplace observation would support translation of knowledge into clinical competency; supportive supervision and action planning would address facility-level barriers; and improved competency, service readiness, and client mobilisation would be reflected in quality-of-care indicators and service-delivery outputs. Because this pathway may be influenced by contextual factors such as commodity availability, equipment readiness, job aids, supervision intensity, reporting quality, provider motivation, demand creation, client flow, and facility-level implementation capacity, the evaluation did not assume a simple causal sequence.

Data Sources

The evaluation used routinely collected programme data from multiple sources. These included trainee reaction evaluation forms, pre-test and post-test scores, training reports, competency and training database records, workplace observation and supportive

supervision records, quality-of-care assessment results, facility action plan trackers, service delivery statistics, programme budget data, and modelled programme impact estimates.

Training reports were reviewed to provide additional insight into implementation processes, participant feedback, contextual barriers, and factors that may have influenced changes in knowledge, skills, competency, and service delivery. Action plan trackers from regional teams and facility action plan booklets were reviewed to assess whether identified post-training actions were implemented. Modelled health and economic impact estimates were generated using MSI Impact 2 version 5, a reproductive health programme impact estimation tool [8].

Measurement Tools and Validation Considerations

Trainee reaction was measured using structured training evaluation forms used routinely by the programme. Knowledge was measured using programme pre-test and post-test tools administered before and after training. Clinical competency was assessed using standardised competency assessment checklists used by master trainers, mentors, and supervisors. Quality-of-care status was assessed using the programme's quality-monitoring framework, including model-site and model-area classifications documented in the programme report [5].

The measurement tools were programme-standard instruments used for training, mentorship, competency assessment, supportive supervision, and quality assurance, rather than research instruments developed specifically for this manuscript. Therefore, formal psychometric validation, reliability testing, pilot testing, and Cronbach's alpha values were not available in the summary dataset. This is acknowledged as a measurement limitation. However, the use of standardised programme tools, competency assessment checklists, supervision records, and routine quality-assurance processes supported consistency in implementation monitoring within the programme context.

Outcome Measures

The primary outcome measures were provider knowledge, clinical competency, quality-of-care status, and post-abortion care service delivery. Provider knowledge was measured using average pre-test and post-test scores. Clinical competency was assessed using competency assessment records and expressed as the proportion of providers attaining Level 1 competency over time. In the programme competency framework, Level 1 competency referred to providers who had been assessed as competent to provide the relevant family planning or post-abortion care service independently according to programme-standard competency assessment checklists, while remaining subject to routine mentorship, supervision, and periodic reassessment. Competency assessment focused on observed ability to apply knowledge and skills safely in service-delivery settings, rather than training attendance alone.

Quality-of-care outcomes were assessed using the proportion of facilities attaining model-area and model-site status. In the programme quality-assurance framework, a model area referred to a specific technical section, domain, or service-readiness area in which a facility achieved a score of 90% or above during quality monitoring. For example, where 22 technical areas were assessed, a facility could achieve model-area status in some, most, or all of the assessed areas. Model-site status referred to a facility-level classification achieved when the facility attained model-area status across all assessed technical areas or domains. These categories were programme-standard quality-assurance indicators used to monitor facility-level and service-area performance, guide supportive supervision, and track progress in service

readiness and quality improvement within the implementation context.

Post-abortion care service delivery was assessed using routine monthly service statistics for 2019 and 2020. Secondary outcome measures included trainee satisfaction, implementation of post-training action plans, exploratory return on training investment, and modelled health and economic impact estimates. Trainee satisfaction was assessed using structured reaction evaluation forms. Return on training investment was treated as an exploratory programme-value indicator rather than a formal economic evaluation because it was based on routine programme financial data and modelled benefit estimates.

Data Analysis

Data were analysed descriptively using frequencies, percentages, mean scores, absolute changes, and relative percentage changes. Trainee reaction data were summarised across satisfaction domains. Pre-test and post-test scores were compared using mean percentage scores, and knowledge gain was calculated as the difference between average pre-test and post-test scores. Competency progression was assessed by comparing the proportion of providers attaining Level 1 competency across implementation quarters from Q3 2019 to Q4 2020. Quality-of-care improvement was assessed by comparing model-site and model-area status between 2019 and 2020.

Post-abortion care service trends were summarised using monthly and annual service totals for 2019 and 2020. Annual percentage change was calculated by comparing total post-abortion care services provided in 2020 with those provided in 2019. Financial and modelled impact findings were summarised descriptively and interpreted cautiously because the evaluation did not include a formal cost-effectiveness design, a control group, or a counterfactual comparison.

No inferential hypothesis testing was performed because the available dataset was derived from routine programme summary records and was not structured for statistical comparison with a control group. Therefore, assumptions for parametric testing, regression modelling, or adjusted confounder analysis were not applied. Missing data were handled using complete-case inclusion within the available programme summary tables. Where denominator information was unavailable or inconsistent across programme records, we presented findings descriptively and interpreted them cautiously. The analysis was conducted using programme summary records and Microsoft Excel-based tabulations.

Bias and Confounding

Potential sources of bias were considered in interpretation. Selection bias may have occurred because facilities and providers were selected through programme processes rather than probability sampling. Measurement bias may have occurred because programme tools were used for routine monitoring rather than independent research measurement. Observer bias may have affected competency and quality assessments where assessors were programme staff or mentors. Confounding is possible because changes in service delivery may have been influenced by commodities, equipment, demand-generation activities, reporting completeness, referral systems, programme maturity, or broader health-system factors. Recall bias was considered less relevant for routine records but may have affected qualitative or narrative training-report information. These limitations informed the cautious interpretation of findings as programme-associated changes.

Ethical Considerations

This evaluation used routinely collected programme data generated during implementation of the Saving Lives Phase 2 project. The evaluation was conducted as an internal programme and operations research activity within Marie Stopes Sierra Leone, with

technical leadership from the Medical Development Team and collaboration from relevant quality assurance, programme, monitoring and evaluation, and finance functions. The report was submitted to the Reproductive Health Department of the Ministry of Health and Sanitation in Sierra Leone as part of programme accountability, learning, and performance review.

No individual client-identifiable information is reported in this manuscript. Provider and facility-level findings are presented in aggregate form. As the work involved retrospective analysis of routine programme implementation and quality-improvement data, it was treated as a programme evaluation rather than an interventional human-subjects research study. Institutional permission to publish the findings was obtained from the relevant data-owning and implementing bodies.

Results

Programme Reach and Evaluation Pathway

The Saving Lives Phase 2 intervention trained more than 180 public-sector providers from 90 selected public-sector sites in Sierra Leone [5]. The intervention combined competency-based classroom training with post-training mentorship, workplace observation, supportive supervision, action planning, and quality-of-care monitoring. Results are presented across the evaluation pathway, moving from trainee reaction and learning outcomes to competency progression, quality-of-care performance, post-abortion care service delivery, and exploratory programme-value indicators.

Trainee Reaction to Training

Trainee reaction to the training was highly positive across all assessed domains, as shown in Table 1. Most participants rated the training objectives, achievement of training objectives, content, materials, facilitation, timeframe, opportunities for participation, and opportunities to practise and apply learning as either excellent or good. No participant rated any assessed domain as unsatisfactory or poor.

The highest excellent ratings were observed for facilitation of the training course, achievement of training objectives, and content of the training. These findings indicate high acceptability of the training approach among participating providers.

Table 1. Trainee Reaction to the Family Planning and Post-Abortion Care Training

Training evaluation domain	Excellent	Good	Satisfactory	Unsatisfactory	Poor
Training objectives	146	40	6	0	0
Achievement of training objectives	154	34	7	0	0
Contents of the training	154	36	6	0	0
Materials provided	132	54	10	0	0
Facilitation of training course	156	37	4	0	0
Timeframe allocated for training	148	40	2	0	0
Opportunities for sharing and participation	136	56	2	0	0
Opportunities to practise and apply learning	130	62	6	0	0

Source: Programme evaluation report [5].

Knowledge Gain Following Training

Mean knowledge scores increased from 28% at pre-test to 81% at post-test, as shown in Table 2, representing a 53-percentage-point gain following the classroom-based training component.

Table 2. Pre-Test and Post-Test Knowledge Scores

Indicator	Score (%)
Mean pre-test score	28
Mean post-test score	81
Absolute knowledge gain	53 percentage points

Source: Programme evaluation report [5].

The increase in post-test scores indicates substantial immediate learning following the training. This result shows improved knowledge acquisition but should be interpreted as an immediate post-training outcome rather than evidence of long-term knowledge retention.

Provider Competency Progression

Provider competency improved over the implementation period, although the trend was not linear, as shown in Table 3. The proportion of providers attaining Level 1 competency was 58.96% in Q3 2019, declined to 48.53% in Q4 2019, increased to 71.01% in Q2 2020, remained relatively stable at 70.17% in Q3 2020, and reached 96.70% by Q4 2020.

Table 3. Provider Level 1 Competency by Quarter

Period	Providers attaining Level 1 competency (%)
Q3 2019	58.96
Q4 2019	48.53
Q2 2020	71.01
Q3 2020	70.17
Q4 2020	96.70

Source: Programme evaluation report [5].

Note: *Level 1 competency refers to providers assessed as competent to provide the relevant service independently, subject to regular re-assessment according to programme-standard competency assessment checklists.*

The decline between Q3 and Q4 2019 coincided with early implementation challenges documented in the programme report, including inadequate equipment and consumables for service provision and practice. The subsequent improvement through 2020 suggests progressive translation of training into workplace competence, supported by mentorship, supervision, action planning, and problem-solving support.

Quality-of-Care Outcomes

Quality-of-care indicators improved between 2019 and 2020, as shown in Table 4. Model-site status increased from 3% in 2019 to 33% in 2020, representing a 30-percentage-point increase. Model-area status increased from 8% to 22%, representing a 14-percentage-point increase.

Table 4. Quality-of-Care Status, 2019–2020

Quality-of-care indicator	2019 (%)	2020 (%)	Absolute change
Model-site status	3	33	+30 percentage points
Model-area status	8	22	+14 percentage points

Source: Programme evaluation report [5].

Note: *A model area refers to an assessed technical section or domain in which a facility scored 90% or above. Model-site status refers to achievement of model-area status across all assessed technical areas or domains.*

These findings indicate improvement in facility-level and service-area quality indicators during the implementation period. The larger increase in model-site status suggests broader improvement in overall facility quality performance, while the increase in model-area status indicates progress in specific quality domains.

Post-Abortion Care Service Delivery

Post-abortion care service delivery increased substantially between 2019 and 2020, as shown in Table 5. A total of 442 post-abortion care services were reported in 2019 compared with 1,950 in 2020, representing an absolute increase of 1,508 services and a relative increase of approximately 341%.

Table 5. Monthly Post-Abortion Care Service Volume, 2019–2020

Month	2019	2020
January	1	52
February	0	112
March	2	153
April	0	126
May	2	156
June	3	107
July	14	156
August	40	131
September	62	289
October	83	294
November	67	207
December	168	167
Total	442	1950

Source: Programme evaluation report [5].

Monthly service data showed higher post-abortion care service volumes in 2020 than in 2019 across nearly all months. The largest monthly service volumes in 2020 were recorded in September and October, while service volumes in 2019 increased mainly in the final quarter. The overall pattern suggests improved service availability, readiness, reporting, demand, or a combination of these factors during the implementation period.

Exploratory Programme-Value and Modelled Impact Estimates

Exploratory return on training investment was estimated at 163%. This suggests that, under the programme's internal value-estimation approach, the estimated benefits of the training and post-training support package exceeded the documented investment cost. However, interpret this estimate cautiously. It

was derived from routine programme financial data and modelled benefit estimates, rather than from a formal cost-effectiveness analysis, cost-benefit study, or controlled economic evaluation. The estimate should therefore be understood as an indicative programme-value measure, useful for internal learning and decision-making, rather than as definitive evidence of economic return attributable solely to the training intervention.

The programme report also included modelled impact estimates generated using MSI Impact 2 version 5, as shown in Table 6. These estimates suggested increases in reproductive health and economic benefits between 2019 and 2020, including unintended pregnancies averted, unsafe abortions averted, maternal deaths averted, DALYs averted, direct healthcare costs saved, and couple-years of protection. These indicators are presented as modelled programme-impact estimates rather than directly observed clinical outcomes.

Table 6. Modelled Programme Impact Estimates, 2019–2020

Indicator	**2019**	**2020**
Unintended pregnancies averted	51,923	56,959
Live births averted	23,540	25,823
Abortions averted	21,505	23,591
Maternal deaths averted	374	397
Child deaths averted	1,164	1,277
Unsafe abortions averted	18,664	21,722
Maternal DALYs averted	21,727	23,042
Child DALYs averted	98,388	107,931
Total DALYs averted	120,115	130,973
Direct healthcare costs saved, 2018 GBP	2,061,920	2,278,754
Total CYPs, FP only	115,569	127,512

Source: Programme evaluation report [5].

Overall, the findings show improvement across the evaluation pathway. Trainee reaction was highly positive, knowledge scores improved substantially after training, provider competency increased over time, quality-of-care indicators improved, and post-abortion care service delivery increased markedly between 2019 and 2020. Because the evaluation did not include a comparison group, these findings should be interpreted as programme-associated changes rather than definitive causal effects.

Discussion

This operations research evaluation found improvements across the training-to-practice pathway: trainee reaction was highly positive, mean knowledge scores increased substantially after training, provider Level 1 competency improved over time, quality-of-care indicators improved between 2019 and 2020, and post-abortion care service delivery increased markedly during the same period. These findings suggest that a competency-based training model, when combined with mentorship, workplace observation, supportive supervision, service-readiness support, and facility action planning, may contribute to improved provider readiness and service delivery in public-sector reproductive health programmes. However, because the evaluation was retrospective and did not include a comparison group, the findings should be interpreted as programme-associated improvements rather than definitive causal effects.

The increase in mean knowledge score from 28% at pre-test to 81% at post-test demonstrates substantial immediate learning following the classroom-based component of the intervention. This finding is consistent with the purpose of structured clinical training, which is to improve provider knowledge, confidence, and technical understanding before clinical practice. However, knowledge gain alone is insufficient evidence of service readiness. In family planning and post-abortion care, providers must translate knowledge into safe counselling, eligibility assessment, infection prevention, procedural competence, emergency preparedness, documentation, incident reporting, and follow-up care. The WHO Family Planning Global Handbook emphasises that family planning providers require practical, method-specific guidance to support informed choice, safe method provision, and management of client concerns [9]. The present findings reinforce this distinction by showing that immediate knowledge gain was followed by more gradual competency improvement that depended on post-training support.

The competency trend is one of the most important findings. Although knowledge improved immediately after training, Level 1 competency increased progressively over time, from 58.96% in Q3 2019 to 96.70% in Q4 2020. This pattern supports the central argument that competency development was not achieved through classroom training alone, but through an implementation model that included mentorship, supervision, workplace observation, supervised practice, facility-level problem solving, and service-readiness support. The temporary decline in competency between Q3 and Q4 2019 is also important because it shows that early post-training implementation was affected by practical constraints, including equipment and consumable gaps documented in the programme report [5]. These constraints may have limited providers' opportunities to practise, consolidate new skills, and demonstrate competency immediately after training.

This finding is consistent with contemporary competency-based education approaches, which emphasise observable performance, real-world application of learning, problem-solving, decision-making, and iterative skill development rather than knowledge retention alone [10, 23, 24]. Evidence from low- and middle-income settings further suggests that health-worker performance improvement requires more than initial training and is strengthened by ongoing support, supervision, feedback, mentoring, and context-sensitive intervention design [11, 12, 20, 21]. In this study, the combination of competency assessment, mentorship, facility action planning, supportive supervision, job aids, equipment readiness, and commodities appears to have provided a mechanism through which training was translated into workplace performance. The contribution of this evaluation lies in documenting how these components were operationalised within a public-sector reproductive health programme in a resource-constrained setting.

The improvement in quality-of-care indicators further supports this interpretation. Model-site status increased from 3% in 2019 to 33% in 2020, while model-area status increased from 8% to 22%. These improvements suggest that gains were not limited to individual provider knowledge but extended to broader service-readiness and quality-performance domains. This is consistent with the Bruce quality-of-care framework, which emphasises method choice, information provided to clients, technical competence, interpersonal relations, continuity, and appropriate service organisation [13]. More recent rights-based family planning frameworks further emphasise informed choice, voluntarism, respectful care, accountability, and client-centred counselling [14-16].

Reproductive health quality is multidimensional. WHO's abortion care

guideline defines quality abortion care as care that is safe, timely, affordable, non-discriminatory, respectful, effective, accessible, acceptable, equitable, and efficient [4]. WHO's broader quality-of-care vision also emphasises both evidence-based provision of care and the experience of care within health facilities [17], while respectful care guidance highlights dignity, privacy, confidentiality, informed choice, continuous support, and freedom from mistreatment [18]. Although this evaluation did not directly measure all dimensions of quality, the observed improvement in model-site and model-area status suggests progress in facility-level systems supporting quality family planning and post-abortion care. The findings also align with recent evidence that expanding family planning coverage requires attention not only to availability, but also to quality, equity, policy support, and health-system context [25].

The increase in post-abortion care service delivery from 442 services in 2019 to 1,950 in 2020 is notable. This increase may reflect improved provider competence, enhanced service readiness, better documentation, increased awareness, improved referral, increased demand, demand creation around supported facilities, commodity availability, or a combination of these factors. It should not be attributed to training alone. Nevertheless, the increase is programme-relevant because access to post-abortion care and post-abortion contraception is a recognised component of quality reproductive health service delivery [4, 19, 22]. The finding suggests that improvements in provider competency and facility quality systems may coincide with increased service utilisation when accompanied by mentorship, service-readiness support, community mobilisation, and public-sector collaboration.

Kirkpatrick's model provided a useful structure for interpreting the evaluation findings across reaction, learning, behaviour, and results [6]. In this study, Level 1 was reflected in positive trainee reaction; Level 2 in knowledge gain; Level 3 in competency progression; and Level 4 in quality-of-care improvement, service-delivery trends, and exploratory programme-value indicators. However, the findings also illustrate one of the known limitations of Kirkpatrick's model: improvement at one level does not automatically prove improvement at the next level [7]. In this evaluation, the improvement observed across levels is best interpreted as a coherent programme pattern rather than proof of a linear causal chain.

The findings have several implications for public-sector family planning and post-abortion care capacity strengthening. First, they support moving beyond one-off training toward competency-based implementation models. Classroom training should be treated as the starting point of capacity building, not the endpoint. Second, mentorship and supportive supervision should be structured, documented, and linked to problem-solving, equipment readiness, documentation quality, commodity availability, provider confidence, and facility action plans. Supportive supervision is more likely to improve performance when it is collaborative, data-informed, and oriented toward service improvement rather than inspection alone [20, 21].

Third, the intervention demonstrated the value of government-partner collaboration. The programme was coordinated by Marie Stopes Sierra Leone, with regulatory oversight and national alignment from the Ministry of Health and Sanitation, support from national master trainers, district health structures, and participating public-sector facilities [5]. Such collaboration may improve legitimacy, alignment with national systems, and feasibility of implementation. This is relevant for sustainability because public-sector capacity strengthening requires ownership beyond a single implementing organisation and aligns with global health workforce priorities that emphasise competency, system integration, and sustained workforce investment [23, 26].

Fourth, the findings reinforce the importance of quality systems alongside service expansion. Increased service volume is valuable only if services are safe, respectful, technically competent, well documented, and client-centred. Recent evidence on family planning policy and coverage suggests that service expansion requires attention to quality, equity, health-system context, and the needs of vulnerable populations [25]. Future scale-up should therefore preserve the model's quality-assurance components, including competency assessment, incident reporting, consent documentation, infection prevention, supportive supervision, and facility action planning.

Incident reporting and management were also important components of the programme's quality-improvement pathway. Through training, mentorship, and district-level support, providers were introduced to structured incident reporting processes and supported in identifying, documenting, escalating, and learning from clinical incidents. Within the supported facilities, this represented an important step toward embedding incident reporting into routine public-sector family planning and post-abortion care service delivery. The programme's Medical Development Team also shared lessons learned from incidents, both locally and globally, with supported facilities. These lessons were reviewed with district mentors and used to strengthen local practice, improve provider awareness of preventable risks, and support a learning-oriented safety culture. This approach is consistent with global patient-safety guidance, which emphasises that incident reporting and learning systems should support structured analysis, non-punitive investigation, feedback, and system improvement to prevent recurrence [27, 28]. Therefore, the introduction of incident reporting within the capacity-building model should be viewed as a clinical governance intervention, not merely an administrative reporting requirement.

The exploratory return-on-training investment estimate of 163% suggests that, within the programme's internal value-estimation approach, the estimated benefits associated with the training and post-training support package exceeded the documented investment cost. However, interpret this estimate cautiously. It was derived from routine programme financial data and modelled benefit estimates rather than from a formal cost-effectiveness analysis, cost-benefit study, or controlled economic evaluation. Similarly, the Impact 2 estimates for unintended pregnancies averted, unsafe abortions averted, maternal deaths averted, disability-adjusted life years averted, healthcare costs saved, and couple-years of protection represent modelled programme-impact estimates rather than directly observed clinical outcomes [8]. These estimates are useful for programme learning and value-for-money discussion, but they should not be presented as independently measured health outcomes or as economic return attributable solely to the training intervention.

This evaluation has several strengths. It drew on real-world implementation data from a public-sector reproductive health programme, assessed multiple levels of the training-to-practice pathway, included provider-level and facility/service-level indicators, and used routine data commonly available to programme implementers and ministries of health. It also documented implementation barriers, including equipment and consumable constraints, which provide practical learning for future programme design. In addition, the evaluation examined a combined intervention package rather than classroom training alone, making the findings relevant to implementation contexts where service readiness, mentorship, quality assurance, and supervision influence whether providers can apply newly acquired skills.

The evaluation also has important limitations. The retrospective design and absence of a comparison group limit causal

inference. Improvements observed between 2019 and 2020 may have been influenced by factors other than the training and supportive supervision model, including demand-generation activities, changes in reporting, commodity availability, referral systems, programme maturity, provider motivation, or broader health-system dynamics. The analysis was primarily descriptive, and available summary data did not allow adjustment for provider cadre, facility type, district, service volume, baseline readiness, supervision intensity, or facility-level implementation capacity.

The knowledge-gain analysis used average pre-test and post-test scores and did not assess long-term knowledge retention. Competency improvement was assessed using programme competency records, but inter-assessor standardisation and consistency over time could not be independently verified from the summary dataset. Quality-of-care indicators were reported as model-site and model-area percentages; while these were programme-standard quality-assurance indicators, further evaluation would benefit from clearer documentation of denominators, component criteria, and facility-level trajectories. The post-abortion care service increase is significant but cannot be attributed solely to training because service output may be affected by demand, referrals, commodities, documentation, client mobilisation, and programme implementation factors.

Finally, the return-on-training investment and Impact 2 estimates were modelled programme-value indicators rather than formal economic or epidemiological outcome measures. Potential selection bias, measurement bias, observer bias, reporting bias, and confounding should therefore be considered when interpreting the findings. These limitations do not negate the programme-learning value of the evaluation, but they require cautious interpretation and avoidance of causal overstatement.

Future evaluations should use stronger designs where feasible, including quasi-experimental designs, comparison facilities, interrupted time-series analysis, or facility-level longitudinal analysis. Further research should examine whether competency gains are sustained beyond the initial supervision period and whether improvements vary by provider cadre, facility type, district, supervision intensity, service-delivery context, equipment readiness, commodity availability, and demand-generation support. Studies should also assess client-level outcomes, including satisfaction, informed choice, method continuation, complication management, referral completion, experience of respectful care, and whether improvements in incident reporting translate into safer practice.

More rigorous economic evaluation would also be valuable. Future studies should distinguish training costs, supervision costs, mentorship costs, equipment costs, commodity costs, demand-creation costs, and broader programme implementation costs. This would allow clearer assessment of cost-effectiveness, affordability, scalability, and sustainability. Overall, the evaluation provides practical evidence that competency-based training, when embedded within a structured supportive supervision and quality-improvement system, can strengthen public-sector family planning and post-abortion care service delivery in resource-constrained settings.

Conclusion

This operations research evaluation found that a competency-based family planning and post-abortion care training and supportive supervision model was associated with improvements in provider knowledge, clinical competency, quality-of-care indicators, and post-abortion care service delivery in selected public-sector facilities in Sierra Leone. Mean knowledge scores improved substantially after training, provider Level 1 competency increased over the implementation period,

quality-of-care indicators improved between 2019 and 2020, and post-abortion care service volume increased markedly during the same period.

The findings suggest that classroom-based training alone is unlikely to be sufficient for sustained clinical performance improvement. Instead, the observed pattern of results supports the value of combining training with competency assessment, mentorship, workplace observation, supervised practice, supportive supervision, action planning, service-readiness support, and facility-level problem solving. This model appears particularly relevant for reproductive health services that require both technical competence and system readiness support, including long-acting reversible contraception and post-abortion care.

The evaluation also highlights the importance of embedding quality-assurance and clinical-governance systems within capacity-building programmes. Incident reporting, consent documentation, infection prevention, emergency preparedness, mentorship, and facility action planning strengthened the training-to-practice pathway by helping providers apply new skills within safer and more accountable service-delivery systems.

However, interpret the findings with caution because the evaluation was retrospective, descriptive, and did not include a comparison group. Improvements observed during the implementation period may have been influenced by other programme or health-system factors. The return-on-training investment and health impact estimates should also be interpreted as exploratory and modelled programme-value indicators rather than definitive economic or clinical outcomes.

Future evaluations should use stronger comparative or longitudinal designs to assess causality, sustainability, scalability, and cost-effectiveness. They should also examine long-term competency retention, variation by provider cadre and facility context, client-level outcomes, referral completion, experience of respectful care, and the contribution of incident reporting and quality-improvement systems to safer reproductive health service delivery.

Overall, this evaluation provides practical, context-specific evidence that competency-based training, when embedded within a structured supportive supervision and quality-improvement system, can strengthen public-sector family planning and post-abortion care service delivery in resource-constrained settings. The findings offer actionable insights for policymakers, programme implementers, and global health partners seeking to improve reproductive health outcomes through sustainable, system-integrated capacity-building approaches.

Conflict of Interest

The author declares no conflict of interest. The evaluation was conducted as part of routine programme accountability, learning, and performance review under the Saving Lives Phase 2 project. The findings and interpretations presented in this manuscript are the author's and do not necessarily represent the official position of any affiliated institution, funder, or implementing partner.

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Author Contributions

Felix Ikenna Onunkwor conceptualised the evaluation, led the programme's quality assurance and management components, contributed to programme implementation oversight, coordinated evaluation inputs, reviewed programme data, analysed and interpreted the findings, and drafted the manuscript. The author also reviewed and approved the final manuscript version for submission.

Ethical Approval

This study used routinely collected programme data generated during implementation of the Saving Lives Phase 2 project. The Quality Assurance and Management team at Marie Stopes Sierra Leone conducted this work as an internal programme evaluation and operations research activity, in collaboration with relevant programme, monitoring, evaluation, and finance functions.

This manuscript reports no individual client-identifiable information. Provider and facility-level findings are presented in aggregate form. As the work involved retrospective analysis of routine programme implementation and quality-improvement data, it was treated as a programme evaluation rather than an interventional human-subjects research study. Institutional permission to publish the findings was obtained from the relevant data-owning and implementing bodies.

Data Availability

The data used for this study were derived from routine programme implementation records of the Saving Lives Phase 2 project and the internal programme evaluation report of Marie Stopes Sierra Leone. The data are not publicly available because they form part of internal programme records; however, the manuscript tables present aggregated data supporting the findings. Further information may be made available by the author upon reasonable request and subject to institutional permission from the relevant data-owning bodies.

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Evaluating Active Versus Passive Surveillance under IDSR 3rd Edition in Central Africa: A Comparative Implementation Analysis of Outbreak Detection, Reporting Completeness, and Cost-effectiveness (2018 to 2024)

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Abstract *Central Africa faces recurrent outbreaks of cholera, measles, yellow fever, Mpox, and viral haemorrhagic fevers, compounded by fragile health systems, insecurity, and limited laboratory capacity. The 3rd Edition of the Integrated Disease Surveillance and Response (IDSR) framework provides updated guidance for strengthening early warning and response, yet implementation remains uneven across the region. This mixed methods implementation analysis combines a narrative review of policy documents, surveillance performance data (2018–2024), peer reviewed literature, and grey literature from Central African countries. Data were synthesized using thematic analysis and a comparative assessment guided by IDSR core functions, IHR (2005) capacities, and health system resilience dimensions (absorption, adaptation, transformation). Active surveillance approaches, including community based surveillance (CBS), active case finding, event based surveillance (EBS), and proactive rapid response teams, substantially outperformed passive facility*

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based models. Active strategies reduced outbreak detection delays by a median of 8 days, increased weekly reporting completeness by 39 percentage points, and lowered cost per true alert detected by 65%. Countries such as Cameroon, DRC, Gabon, and CAR demonstrated scalable innovations: integrated digital IDSR platforms, motorcycle courier laboratory networks, remote SMS hotlines in conflict zones, and the region's first functional cross-border mechanism in the Lake Chad Basin. However, six systemic challenges persist, namely workforce deficits, laboratory fragmentation, fragmented information systems, insecurity, financing gaps, and weak cross-border coordination. Low-cost, adaptive interventions—community surveillance supervisors, integrated digital platforms, sample transport networks, and cross-border coordination calls—can transform surveillance performance across Central Africa within 24 months. Intentional or structured governance, domestic financing, and active implementation are essential to achieving regional health security aligned with IDSR 3rd Edition and IHR (2005).

Keywords *Central Africa, Community-Based Surveillance, Cross-Border Coordination, Event-Based Surveillance, Health Security, Integrated Disease Surveillance and Response (IDSR), One Health, Surveillance Resilience.*

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Introduction

Central Africa continues to face a high and recurrent burden of epidemic-prone diseases, driven by a combination of ecological, demographic, and health system vulnerabilities [2]. The region experiences frequent outbreaks of cholera, measles, yellow fever, Mpox, viral haemorrhagic fevers, and other priority conditions that challenge national capacities for early detection and rapid response [2, 4]. These threats are amplified by persistent structural constraints, including fragile health systems, limited laboratory capacity, protracted humanitarian crises, population displacement, and porous borders that facilitate cross border transmission [4, 16]. The COVID-19 pandemic further exposed weaknesses in surveillance architecture, underscoring the need for resilient, integrated, and adaptive systems that can function effectively under stress [18, 19].

In response, the Integrated Disease Surveillance and Response (IDSR) strategy has served as the cornerstone of national surveillance systems across the African region since its introduction in 1998 [19]. The release of the 3rd Edition of IDSR marked a significant evolution of the framework, incorporating updated technical guidance, expanded priority diseases, enhanced emphasis on event-based surveillance, and stronger alignment with the International Health Regulations (IHR 2005) [1]. The revised edition also promotes digital transformation, multisectoral collaboration, and community-level engagement, elements that are essential for building surveillance systems that can absorb shocks, adapt to changing epidemiological patterns, and sustain core functions during crises [3, 11].

Despite widespread adoption of IDSR, implementation across Central Africa remains uneven, and surveillance network resilience varies considerably between and within countries [4]. Many districts continue to struggle with incomplete reporting, delayed notification, limited data analysis, and insufficient integration of community-based and event-based surveillance [15]. At the same time, several countries have demonstrated promising innovations, such as mobile reporting platforms, strengthened rapid response teams, and cross-border coordination mechanisms, that illustrate the potential of active, system-strengthening approaches to enhance surveillance performance [5, 6, 8].

Given the region's complex risk landscape, there is a growing need to critically examine how active surveillance is being operationalized and to identify strategies that reinforce the resilience, sensitivity, and timeliness of surveillance systems [3]. Understanding what works, what remains constrained, and what innovations can be scaled is essential to inform national policies, guide partner investments, and advance regional health security [12, 13]. Among health districts in Central Africa implementing IDSR 3rd Edition (2018–2024), what differences exist between active and passive surveillance systems in outbreak detection timeliness and sensitivity, reporting completeness, cost-effectiveness, and documented barriers or facilitators, as reported in peer-reviewed and grey literature?

This study therefore aims to assess the implementation of the IDSR 3rd Edition in Central Africa and to evaluate how active surveillance approaches contribute to building resilient surveillance networks capable of detecting and responding to public health threats more effectively [1, 19]. By synthesizing evidence from policy documents, surveillance performance data, and country experiences, the article provides insights to support stronger, more adaptive surveillance systems aligned with both IDSR and IHR (2005) requirements [1].

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Objectives

Overall Objective

Evaluate active versus passive surveillance under IDSR 3rd Edition in Central Africa from 2018 to 2024.

Specific Objectives

1. To compare the timeliness and sensitivity of outbreak detection between active and passive surveillance systems for priority diseases (e.g., measles, yellow fever, Ebola) across selected health districts in Central Africa from 2018 to 2024.
2. To assess and compare reporting completeness (i.e., weekly/monthly IDSR summary forms) and data quality (e.g., timeliness, consistency, use of IDSR 3rd Edition case definitions) between health facilities employing active surveillance versus those relying on passive surveillance.
3. To conduct a cross-country comparison to examine variations in IDSR implementation across Central African countries, identify enabling factors and bottlenecks and highlight innovations and adaptive practices that strengthen surveillance resilience.
4. To propose evidence-based recommendations for system optimization.

Method of Study

Study Design

This article employs a mixed-methods implementation analysis, combining a narrative review of evidence with a comparative assessment of IDSR 3rd Edition implementation experiences across Central African countries. The approach integrates document review, secondary data analysis, and thematic synthesis to examine how active surveillance strategies contribute to system resilience.

Data Sources

The study draws on multiple categories of data:

1. Policy and technical documents: IDSR 3rd Edition guidelines, national surveillance strategies, IHR (2005) reports, Joint External Evaluation (JEE) findings, and national health security plans.
2. Surveillance performance data: routine IDSR indicators, timeliness and completeness reports, outbreak detection timelines, and event-based surveillance outputs from Ministries of Health and WHO AFRO.
3. Peer-reviewed literature: studies on surveillance system performance, resilience frameworks, and health systems strengthening in Central Africa.
4. Grey literature: WHO mission reports, Africa CDC assessments, partner evaluations, and operational field reports from outbreak responses.

Data Collection Procedures

1. The review concerned literature and technical documents published between 2015 and 2024.
2. Surveillance performance indicators were extracted from publicly available national and regional datasets.

Analytical Framework

The analysis is guided by three complementary frameworks:

1. IDSR 3rd Edition core functions and support functions.
2. IHR (2005) core capacities for surveillance and response.
3. Health system resilience dimensions (absorption, adaptation, transformation).

Data were synthesized using a thematic analysis approach to identify patterns related to system resilience, operational challenges, and effective implementation strategies.

Comparative Assessment

A cross-country comparison was conducted to:

1. Examine variations in IDSR implementation across Central African countries.
2. Identify enabling factors and bottlenecks.
3. Highlight innovations and adaptive practices that strengthen surveillance resilience.

Ethical Considerations

The study relies exclusively on publicly available secondary data and published materials. No individual-level or confidential data were used, and therefore formal ethical approval was not required.

Results

Strategic importance of resilient surveillance systems for health security in Central Africa

The following results highlight the importance of robust, adaptive, and interoperable surveillance networks for preventing, detecting, and responding to priority diseases, public health events, and emerging threats in a region marked by recurrent epidemics and fragile health systems [2, 4] (Table 1).

Table 1. Key Epidemic-Prone Diseases and Outbreak Frequency in Central Africa (2018–2024)

Disease	Countries Most Affected	Average Annual Outbreaks	Typical Detection Delay (Days)
Cholera	DRC, Cameroon, Chad, CAR	8–12	7–14
Measles	DRC, CAR, Chad, Cameroon	15–20	10–21
Yellow Fever	Gabon, Congo, DRC, Cameroon	3–5	5–10
Mpox	DRC, CAR, Congo, Cameroon	6–10	7–14
Viral Haemorrhagic Fevers	DRC, Equatorial Guinea, Gabon	1–2 (Ebola/Marburg)	3–7
Polio (cVDPV)	DRC, CAR, Chad, Congo	4–8	5–15

Data sources: [2, 4, 22]

Table 2 contrasts low versus high resilience settings across six core surveillance metrics.

Table 2. Surveillance Resilience Indicators – High vs. Low Resilience Settings

Indicator	Low Resilience Settings	High Resilience Settings
Outbreak detection delay (median)	14+ days	3–5 days
Weekly IDSR reporting completeness	<50%	>90%
Alert verification time (median)	5–7 days	<24 hours
Laboratory sample transport time	10–21 days	2–5 days
Cross-border data sharing	Ad hoc or none	Systematic monthly
Reporting completeness during active conflict	<20%	>60%
IHR (2005) Surveillance core capacity score (JEE)	1–2	3–4

Data sources: [3, 4, 15]

Structural barriers to surveillance resilience are summarized in Table 3.

Table 3. Structural Barriers to Surveillance Resilience in Central Africa

Barrier Category	Specific Constraint	Affected Countries (Most Severe)
Workforce	No dedicated district surveillance officer in >40% of districts	CAR, Chad, DRC
Laboratory	<30% of districts have functional sample transport	CAR, Chad, DRC, Congo
Supply Chain	Regular stockouts of collection materials	All countries
Digital Infrastructure	Paper-based reporting in >50% of rural districts	CAR, Chad, DRC, Gabon
Insecurity	Active conflict zones with <20% reporting completeness	CAR, eastern DRC
Financing	Unpredictable government and donor funding	All countries

Data sources: [4, 6, 16]

The COVID-19 pandemic further stressed surveillance systems, reducing completeness and timeliness while temporarily expanding event-based surveillance capacity [18] (Table 4).

Table 4. COVID-19 Stress Test – Performance of Surveillance Systems in Central Africa

Indicator	Before COVID-19 (2019)	During COVID-19 Peak (2020–2021)	After COVID-19 (2023–2024)
Average weekly IDSR completeness (region)	62%	48%	58%
Timeliness of reporting (within 24h)	55%	41%	52%
Districts with functional event-based surveillance	18%	47%	35%
Rapid response team deployment within 48h	32%	28%	31%

Data sources: [15, 18]

3rd Edition of IDSR core capacities in early warning and response

These findings highlight the updated technical guidance, new priority conditions, digital innovations, and enhanced multisectoral approaches introduced in IDSR 3.0, and how these elements address persistent gaps in surveillance and response across Central African countries [1, 3]. Table 5 quantifies the performance of community-based surveillance in conflict-affected health zones in DRC.

Table 5. Community-Based Surveillance in DRC – Performance During Active Conflict

Indicator	Health Zones with CBS	Health Zones without CBS	Difference
Reporting completeness during active conflict	55%	12%	+43 pts
Outbreaks first detected at community level	34%	6%	+28 pts
Community alerts reported (monthly per 100k)	18–25	2–5	5–12 × higher
Time from community event to formal alert	1–2 days	5–10 days	4–8 days faster

Data sources: [6, 9]

The following table 6 demonstrates the operational value of multisectoral surveillance.

Table 6. One Health Impact – Early Warning for Zoonotic Diseases

Country	One Health Coordination	Zoonotic Disease Alerts Shared (2024)	Early Warning Achieved?	Days of Advance Warning
Cameroon	National Platform	45	Yes (anthrax)	10 days
DRC	Technical Working Group	38	Partial (mpox)	3 days
Gabon	Inter-ministerial	22	No	0 days
Chad	None	8	No	0 days
CAR	None	3	No	0 days
Congo	None	2	No	0 days

Data sources: [5, 25]

Cameroon detected an anthrax outbreak 10 days before human cases appeared by monitoring livestock mortality through the One Health platform. This shows how animal health surveillance can predict human outbreaks days in advance, a compelling "why One Health matters" exhibit.

Post-IDSR 3.0 improvements across the region, including expanded priority conditions, increased digital reporting, and broader EBS coverage, reflect the impact of updated technical guidance and stronger alignment with IHR (2005) [1, 3] (Table 7).

Table 7. Summary Comparison of Core Capacities (Pre-IDSR 3.0 vs. Post-IDSR 3.0)

Core Capacity	Pre-IDSR 3.0 (~2018)	Post-IDSR 3.0 (~2024)	Change
Priority conditions covered	12 diseases	22 conditions	+83%
Districts with EBS functional	<5%	35% (regional)	+30 pts
Timely digital reporting (≤24h)	41%	67%	+26 pts
Confirmation within 7 days (lab)	32%	55%	+23 pts

One Health coordination (countries)	1 country	3 countries	+2
Outbreaks first detected at community level	<5%	34% (where CBS exists)	+29 pts
Functional cross-border mechanisms	0	1 (Lake Chad)	+1

This table tells the entire "progress story" of the 3rd Edition in Central Africa.

Community-based surveillance (CBS) in the DRC demonstrated substantial gains in reporting completeness, early detection, and alert generation during active conflict, highlighting the value of community engagement in fragile settings [6]. One Health coordination also showed measurable benefits: Cameroon's national platform enabled early warning of an anthrax outbreak ten days before human cases appeared, demonstrating the operational value of multisectoral surveillance [25]. Post-IDSR 3.0 improvements across the region, including expanded priority conditions, increased digital reporting, and broader EBS coverage, reflect the impact of updated technical guidance and stronger alignment with IHR (2005) [1, 3] (Table 7).

Practical Strategies for Operationalizing an "Active Approach" to IDSR Implementation

Findings detail actionable methods such as active case finding, community-based surveillance, event-based surveillance, cross-border coordination, and real-time data use that can transform IDSR from a policy framework into a functioning, resilient surveillance ecosystem [5, 6, 8].

As shown in Table 8, active case finding consistently outperformed passive surveillance.

Table 8. Impact of Active Case Finding on Outbreak Detection

Strategy	Setting (Country)	Cases Detected per 1,000 Screened	Detection Delay (Days)	Outbreak Size (Cases)
Passive surveillance only	Rural DRC	0.8	14 days	1,240
Active case finding (door-to-door)	Rural DRC	12.4	4 days	320
Passive surveillance only	Urban Cameroon	1.2	10 days	890
Active case finding (market + school)	Urban Cameroon	9.7	3 days	215

Data sources: [5, 6]

Table 9 illustrates CBS performance gains in Cameroon

Table 9. CBS Performance Compared to Facility-Only Surveillance: Example of Cameroon

Indicator	Facility-Only Surveillance	Facility + CBS	Difference
Weekly reporting completeness	51%	89%	+38 percentage points
Alerts generated per 100,000 population	6	42	7× higher
Outbreaks detected before 5 cases	12%	58%	+46 percentage points
Time from first case to alert (median)	7 days	2 days	5 days faster
Cost per outbreak averted	Not calculable	$1,200	Cost-effective

Source: Cameroon CBS pilot evaluation (2023–2024) [5, 23]

Community-Based Surveillance (CBS) is the "Ears and Eyes" of the System

A comprehensive comparison between passive and active IDSR models is presented in Table 10.

Table 10. Comparison between Passive IDSR and Active IDSR

Metric	Passive IDSR	Active IDSR	Difference	Advised choice
Outbreak detection delay (median)	12 days	4 days	8 days faster	□ Active
Weekly reporting completeness	48%	87%	+39 pts	□ Active
Alerts investigated within 48 hours	22%	79%	+57 pts	□ Active
Outbreaks contained within 4 weeks	34%	81%	+47 pts	□ Active
Community awareness of reporting	12%	68%	+56 pts	□ Active
Health worker competency (1–10)	4.1	8.3	+4.2 pts	□ Active
Cost per true alert detected	$240	$85	65% lower	□ Active
Cross-border info sharing	Sporadic	Systematic	Qualitative	□ Active
Alerts generated per 100k population	6	42	7 × higher	□ Active
Outbreaks detected before 5 cases	12%	58%	+46 pts	□ Active
Time from alert to sample transport	8 days	2 days	6 days faster	□ Active
Health worker reporting time (hours/week)	18 hrs	6 hrs	12 hrs saved	□ Active

Data sources: [5, 6, 8, 15]

Active case finding consistently outperformed passive surveillance, detecting 10–15 times more cases per 1,000 persons screened and reducing outbreak size by up to 75% through earlier intervention [5, 6]. CBS also significantly strengthened surveillance performance in Cameroon, increasing weekly reporting completeness, alert generation, and early outbreak detection while reducing reporting delays [5]. Comparative analysis between passive and active IDSR models shows that active approaches improve detection speed, investigation timeliness, community awareness, and cost-effectiveness, reinforcing the value of proactive surveillance strategies [5, 6].

Challenges Limiting Surveillance Performance in Central Africa

Across Central Africa, six systemic challenges persistently undermine surveillance resilience, each with feasible, context-appropriate solutions [3, 4].

Workforce Deficit: Fifty-eight percent of districts regionally lack a dedicated surveillance officer. In Chad and CAR, only 18–22% of districts have such staff, with individual officers overseeing up to 51 health facilities. Training coverage in the past 12 months is below 10% in the most fragile settings [4]. Feasible solution: Community surveillance supervisors (12-month certificate)

costing $3,000 per person per year, one-fifth the cost of a degree-holding officer. A DRC pilot increased reporting completeness from 31% to 67% within six months [6].

Laboratory Fragmentation: Rural districts experience sample transport delays of 10–21 days; 58% of district laboratories do not report results into IDSR; and stockouts occur 3.2 months annually [4]. Feasible solution: Motorcycle courier networks with GPS tracking. A Cameroon pilot reduced transport time from 14 to 4 days and increased confirmation rates from 34% to 71% at $4.50 per sample [5].

Information System Fragmentation: Health workers complete seven separate reporting forms weekly, consuming nine hours, 3.5 hours of which is redundant data entry. Duplication is highest for COVID-19 (70% overlap with IDSR) and polio (45%) [4]. Feasible solution: A single integrated IDSR platform. A DRC pilot consolidated five vertical forms into one module, reducing reporting time from nine to 5.5 hours weekly and cutting data errors from 18% to 7% [6].

Insecurity and Access Constraints: In eastern DRC, reporting completeness drops from 78% in stable zones to 19% in active conflict zones and below 5% in no-go areas. An estimated 12–18 outbreaks are missed annually per conflict zone [6]. Feasible solution: Remote SMS hotlines and community informants. CAR received 34% of alerts from inaccessible areas via hotlines; DRC maintained 64% reporting during a three-month conflict using trained informants, at $2,000–5,000 per zone [9].

Financing Gaps: Government allocations cover only 8–34% of surveillance costs; donor dependence reaches 92% in CAR and 88% in Chad [16]. Annual funding gaps exceed $12 million in DRC. Consequences include 40% of EBS sites inactive in Cameroon and reporting falling below 50% for six months annually in Chad [4]. Feasible solution: Mandatory domestic budget lines for surveillance plus Pandemic Fund access. Twelve districts in Cameroon allocated $500–1,500 each, improving reporting completeness by 18 percentage points [5].

Data Quality Deficits: Regional completeness (58% vs. 95% target), timeliness (52% vs. 90%), and laboratory confirmation accuracy (44% vs. 90%) all fall far below IHR standards [4]. False zero reporting occurs in 38% of districts. *Feasible solution:* Automated data validation rules in DHIS2-IDSR. Gabon reduced implausible reports from 22% to 6% within four months at zero software cost [7].

In summary, the five highest-priority challenges—workforce, laboratory, information systems, insecurity, and financing—can be addressed through low-cost, scalable interventions that together could transform surveillance performance across the region within 12–24 months [3].

Country Experiences and Innovations Demonstrating Resilience

Despite shared challenges, several Central African countries have developed adaptive strategies and innovations that demonstrate surveillance resilience in practice. These experiences offer scalable models for the region [5-10].

Cameroon: Integrated digital IDSR at scale. Cameroon achieved the region's most comprehensive digital transformation, rolling out DHIS2-based IDSR to 60% of districts by 2024. The team integrated event-based surveillance alongside indicator-based reporting and trained community volunteers in 45 high-risk health zones. Results: Weekly reporting timeliness increased from 41% to 67%; alert verification time dropped from five days to under 24 hours; and 34% of outbreaks were first detected at community level. The country also operationalized a One Health platform that detected an anthrax outbreak ten

days before human cases appeared by monitoring livestock mortality [5, 25].

Democratic Republic of the Congo: Resilience under humanitarian stress. Despite active conflict affecting eastern provinces, DRC piloted innovative approaches to maintain surveillance functions. Community-based surveillance was deployed in 15 high-risk health zones, training local volunteers to report via encrypted SMS. Rapid response teams were reconfigured as active surveillance extenders, conducting routine patrols rather than waiting for alerts. Results: During active conflict, zones with community volunteers maintained 55% reporting completeness compared to 12% in zones without. Each active RRT investigated 18 alerts monthly (up from 2 in the passive model) and collected 45 samples per month during routine patrols [6, 23].

Gabon: Laboratory integration and digital dashboards. Gabon achieved the region's strongest laboratory-to-IDSR linkage, with 72% of districts connected to functional sample transport networks and 68% of laboratories routinely reporting into the surveillance system. We deployed a real-time digital dashboard at national and regional levels. Results: Average sample transport time was 2–4 days, the fastest in Central Africa; 78% of suspected outbreaks were laboratory-confirmed within seven days; and automated validation rules reduced implausible reports from 22% to 6% within four months [7].

Lake Chad basin (Cameroon-Chad-Nigeria): Cross-border surveillance success. This tri-country initiative represents the region's only fully functional cross-border surveillance mechanism. The initiative adopted harmonized case definitions for six priority diseases, established shared alert thresholds, and routinely conducted joint outbreak investigations. Results: Mpox detection delay decreased from 14 to 5 days; monthly cross-border alerts increased from 1 to 14; and four joint investigations were conducted in 2023–2024, a new regional capability [8, 24].

Central African Republic: Remote surveillance in conflict zones. Facing the region's most severe access constraints, CAR innovated with SMS and voice hotlines that allowed community members to report health events from areas where surveillance staff could not travel. Results: During 2023, 34% of all alerts originated from remote hotlines in inaccessible zones, detecting outbreaks that would otherwise have been missed entirely [9].

Chad: Humanitarian surveillance windows. In security-compromised border districts, Chad piloted intensified data collection during ceasefires and humanitarian lulls. Results: A single ten-day lull in 2024 captured 78% of quarterly surveillance data, showing that even fragmented access can yield high-value data when windows are anticipated and staff are pre-positioned [10].

Congo: Early pilot of cross-border mechanisms. Though lagging on most IDSR 3.0 components, Congo initiated a pilot cross-border surveillance project on the Sangha River with Cameroon and CAR. While still in early stages, this represents an important first step toward addressing one of the region's most persistent gaps [8].

Synthesis of lessons learned. Across these experiences, five cross-cutting enablers of resilience emerge: (1) digital integration reduces fragmentation and improves timeliness; (2) community engagement maintains functions where facilities cannot; (3) active RRTs extend surveillance reach into remote areas; (4) cross-border mechanisms require sustained facilitation but yield high returns; and (5) humanitarian adaptation—using SMS, hotlines, and surveillance windows—preserves data flow during crises. Countries that have invested in these enablers consistently outperform their neighbours on

detection delays, reporting completeness, and outbreak containment [3, 5-10].

Role of Governance, Multisectoral Coordination, and Collaboration Mechanisms in Building Resilient Systems

The analysis shows that governance quality and the strength of coordination mechanisms are among the most decisive factors shaping surveillance resilience across Central Africa [3]. Countries with structured national leadership and harmonized coordination platforms consistently demonstrate superior performance in timeliness, laboratory confirmation, and early detection. Cameroon and Gabon illustrate this pattern most clearly: Cameroon reduced alert verification from five days to under 24 hours through integrated national coordination, while Gabon confirmed 78% of suspected outbreaks within seven days due to strong laboratory governance and digital reporting systems [5, 7]. These examples highlight how coherent national governance directly enhances surveillance sensitivity and operational efficiency.

Regional and cross-border coordination mechanisms further amplify resilience, particularly in areas with high population mobility and shared ecological risks. The Lake Chad Basin initiative, the region's only fully functional cross-border surveillance mechanism, produced measurable improvements, including reducing Mpox detection delay from 14 to 5 days and increasing cross-border alerts from one to fourteen per month [8, 24]. The mechanism also facilitated four joint outbreak investigations, demonstrating the value of harmonized case definitions, shared thresholds, and routine information exchange. Early-stage pilots, such as the Congo–Cameroon–CAR collaboration along the Sangha River, signal emerging governance momentum in historically underserved border zones [8].

Multisectoral collaboration with the One Health platforms also contributes significantly to early warning and risk detection. Countries with operational One Health coordination, most notably Cameroon, reported more frequent zoonotic alerts and earlier detection of animal-to-human spillover events [5]. Cameroon's platform detected an anthrax outbreak ten days before human cases appeared, underscoring the operational value of integrating veterinary, environmental, and public health data streams [25]. In contrast, countries without functional One Health structures reported no advance warning for zoonotic threats, reinforcing the importance of multisectoral governance [4].

Community Engagement and Partner Coordination and Financing

Community engagement emerged as a critical governance modality in fragile and conflict-affected settings. Community-based surveillance (CBS) systems in the Democratic Republic of the Congo maintained 55% reporting completeness in conflict zones, compared to only 12% in areas without CBS, while remote hotlines in the Central African Republic generated 34% of all alerts from inaccessible areas [6, 9]. These findings demonstrate that governance models that formally integrate community actors can sustain surveillance functions even when state presence is limited.

Partner coordination and financing also shape system resilience. Although government allocations cover only 8–34% of surveillance costs and donor dependence remains high, aligned investments yield measurable improvements [16]. In Cameroon, modest district-level allocations of USD 500–1,500 increased reporting completeness by 18 percentage points [5]. Similarly, WHO facilitated coordination in the Ubangi River basin increased cross-border alerts from zero to 24 and enabled three joint investigations, illustrating the catalytic role of regional institutions [8].

Overall, governance quality consistently predicts surveillance performance across the region [3]. Countries that have invested in integrated national coordination, multisectoral platforms, community engagement, and structured cross-border mechanisms outperform their neighbours on detection delays, reporting completeness, and outbreak containment [5-9]. Governance is therefore not a peripheral factor but a central determinant of surveillance resilience in Central Africa.

Forward-looking Roadmap for Scaling and Sustaining Resilient IDSR-based Surveillance Networks

The evidence synthesis across Central Africa highlights a clear set of strategic priorities that together form a practical roadmap for scaling and sustaining resilient IDSR-based surveillance systems [3]. Digital transformation emerges as the most powerful and scalable driver of improvement. Countries that adopted integrated digital IDSR platforms, such as Cameroon and Gabon, demonstrated substantial gains in reporting timeliness, data quality, and laboratory confirmation [5, 7]. These results indicate that expanding DHIS2 IDSR, automated validation rules, and real-time dashboards across the region would significantly reduce fragmentation and accelerate early warning [3].

Institutionalizing community-based and event-based surveillance is equally essential. Evidence from DRC, Cameroon, and CAR shows that CBS and EBS dramatically increase alert generation, shorten detection delays, and maintain surveillance functions in conflict-affected or inaccessible areas [5, 6, 9]. Scaling these approaches requires formal policy integration, standardized training, and simple mobile reporting tools [3].

Laboratory system strengthening remains a central pillar of the roadmap. Persistent delays in sample transport and confirmation undermine early detection, yet low-cost innovations—such as motorcycle courier networks and integrated laboratory IDSR reporting—have proven highly effective and scalable [5, 7].

Cross-border coordination also emerges as a high-impact priority. The Lake Chad Basin mechanism demonstrates that structured cross-border governance reduces detection delays, increases information sharing, and enables joint investigations [8, 24]. Replicating this model in other high-risk border zones would address one of the region's most persistent surveillance gaps [8].

Discussion

The findings from this mixed-methods implementation analysis confirm that the 3rd Edition of the IDSR framework has catalysed measurable, though uneven, progress in surveillance system resilience across Central Africa [3]. While the updated guidance on event-based surveillance, digital integration, and community engagement has enabled tangible gains in several settings [1], persistent structural barriers—workforce shortages, laboratory fragmentation, insecurity, and financing gaps- continue to constrain performance in the most fragile contexts [4, 16]. This discussion synthesizes the main cross-cutting insights, compares them with evidence from other African regions, examines the practical meaning of "resilience" in Central Africa, and outlines strategic implications for policy and practice. Sustainable resilience will depend on expanding the surveillance workforce through tiered, cost-effective models, securing predictable domestic financing, and operationalizing One Health platforms for zoonotic early warning [3, 16].

Resilience as a Function of Adaptive Capacity, Not Just Resources

A core finding of this study is that resilient surveillance networks are distinguished less by total financial or technical resources and more by their ability to adapt under stress [14]. The comparison of high versus low resilience

settings (Table 2) shows that even relatively under resourced districts, such as those in Cameroon's CBS pilot or DRC's active RRT zones, achieved outbreak detection delays of 3–5 days and maintained >60% reporting completeness during crises [5, 6]. What enabled this performance was not an influx of external funding but rather a deliberate reconfiguration of existing assets: training community volunteers, repurposing rapid response teams for proactive case finding, and using simple SMS hotlines when paper reporting failed [9].

This aligns with the health system resilience literature, which emphasizes absorption, adaptation, and transformation as core dimensions [14, 11]. In Central Africa, absorption (maintaining functions with fewer resources) is evident in CAR's remote hotlines [9]; adaptation (using new methods to sustain performance) is seen in Chad's "surveillance windows" during ceasefires [10]; and transformation (fundamental redesign) is exemplified by Cameroon's integrated digital IDSR platform [5]. These findings suggest that resilience-building investments should prioritize adaptive capacity—training, community trust, and flexible data flows—over static infrastructure alone.

The Active Approach: Moving Beyond Passive IDSR Implementation

The results consistently demonstrate that an active approach---active case finding, community-based surveillance, event-based surveillance, and proactive rapid response teams---substantially outperforms passive, facility-only IDSR implementation [5, 6]. The magnitude of difference is striking: active strategies reduced outbreak detection delays by 8 days (from 12 to 4 days), increased weekly reporting completeness by 39 percentage points, and improved outbreak containment within 4 weeks from 34% to 81% [5] (Table 10).

These findings challenge the common assumption that resource-constrained settings should prioritize passive surveillance as a baseline. On the contrary, the evidence from Central Africa indicates that active strategies are often more cost effective (85 per true alert detected vs 240 for passive) and more resilient under stress [5]. This aligns with broader regional analyses showing gradual but uneven improvements in IDSR performance indicators across the WHO African Region [20]. Furthermore, the original vision of IDSR as an integrated, action-oriented system—rather than a passive reporting mechanism—supports the active strategies documented here [21]. Community-based surveillance, in particular, proved essential in conflict-affected zones where health facilities were non-functional [6] (Table 5). This echoes recent evaluations from the WHO African Region that recommend CBS as a core component of IDSR 3.0 implementation in fragile settings [15].

Persistent Gaps: Workforce, Laboratories, and Insecurity

Despite promising innovations, the study confirms that six systemic challenges remain pervasive [4]. The workforce deficit—58% of districts regionally lacking a dedicated surveillance officer—is arguably the most binding constraint [4]. Without a designated person to collate, validate, and act on data, even well-designed digital tools and community networks underperform. The DRC pilot of community surveillance supervisors (12-month certificate) offers a scalable solution, but this model requires national policy endorsement and recurrent financing to move from pilot to routine practice [6].

Laboratory fragmentation continues to delay confirmation by 10–21 days in rural districts [4], directly undermining the IDSR objective of timely response. Gabon's achievement of 2–4-day sample transport times and 78% confirmation within 7 days demonstrates that rapid transport networks and laboratory IDSR integration are feasible even in the Central African context [7]. The motorcycle courier

model from Cameroon ($4.50 per sample) is highly cost-effective and could be replicated across all countries with support from Africa CDC and WHO [5].

Insecurity remains a distinctive challenge for Central Africa relative to other regions [16]. The finding that reporting completeness drops from 78% to <20% in active conflict zones, and that an estimated 12–18 outbreaks are missed annually per conflict zone, underscores the need for dedicated humanitarian surveillance protocols [6]. CAR's remote SMS hotlines and DRC's trained community informants provide practical models that should be systematically integrated into national IDSR guidelines for insecure areas [9, 23].

Cross-Border Coordination: A Regional Imperative

The Lake Chad Basin mechanism stands out as the region's only fully functional cross-border surveillance system, reducing mpox detection delay from 14 to 5 days and enabling four joint investigations [8, 24]. This success contrasts sharply with the Ubangi, Sangha, and other border zones where coordination remains ad hoc or non-existent [8]. Given that Central Africa has some of the most porous borders and highest population mobility on the continent, the absence of systematic cross border surveillance represents a major health security gap [3].

The WHO facilitated Ubangi pilot, which increased cross border alerts from zero to 24 at a cost of $200 per month, demonstrates that even minimal investment can yield returns [8]. Scaling such mechanisms to all high risk borders should be a top priority for regional bodies (ECCAS, WHO AFRO, Africa CDC), with dedicated funding from the Pandemic Fund and other instruments [17].

Governance and Multisectoral Coordination as Determinants

Objective 6 results clearly show that governance quality predicts surveillance performance more consistently than any single technical input [3]. Countries with integrated national coordination (Cameroon, Gabon) outperform those with fragmented oversight [5, 7]. The One Health finding—Cameroon detected an anthrax outbreak 10 days before human cases appeared—compellingly illustrates multisectoral value [25], yet only three countries have functional One Health platforms [4]. Expanding One Health coordination to all Central African countries is not a niche environmental activity but a core early warning strategy [3].

Community engagement as a governance modality is particularly relevant for fragile settings. When community actors are formally integrated into surveillance governance, with training, supervision, and feedback loops, they maintain functions that the state cannot [6, 9]. This finding supports the growing consensus that resilience requires distributed governance, not centralized command and control [14].

Limitations

Several limitations should be acknowledged. First, the study relies on publicly available secondary data and published reports, which may overrepresent successful experiences and underrepresent failures or settings with no surveillance data at all [4]. Second, cross country comparisons are constrained by differences in data quality, completeness, and definitions; for example, "reporting timeliness" is calculated differently across national IDSR systems [4]. Third, the analysis captures a snapshot from 2018–2024, but surveillance system resilience is inherently dynamic, and recent improvements could reverse with funding cuts or escalating conflict [16]. Fourth, the study did not include primary data collection from health workers or community reporters, whose perspectives might reveal additional barriers or innovations. Finally, while the cost estimates presented are plausible, they are drawn from pilot projects and may not fully reflect the costs of regional scale up [5-7].

Implications for Policy and Practice

The findings carry several direct implications for national governments, regional bodies, and international partners [3].

First, national IDSR strategic plans should explicitly incorporate resilience benchmarks, not only timeliness and completeness in stable periods, but also performance indicators during crises [14]. Without such benchmarks, resilience remains an abstract goal rather than an actionable target.

Second, financing models must shift from episodic, donor driven projects to predictable domestic budget lines for surveillance [16]. Cameroon's experience, where district allocations of $500–1,500 improved reporting completeness by 18 percentage points, suggests that even modest domestic resources can generate meaningful gains [5].

Third, the Pandemic Fund and other global financing instruments should prioritize cross border surveillance, community based systems, and laboratory transport networks—the three interventions with the highest demonstrated return on investment in Central Africa [8, 9, 17]. Funding for digital transformation should require integration (no new standalone vertical platforms) and support for automated validation rules to address data quality deficits [7].

Fourth, workforce strategies should adopt the tiered model demonstrated in DRC: degree holding surveillance officers at provincial level, community surveillance supervisors (12-month certificate) at district level, and trained community volunteers at village level [6]. This approach is affordable ($3,000 per supervisor per year) and rapidly scalable.

Fifth, One Health coordination should be operationalized not as high level policy dialogue but as routine data sharing between human, animal, and environmental surveillance systems [25]. Cameroon's 10 day advance warning for anthrax provides a clear return on investment that ministries of finance and health can readily appreciate.

Conclusion

The 3rd Edition of IDSR has provided a technically robust and strategically relevant framework for strengthening surveillance in Central Africa. However, the framework alone does not guarantee resilience. This study demonstrates that active, adaptive, and community embedded implementation is what distinguishes high performing systems from those that continue to fail. The way forward is not to wait for conflict to end, for laboratory infrastructure to arrive, or for donor funding to increase. Rather, it is to systematically apply the low cost, scalable innovations already proven in the region: community surveillance supervisors, motorcycle courier networks, integrated digital platforms, SMS hotlines, and cross border coordination calls. With deliberate governance and sustained but modest investment, resilient surveillance networks are achievable across Central Africa within the next 24 months, and they will be the foundation for regional health security long into the future.

Recommendations

The following actionable recommendations are prioritized by feasibility and impact, drawn directly from proven innovations across Central Africa.

For National Governments

1. Institutionalize community-based surveillance (CBS). Train community surveillance supervisors for all districts lacking dedicated officers. Target: 80% CBS coverage in high-risk districts within 24 months [6, 23].
2. Adopt integrated digital IDSR platforms. Replace vertical reporting systems with a single DHIS2-IDSR module. Implement automated validation rules. Target: All districts digital within 36 months [5, 7].
3. Strengthen laboratory transport. Deploy motorcycle courier networks with GPS tracking (Cameroon: $4.50/sample, reduced transport from 14 to 4 days).

Target: Confirmation within 7 days for ≥70% of outbreaks within 24 months [5, 7].
4. Establish domestic budget lines. Allocate minimum 5% of health budget to IDSR. Provide district-level flexible funds ($500–1,500 annually). Target: No district without operational funding within 24 months [5, 16].
5. Operationalize One Health platforms. Mandate weekly data sharing between human, animal, and environmental surveillance. Target: All countries have functional early warning systems within 24 months [25].

For Regional Bodies (OCEAC, WHO AFRO, Africa CDC)

1. Scale cross-border mechanisms. Replicate Lake Chad Basin model on Ubangi, Sangha, and Congo River borders. Establish monthly coordination calls. Target: Functional mechanisms on all major borders within 36 months [8, 24].
2. Establish a regional resilience fund. Pool resources from member states and donors to finance cross-border networks, laboratory transport, and training. Target: $10 million seed capital within 12 months [17].
3. Deploy regional surveillance mentors. Provide on-site technical support to lagging countries. Target: Two mentors per country within 18 months [3, 15].

For International Partners & Donors

1. Prioritize three proven interventions. Direct 50% of new surveillance funding to: (a) cross-border mechanisms, (b) CBS with paid supervisors, (c) laboratory transport networks. No standalone vertical digital platforms [5, 6, 8].
2. Link funding to active implementation. Incentivize outcome-based metrics (reduced detection delays, conflict-zone completeness) over input-based reporting [3, 17].
3. Finance humanitarian adaptations. Support remote SMS hotlines, community informants, and pre-positioned supplies for conflict-affected zones. Target: All conflict districts have remote surveillance within 24 months [9, 10].
4. Require domestic counterpart financing. Provide matching funds conditional on government budget allocations for surveillance. Target: Reduce donor dependence from 70–90% to ≤50% within 5 years [16].

For District & Facility Levels

1. Conduct weekly active case finding in high-risk areas (markets, schools, border crossings, displacement camps) [5, 6].
2. Engage community volunteers as formal surveillance partners with simple mobile reporting tools and regular feedback [6, 23].
3. Use data for action—review weekly, detect anomalies, trigger responses, and provide real-time feedback to reporting sites [5, 7].
4. Prepare crisis contingency plans including pre-identified remote reporting methods and pre-positioned supplies [9, 10].

Conflict of Interest

The authors declare no competing interests.

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Ethical Approval

Although the research did NOT involve humans or animals, it adhered to ethical standards for using public domain data and followed principles of transparency, integrity, and responsible reporting. All analyses respected country-level confidentiality and did not manipulate or misrepresent the data.

Informed Consent

This was not required as we did not deal with patients.

Author Contributions

All authors contributed significantly to this study. The roles and responsibilities were distributed as follows:

1. **Daniel YOTA** (Lead Author): developed the research concept, defined the objectives, and structured the methodology.
2. **Vatsiharizandry MANDROSOVOLOLONA**: contributed to the initial draft of the manuscript, to the field implementation and the data collection in the field with IHR national focal point.
3. **Christian Eric MASSIDI:** collaborated in extracting and analysing data from the WHO platform, applying statistical methods to identify trends and disparities across countries.
4. **Anderson LATT**: As Emergency Preparedness Team Lead, He played a supervisory role and participated in interpreting the findings, identifying thematic patterns.
5. **Tieble TRAORE:** As Emergency Preparedness member team, he contributed to the initial draft of the manuscript.
6. **Freddy Banza Mutoka** : He participated in interpreting the findings, identifying thematic patterns, and formulating strategic recommendations. He also provided high-level oversight, ensured alignment with regional priorities, and contributed to interpreting results.
7. **Allan MPAIRWE:** As Emergency Preparedness member team, he contributed to the initial draft of the manuscript.
8. **Hermann TCHIYANE:** He ensured alignment with IDSR priorities and contributed to interpreting results.
9. **Omer NJAJOU TCHIKAMGOUA (Supervisor):** Oversees research design and implementation, provides strategic guidance, reviews manuscript drafts critically, and validates findings.
10. **Marie Roseline Darnycka BELIZAIRE (Supervisory role) :** provided strategic direction and expert guidance throughout the study, coordinated the research activities and offered substantial revisions to the manuscript before submission.
    - Conceptualization – Daniel Yota
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    - Data curation – Christian Massidi, Tieble Traore, Hermann Tchiyane
    - Formal analysis – Daniel Yota, Christian Massidi,
    - Writing – original draft – Daniel Yota, Anderson Latt
    - Writing – review & editing – Daniel Yota, Vatsiharizandry Mandrosovololona,
    - Supervision – Omer Njajou, Marie Roseline Belizaire

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Data Availability

All data used in this study were obtained from the publicly accessible WHO platform. The analysis was performed independently, and interpretations relied solely on the reported data and documented methodologies. The authors have ensured transparency, reproducibility, and objectivity in presenting their findings.

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Perceived Difficulty Accessing Healthcare in Guinea: A Population-Based Analysis of Financial, Organizational and Geographic Barriers

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Abstract *Background: In Guinea, access to healthcare remains constrained despite facility availability. Objective: to estimate the prevalence and determinants of perceived difficulty obtaining care. Methods: We analyzed 2024 Afrobarometer Round 10 survey data from Guinea (n=1,200; n=948 with facility contact) using survey-weighted statistics and multivariable logistic regression. Results: 59.2% of respondents reported difficulty obtaining care. The most frequent barriers were high costs and informal payment requests (36.1% each), followed by long waiting times (22%) and drug shortages (16.2%). After adjustment, perceived difficulty was associated with informal payment demands (OR=2.11; 95% CI:1.54–2.87), high costs (OR=1.89; 1.35–2.63), long waiting times (OR=1.56; 1.03–2.35), and urban residence (OR=1.49; 1.10–2.03). Conclusion: Financial and organizational barriers are the main drivers of perceived access difficulty in Guinea; addressing fees, informal payments, and waiting times is essential to improve access.*

Keywords *Afrobarometer, Guinea, Healthcare Access, Health Barriers, Lived Poverty, Survey Analysis, West Africa.*

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Background

Universal health coverage is often discussed in terms of service availability [17]. Yet availability is only part of access. From a patient's point of view, the practical issue is whether they can obtain care without excessive waiting, unexpected payments, or a failed search for essential medicines. These everyday constraints continue to limit effective healthcare use in many low-income settings [1, 2, 22, 23].

This distinction matters in Guinea. Health infrastructure, workforce availability, and pharmaceutical supply remain constrained, while direct household payments and poverty continue to shape whether households can start and complete a care episode [3, 4]. For patients, these conditions are not separate problems. A nearby clinic may still be hard to use if medicines are unavailable, fees are uncertain, or wait times are too long.

Facility statistics are useful for monitoring service delivery [18], but they rarely show how patients experience the care-seeking process. Population-based surveys can fill part of this gap by documenting barriers as reported by citizens themselves. Respondent-reported access barriers therefore provide a practical way to examine how supply constraints, affordability, and service organization come together during care seeking [5]. Afrobarometer is one of the few nationally representative data sources through which these perceptions can be studied in Guinea.

The Andersen and Newman behavioral model of healthcare utilization [5] links service use to predisposing factors such as age and sex, enabling factors such as income and geographic access, and need factors related to health status. This framework guided predictor selection in the present analysis.

Studies from West Africa have linked poverty and rural residence with reduced healthcare use [6, 7]. In Guinea, however, national evidence remains limited on how different barriers co-occur and which are most closely related to perceived difficulty in obtaining care [28, 29].

Against this background, we estimated the weighted prevalence of perceived barriers to healthcare use among Guinean adults, described regional differences in access difficulty, and examined the social and geographic factors associated with reported difficulty in obtaining care.

Methods

Study Design and Data Source

We conducted a cross-sectional analysis of the Afrobarometer Round 10 survey, carried out in Guinea between 23 May and 9 June 2024. Afrobarometer is an independent, nonpartisan research network that conducts nationally representative surveys on governance, democracy, and public services in Africa [8].

Sample

The Guinean Round 10 sample included 1,200 adults aged 18 years or older. The survey used a probabilistic, stratified, multistage design. Enumeration areas were selected with probability proportional to size; households and individual respondents were then randomly selected. The final sample is nationally representative and stratified by urban/rural residence and administrative region.

Variables

Outcome Variable

The primary outcome was perceived difficulty obtaining needed medical care. We coded responses of "difficult" or "very difficult" as access difficulty. Responses of "easy" and "very easy" formed the reference category. We excluded respondents who reported no contact with public health services from this outcome denominator because the question was not substantively applicable to them.

Barrier Dimensions

We derived five barrier dimensions from respondents' reported experience during contact with public health facilities. Respondents with no contact with public health services were excluded from the denominator for these indicators:

We defined drug shortages as the absence of medicines or supplies reported "often" rather than never, once or twice, or several times. Absent healthcare staff, when referring to the absence of needed providers, was reported "often". We defined long waiting times as prolonged waiting times reported "often". Poor facility maintenance, referred to as facilities not kept clean or in disrepair, was reported "often". We defined high costs as the inability to afford costs, reported "often".

We constructed a composite barrier index, ranging from 0 to 5, by summing the five binary indicators among respondents with complete, valid responses to all five barrier items.

Two additional indicators were included: informal payment demand, defined as at least one request for a bribe, gift, or favor among respondents with public facility contact, and recent inability to obtain medicines or medical treatment. The corresponding Afrobarometer item codes and response scales are listed in Table 2.

Independent Variables

Sociodemographic covariates included sex (male/female), age group (18 to 24, 25 to 34, 35 to 49, 50+ years), and place of residence (urban/rural). Socioeconomic status was measured with the Lived Poverty Index (LPI), a validated composite measure based on the frequency of deprivation in food, water, medical care, cooking fuel, and income [9]. The LPI was categorized as none (mean = 0), low ($0 < \text{mean} \leq 1$), moderate ($1 < \text{mean} \leq 2$), and high (mean > 2). Its construction is described in the Lived Poverty Index (LPI) section in the Methods.

Geographic access to healthcare infrastructure was represented by the presence of a health facility in the enumeration area. We retained administrative region for descriptive analyses.

Statistical Analysis

Analyses were conducted with the *survey* package in R [10]. The Afrobarometer design weight was applied to all estimates.

For each barrier dimension, weighted proportions and 95% confidence intervals (CIs) were calculated using the valid item denominator. Values indicating no contact with public health services, refusal, or don't know were treated as missing for contact based indicators. Recent inability to obtain medicines or medical treatment was estimated in the full sample because that item was not restricted to public facility contact. Regional variation in access difficulty was described with weighted percentages by administrative region among respondents with valid access difficulty responses.

Multivariable logistic regression was used to estimate adjusted ORs for perceived access difficulty. Covariates were selected before analysis, guided by the Andersen model and by substantive relevance to healthcare access in Guinea. Complete case analysis was used for the adjusted model. Results are presented as adjusted ORs with 95% CIs. Statistical significance was set at $p < 0.05$. All analyses were conducted in R version 4.3 [11].

Spatial Analysis

An exploratory spatial analysis was conducted at the administrative region level (n = 8). Survey-weighted regional prevalences were calculated for perceived access difficulty, high costs, and informal payment demands, then mapped using official administrative boundary files (OCHA Guinea, 2023) and the *sf* package [12].

Spatial autocorrelation was assessed with the global Moran's I statistic, computed from a

queen contiguity spatial weights matrix, using first-order adjacency, with row standardization [13]. Global Moran's I was assessed with 999 Monte Carlo permutations. Local indicators of spatial association (LISA) were computed using local Moran's I with 999 conditional permutations to identify possible spatial clusters and outliers at the regional level [14]. Regions were classified into four quadrants, high high, low low, high low, and low high, at a significance threshold of $p < 0.05$. Spatial analyses were conducted with the *spdep* package [15]. Because only eight regions were available, the spatial findings were interpreted as descriptive and exploratory rather than as firm evidence of clustering.

Ethical Considerations

Afrobarometer data are publicly available, anonymized, and collected under informed consent procedures approved by national ethics committees. No additional ethical approval was required for this secondary analysis.

Results

Sample Characteristics

The weighted analytic sample included 1,200 adults. About 35.6% of respondents lived in urban areas, and the sex distribution was nearly balanced (50% male). Mean age was 43.6 years (SD: 16.5). A health facility was reported in the enumeration area by 61.2% of respondents. High lived poverty (LPI > 2) was observed in 51% of respondents (Table 1). Perceived access difficulty was estimated among 948 respondents with valid public facility contact responses; 252 respondents reported no contact and were excluded from this denominator.

Table 1. Sample Characteristics and Valid Denominators

Characteristic	**n**	**Weighted % (95% CI) or Mean (SD)**
Sex		
Male	600	50 (47.1 to 52.9)
Female	600	50 (47.1 to 52.9)
Age (years)		**43.6 (SD: 16.5)**
Age group		
18 to 24	151	12.6 (10.6 to 14.5)
25 to 34	252	21.1 (18.7 to 23.5)
35 to 49	350	29.2 (26.5 to 31.8)
50+	447	37.2 (34.3 to 40)
Residence		
Urban	440	35.6 (32.8 to 38.4)
Rural	760	64.4 (61.6 to 67.2)
Lived Poverty Index		
None	25	2.1 (1.3 to 3)
Low	220	18.6 (16.3 to 20.9)
Moderate	342	28.3 (25.7 to 31)
High	609	51 (48 to 53.9)
Health facility in area		
Yes	744	61.2 (58.3 to 64.1)
No	456	38.8 (35.9 to 41.7)
Perceived access difficulty among respondents with public facility contact		

Difficult / Very difficult	560	59.2 (56 to 62.5)
Easy / Very easy	388	40.8 (37.5 to 44)

n: unweighted count. Percentages and 95% CIs use Afrobarometer survey weights. The full sample includes 1200 adults; perceived access difficulty is estimated among valid public facility contact responses (n = 948), excluding respondents with no contact. Age is reported as weighted means (SD).

As shown in Figure 1, high costs and informal payment requests were the most frequently reported barriers to healthcare access.

Prevalence of Perceived Barriers

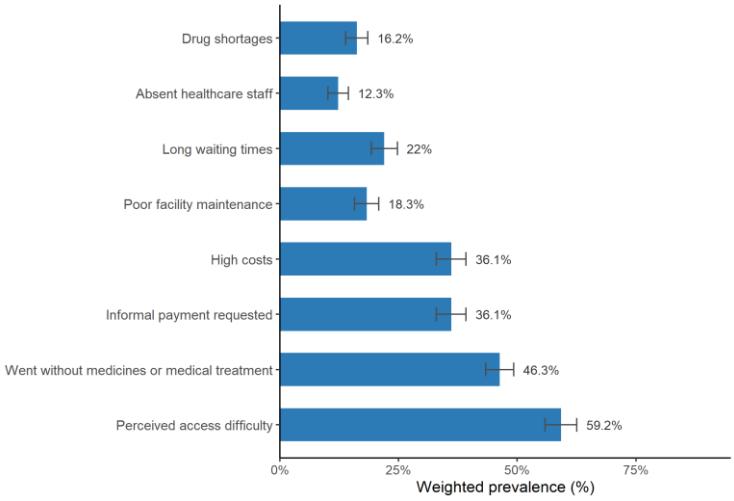


Figure 1. Weighted Prevalence of Perceived Barriers to Healthcare Among Guinean Adults (Afrobarometer R10, 2024)

Source: *Authors' analysis based on Afrobarometer Round 10 Guinea dataset (2024) [8].*

Regional Distribution of Access Difficulty

Regional variation in perceived healthcare access is presented in Figure 2.

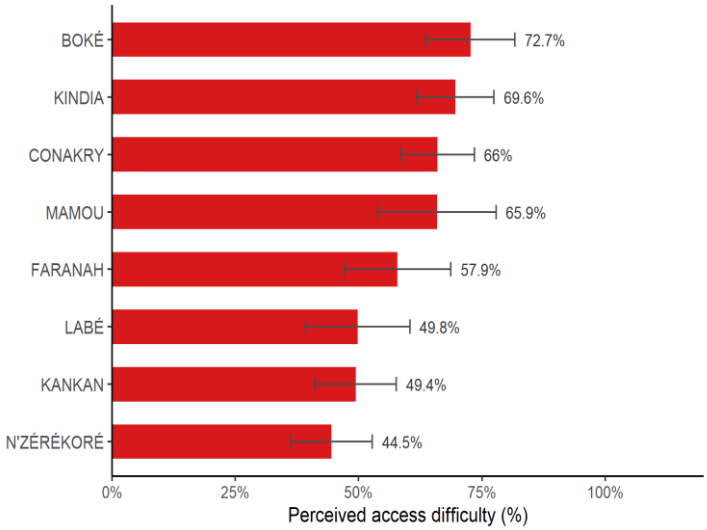


Figure 2. Proportion of Respondents Reporting Perceived Access Difficulty by Administrative Region, Guinea 2024

Source: *Authors' analysis based on Afrobarometer Round 10 Guinea dataset (2024) [8].*

Determinants of Perceived Access Difficulty

Table 2 reports the adjusted ORs from multivariable logistic regression. The model used complete cases for the outcome and covariates (n = 942). Figure 3 displays the same estimates on a logarithmic scale.

Table2. Adjusted Odds Ratios for Predictors of Perceived Healthcare Access Difficulty (multivariable logistic regression, survey weighted, Guinea 2024; complete case n = 942). OR = Odds Ratio; CI = Confidence Interval. *p < 0.05; **p < 0.01. Reference categories: Poverty = None; Residence = Rural; Sex = Female; Age = 18 to 24

Variable	Adjusted OR	95% CI	p value
Lived poverty: Low (ref = None)	0.81	0.24 to 2.77	0.743
Lived poverty: Moderate	1.13	0.34 to 3.77	0.848
Lived poverty: High	1.17	0.35 to 3.88	0.795
Urban residence (ref = Rural)	1.49	1.1 to 2.03	0.011*
Male sex (ref = Female)	1.16	0.87 to 1.55	0.317
Age 25 to 34 (ref = 18 to 24)	1.08	0.66 to 1.77	0.761
Age 35 to 49	1.34	0.84 to 2.16	0.222
Age 50+	0.97	0.61 to 1.54	0.89
Health facility present in area	0.78	0.58 to 1.05	0.102
Drug shortages (often)	1.33	0.81 to 2.18	0.262
Absent staff (often)	1.51	0.82 to 2.8	0.188
Long waiting time (often)	1.56	1.03 to 2.35	0.035*
High costs (often)	1.89	1.35 to 2.63	<0.001
Informal payment requested	2.11	1.54 to 2.87	<0.001

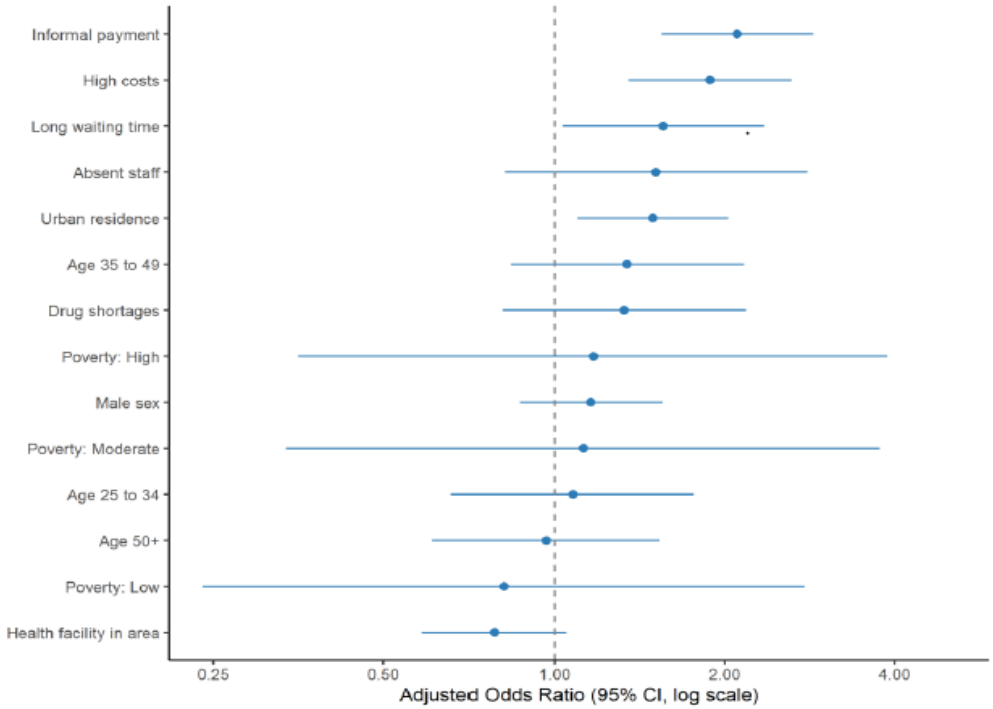


Figure 3. Adjusted Odds Ratios for Predictors of Perceived Healthcare Access Difficulty, Guinea 2024

Source: *Authors' analysis based on Afrobarometer Round 10 Guinea dataset (2024) [8].*

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The results of the multivariable logistic regression are presented in Figure 3.

In the adjusted model, three facility level barriers had p values below 0.05: informal payment demands (OR = 2.11; 95% CI: 1.54 to 2.87), high costs (OR = 1.89; 95% CI: 1.35 to 2.63), and long waiting times (OR = 1.56; 95% CI: 1.03 to 2.35). Urban residence was also positively associated with perceived access difficulty (OR = 1.49; 95% CI: 1.1 to 2.03). The lived poverty index, drug shortages, and absent staff did not reach statistical significance in the multivariable model. [22-24, 28]

Spatial Analysis

Regional Distribution of Key Indicators

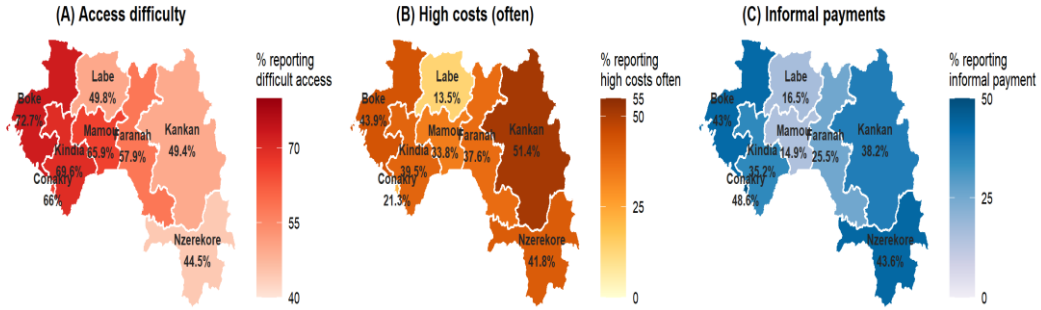


Figure 4. Regional Distribution of Perceived Access Difficulty, High Costs, and Informal Payment Demands, Guinea 2024

Spatial Autocorrelation (Moran's I)

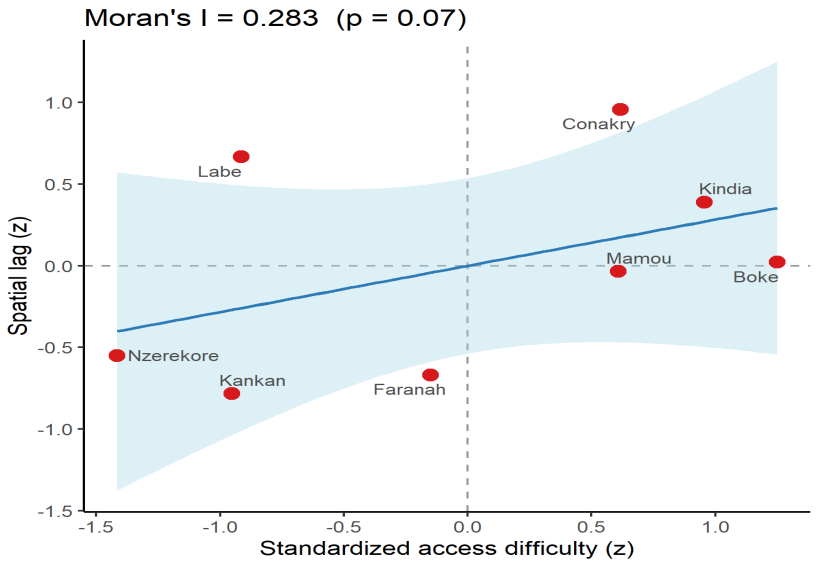


Figure 5. Moran Scatter Plot of Perceived Access Difficulty by Administrative Region, Guinea 2024

https://doi.org/10.21522/TIJPH.2013.14.03.Art014



Figure 6. LISA Cluster Map of Perceived Access Difficulty by Region, Guinea 2024 (no significant clusters)

Discussion

Principal's Findings

In this nationally representative sample, 59.2% of Guinean adults with valid public facility contact responses described care as difficult or very difficult to obtain. High costs (36.1%) and informal payment demand (36.1%) were the most frequently reported contact-related problems. The adjusted model pointed most strongly to barriers experienced during the care episode itself: informal payment demands (OR = 2.11; 95% CI: 1.54 to 2.87; $p < 0.001$), high costs (OR = 1.89; 95% CI: 1.35 to 2.63; $p < 0.001$), and long waiting times (OR = 1.56; 95% CI: 1.03 to 2.35; $p = 0.035$). The findings suggest that the mere presence of a health facility is not sufficient to ensure effective access [20]. Financial constraints and organizational barriers may continue to hinder access to care even when services are geographically available.

We observed pronounced regional differences (Figures 4 to 6). BOKÉ recorded the highest proportion of perceived access difficulty (72.7%), whereas N'ZÉRÉKORÉ recorded 44.5%, a difference of 28.2 percentage points. The spatial analysis showed positive but not significant Moran's I value for access difficulty, high costs, and informal payments. Given the small number of regions, these findings should be interpreted as descriptive spatial patterns, not as statistically confirmed clustering.

Interpretation

The strongest association observed in the adjusted model concerned informal payment requests (OR = 2.11; 95% CI: 1.54 to 2.87). For the 36.1% of respondents with public facility contact who reported such demands, the problem is not limited to the additional amount paid. Informal payment requests make the cost of care uncertain and may weaken trust in the facility before treatment is completed [16]. Their persistence alongside formal fee structures suggests weak tariff enforcement and limited accountability within public facilities.

High costs were also strongly related to perceived difficulty (OR = 1.89; 95% CI: 1.35 to 2.63), consistent with Guinea's high direct household payment share in total health

spending [3, 21]. In practice, formal and informal charges may combine into a single financial barrier for households [25, 26, 31].

Long waiting times (OR = 1.56; 95% CI: 1.03 to 2.35) represent a different kind of constraint. They do not necessarily involve a direct financial charge, but they impose a time cost that can be substantial for people whose care seeking depends on daily work, transport availability, or family support. This finding is consistent with evidence linking wait times to congestion within public facilities [2].

The positive association between urban residence and perceived access difficulty (OR = 1.49; 95% CI: 1.1 to 2.03) may appear counterintuitive, but it is consistent with a utilization paradox reported elsewhere in sub–Saharan Africa. Urban residents may interact more often with health facilities and therefore have greater exposure to service failures [4]. Expectations may also differ in urban settings, lowering the threshold for reporting access difficulty independently of objective service quality.

Lived poverty did not remain associated with perceived access difficulty after the barrier variables were included. This should not be read as evidence that poverty is irrelevant to healthcare access. A more plausible interpretation is that poverty is partly expressed through concrete experiences at the point of care, especially unaffordable costs and informal payments. This pattern is compatible with mediation frameworks in health services research [5, 25, 30].

Strengths and Limitations

The main strength of this study is its national probability sample, which allowed us to move beyond facility records and examine barriers as reported by citizens. Survey weighting further supports the representativeness of the estimates.

Several limitations should be considered. The analysis relied on respondent reported barrier measures, which may be influenced by recall, expectations, or willingness to report negative experiences. Because the design was cross sectional, causal claims cannot be made. Important need factors, including chronic illness or recent acute disease, were not available for inclusion in the model. Regional estimates were based on relatively small subsamples; therefore, interpret comparisons between regions with attention to precision.

Policy Implications

From a policy perspective, the findings highlight several actionable priorities consistent with global commitments to universal health coverage [19]. Control of informal payment practices needs to be visible to patients through clear fee schedules, complaint mechanisms, and enforcement within facilities. Waiting time should also be treated as an access problem, since better triage, patient flow, appointment organization, and staff deployment may reduce the time cost of care. Medicine availability remains central: drug shortages were common even though their adjusted association with perceived difficulty was weaker than that of financial barriers and waiting time. [22, 24].

Financial protection for poor households also remains important, particularly where formal and informal payments overlap. The regional variation observed in this analysis supports targeted action in the regions with the highest burden rather than a strictly uniform national response [25-27, 30, 31].

Conclusions

More than half of respondents who had recent contact with public health facilities reported difficulties in obtaining healthcare. High costs and informal payment demands were the most frequently reported barriers, followed by long waiting times. In adjusted analyses, perceived access difficulty was most strongly associated with informal payment requests, high costs, long waiting times, and urban residence. Improving access in Guinea will require not only expanding service

availability but also addressing the financial and organizational barriers encountered during care seeking.

Ethics Approval and Consent to Participate

This work is a secondary analysis of publicly available, anonymized data collected by the Afrobarometer network. The Afrobarometer Round 10 survey in Guinea was conducted in accordance with local ethical requirements, and researchers obtained informed consent from all participants before data collection. The public dataset contains no personal identifying information. Consistent with principles governing secondary analyses of anonymized survey data, no additional institutional ethics approval was required for the present study.

Acknowledgements

The authors acknowledge the Afrobarometer network and its Guinean national partner institution for designing, implementing, and making publicly available the Round 10 survey data. The views expressed in this article are those of the author and do not represent the positions of the Afrobarometer network or any affiliated institution.

Consent for Publication

Not applicable. The dataset contains no identifying information at the individual level, images, or personal data requiring specific consent for publication.

Data Availability

The Afrobarometer Round 10 dataset for Guinea (2024) used in this study is publicly available from the Afrobarometer website: https://www.afrobarometer.org/data/. The R analysis scripts are available from the corresponding author upon reasonable request.

Competing Interests

The author declares no financial or non financial competing interests that could have influenced the design, conduct, analysis, interpretation, or reporting of this study.

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Authors' Contributions

- **AK (Ansoumane KOUROUMA):** Conceptualized and designed the study; identified and selected variables; conducted the statistical analyses, including survey-weighted descriptive statistics, composite index construction, multivariable logistic regression, and spatial analyses; interpreted the results; drafted and revised the manuscript; and approved the final version for submission.
- **AS(Aboubacar Sidiki MAGASSOUBA):** Contributed to the interpretation of results; critically reviewed the manuscript for intellectual content; and approved the final version for submission.
- **ID (Ibrahima DOUMBOUYA):** Contributed to the study design and contextual framing; critically reviewed the manuscript for intellectual content; and approved the final version for submission.
- **MM (Mory MAGASSOUBA):** Contributed to the interpretation of findings in the Guinean health system context; critically reviewed the manuscript; and approved the final version for submission.
- **MFK (Mory Filany KEITA):** Contributed to the interpretation of findings and policy implications; critically reviewed the manuscript; and approved the final version for submission.
- **JYC (Joseph Yalir CAMARA):** Contributed to data access and contextual validation; critically reviewed the manuscript; and approved the final version for submission.

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WASH Infrastructure and Cholera Incidence in Somalia

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Abstract *Access to safe water and sanitation (WASH) represents the primary defense against cholera. Despite the persistent prevalence of cholera in Somalia, there is a dearth of evidence on the impact of WASH in Somalia. This study employed a mixed-methods approach, including a survey of 134 households across ten cholera-affected districts, regression analysis of WASH influence over a 24-month period, a census of WASH services in health facilities, and interviews with 17 key informants. The regression analysis satisfied all required assumptions. To reduce variable overlap, we combined access to water and sanitation into a single WASH variable. This composite WASH variable demonstrated a strong association with cholera severity ($B = -0.730$, $SE = 0.087$, $\beta = -0.418$, $t(130) = -8.35$, $p = .001$). Individuals with access to WASH were significantly less likely to contract cholera or acute watery diarrhea (OR = 0.13, 95% CI [0.05, 0.36], $p = .001$). The model accounted for 67.8% of the variance in severity across Somalia ($R^2 = 0.678$, $F(3,130) = 91.16$, $p = .001$). Only 36.2% of health facilities had running water, and 41.4% had adequate sanitation. The primary causes of inadequate WASH services included malfunctioning water points, open defecation in densely populated areas, and water contamination during rainfall. Improving WASH should be a top priority, along with ongoing efforts in vaccination and health care. More investment is also needed in WASH systems that can withstand flooding in the Juba and Shabelle river basins to help reduce cholera cases by 2030.*

Keywords *Cholera, Incidence, Mixed Methods, Public Health, Somalia, Water Sanitation Hygiene, WASH.*

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Introduction

Cholera, caused by the bacterium *Vibrio cholerae serogroups O1 or O139, is one of the diseases* that has impacted fragile states worldwide [1]. The most up to date information regarding the number of cases of cholera that have occurred across the world since 1961 reveals that since 2021, there have been more instances of the disease becoming widespread across the planet; in 2022, there were 472,697 cases of cholera reported to occur across the world, however, in 2023 alone, there were 535,321 cases of the disease, representing a 125% increase in cases within the African region of the planet [1, 2].

The number of cases of cholera (since 2017) in Somalia in the Horn of Africa has become the highest of any country within the region, with 21,944 cases reported in 2024 [3]. Several factors contribute to the high rates of cholera that exist within Somalia. For instance, only 52% of Somalis have access to a basic water supply, 34% of Somalis use open defecation facilities, 80% of Somalis do not have access to soap within the locations where they wash their hands, and a disproportionate 28% of Somalis do not have any basic sanitation facilities within their homes [4, 5].

These same factors are present in the regions of the country with the highest rates of cholera; the Juba and Shabelle River basins contain 60% of all cholera cases in the nation [3]. Despite the knowledge of these factors that contribute to the high rates of cholera within Somalia's population, the studies regarding these factors are limited to assessing the factors related to the ecology of Somalia; no studies have published investigations into whether the sanitation and hygiene infrastructure within Somalia has an impact on the rates of cholera within the country's individual households [6, 7].

However, numerous studies have been performed globally related to the impact of inadequate sources of water, sanitation, and hygiene on the development of cholera. For instance, one of the most extensive reviews of the relationship between WASH and cholera found that the odds ratio for individuals living in areas with inadequate water, sanitation, and hygiene supplies ranges from 1.9 to 5.6 [8]. Furthermore, studies have been published related to the factors related to Somalia; a study by Sultan et al. found that limited access to water facilities increases the odds of individuals developing cholera by a factor of 2.4 in the Southwest region of the nation, but the availability of latrines within the area reduces the odds of individuals developing cholera [9]. Each of these studies, however, was limited to investigating one cholera outbreak in one region of the nation; no studies have assessed the impact of WASH infrastructure on cholera rates in Somalia while controlling for the effects of both climate and health system factors within individual households.

To fill this gap, this investigation aims to determine the effect of WASH infrastructure on cholera rates in Somalia. Based on the Political Economy of Health Theory [10, 11] and the Social-Ecological Model [12, 13], this study intends to test the hypotheses that WASH infrastructure has a statistically significant and independent effect on cholera rates in Somalia's population.

Thus, this study intends to investigate the effect that WASH infrastructure has upon each of the following three variables: the severity of cholera cases within the country (as a continuous variable), the odds that individuals within the country have experienced one or more cases of cholera (or AWD episodes from cholera) within the last 24 months, and the mechanisms behind such association between these two variables through surveying the WASH facilities within those areas that experience cholera, as well as the knowledge of individuals within those areas.

Materials and Methods

Study Design

The study used a convergent mixed-methods approach to collect and analyse data using three

methods: a household survey, a census of public health facilities within the study area, and interviews with selected key informants in those areas. Each methodology was used separately to gather and analyse data before combining them into a single interpretation of the research question [14]. This methodology was employed to allow for triangulation, complementarity, and expansion of findings from the survey research [15].

Study Area and Districts

The study was undertaken within the Federal Republic of Somalia. The districts that were selected were among those impacted most severely by cholera over the past five year period - according to the list of districts impacted by the GTFCC [3]. Each of these districts were chosen from each of the country's two river basins (the Juba and the Shabelle), both inland and coastal districts, and from each of the tertile distributions of cases of cholera that have impacted those regions over the past two years. Due to the insecurity within the nation, approximately 20% of the country's districts are inaccessible for the study. Thus these ten districts represent the accessible districts of the nation that have experienced the highest rates of cholera cases.

Participants and Sampling

The survey of households used the head of each household or any adult within the household (of age 18 years or older). The required sample size was worked out using Cochran's formula, with parameters of $z = 1.96$ (indicating 95% confidence), $p = 0.20$ (based upon findings by Sultan et al. [9] of the extent of cholera within Somalia), $d = 0.5$ (indicating a 5% margin of error) - suggesting a size of $n = 246$ households. Thus, 150 households were approached, of which 134 provided complete responses to the survey (indicating an 89.3% response rate). The research data did not indicate whether nonrespondents were distributed in any particular way across districts, whether they were displaced, or whether their responses were gendered.

A census of all public health facilities within the ten districts of Somalia was undertaken. The Federal Ministry of Health published a master list of all facilities ($N \approx 60$). Of these facilities 58 responded to the survey (96.7% response rate). Key informant interviews were performed with 29 individuals - selected via a maximum variation sample from each of the following groups: national policy and partner organisations ($n = 6$); regional and state authorities ($n = 6$); district health and WASH coordinators ($n = 7$); clinical workers ($n = 6$); and community and IDP leaders ($n = 4$) [16].

Data Collection

Data from the households was collected during face-to-face interviews. The interviews were conducted via tablet-based software (KoboToolbox). Each of the questionnaires was translated into Somali by a certified medical translator and then re-translated back into English to ensure accuracy of the translation. Each questionnaire incorporated four main variables: those relating to infrastructure for WASH within the households (B1, 12 items); practice of WASH within the households (B2, 6 items); climate-induced shocks within the household (C1, 10 items); health-care system capacity within the household (D1, 10 items); severity of cases of cholera of the individual within the household (0-8); and whether that individual has had any cases of cholera within the household (yes/no). Each of these WASH items was also visually inspected within each household during these research visits ($ICC \geq 0.75$). The facilities were assessed by two individuals within the research team (a clinical officer and a health systems officer) using a slightly-modified version of the WHO SARA tool. The key informant interviews were performed by the principal researcher of the study and lasted between 42 and 78 minutes (mean = 58 minutes).

WASH and Outcome Variables

The WASH infrastructure as measured via B1 comprised items related to quality of water supplied to the household, availability and quality of latrines within the household, availability of a facility for hand-washing within the household, management of solid waste within the household, management of water resources within the area, vulnerability to drought or flood, knowledge of WASH-related health practices and campaigns, and whether members of the household (especially children) performed such practices.

The variables both of WASH infrastructure (B1) and WASH practices (B2) exhibited very high levels of multicollinearity ($VIF_2 = 9.38$ and 9.34 respectively; Tolerance = 0.107 in each case). We therefore merged these two variables into a single WASH practices and infrastructure variable based on the mean of each item within the survey, in accordance with recommendations by both Field [17] and Wolfe et al. [8]. The new composite variable indicated a combined internal consistency of $\alpha > 0.93$, and VIFs all ≤ 1.02. The primary outcome variable was the severity of cholera ($\alpha = 0.960$). This was calculated according to the total number of cases of cholera within the household, the length of time each case continued during the period, and the number of individuals within the household who required hospitalization due to the disease over the past 24 months. The binary outcome variable was that same interview question that inquired of each individual within the household whether they experienced any cases of cholera (yes/no).

Statistical Analysis

All analyses were undertaken using both IBM SPSS Statistics v28 and R v4.4. We calculated descriptive statistics for each variable. The assumptions of multiple linear regression were tested for normality (Shapiro-Wilk test $W = 0.982$, $p = .075$; Kolmogorov-Smirnov $D = 0.072$, $p = .476$), linearity (Ramsey RESET test $F(1, 129) = 0.004$, $p = .952$), homoscedasticity (Breusch-Pagan LM test $LM = 1.35$, $p = .718$), multicollinearity as revealed via the variance inflation factor (VIF) and tolerance statistics, and independence of observations within the model residuals according to the Durbin-Watson test ($DW = 2.13$). Each test indicated that the model assumptions were met ($p > 0.05$ for each test). A multiple linear regression model was constructed to determine the relationship between WASH infrastructure (B1), climate-induced shocks (C1), and health-care system capacity (D1) within the household and the severity of cholera cases within those households. Additionally, a logistic regression model was constructed to determine the same type of relationship in relation to the outcome variable measuring whether or not any individual within that household had suffered from cholera or AWD episodes within the past 24 months. A series of Pearson correlation tests helped to reveal the relationship between each of the various variables. Additionally, one-way ANOVA and chi-square tests helped determine whether WASH and cholera related differently across subgroups within the study population (specifically, whether WASH and cholera related differently depending on whether any individuals within those households were displaced). Such a significance level of $p = 0.05$ indicates statistical significance of these models (two-tailed test).

Qualitative Analysis

The interview content was analysed according to the Framework Method [18]. The data was first organised according to the objectives of the study - the researchers also performed analyses according to both the objectives and findings of the interviews (inductive analysis). Trustworthiness of the data is ensured through member-checking, expert-debriefing, maintaining an audit trail and journal of the processes used and experiences of the researchers [19]. The results of the data analyses are reported according to both the

SRQR [20] and the GRAMMS [21] quality standards.

Ethical Approval

Ethical approval for this study was granted by the Taxila American University Institutional Review Board. Written consent was secured from the managers of the health facilities; all other participants of both household and key informant surveys were audio-recorded with their consent. The data was stored on an encrypted server and with a password to access that data. All participants were informed that participation was voluntary and that they could withdraw at any time.

Results

Sample Characteristics

To provide a contextual overview of the study areas, Table 1 presents the characteristics of the population within the districts. The sample comprised 134 households, of which 57.5% were female, with an average age of 36.9 years (SD = 9.2). Of these individuals, 43.3% had no formal education beyond Quranic schooling, 38.8% were internally displaced persons (IDPs), and 80.6% lived within households that contained at least one child under the age of five. Each of these characteristics are reflective of the demographics of the ten districts within which the study was performed [3, 5]. Within these districts, the 58 health facilities surveyed represented an average of 9,800 persons living within each facility's catchment area.

WASH Infrastructure: Descriptive Findings

The mean WASH infrastructure composite score (B1) was 3.01 on a 1 to 5 Likert scale (Table 1). The standard deviation of 0.87 indicates the distribution of individual responses within the districts. More than 60% of the individuals within those districts either disagreed with the statement that their primary source of drinking water was safe (B1-1) or that their water sources were not vulnerable to contamination (B1-2). Additionally, 61.2% of the households within the districts did not have access to items B1-3 and B1-5 - private latrines and soap and water access at a handwashing facility. Furthermore, public latrines (B1-6), community handwashing facilities (B1-7), and the local authority maintenance of water points (B1-8) were all below a mean score of 3 on the 1 to 5 scale.

Only 36.2% of health facilities had access to running water, and only 41.4% had appropriate sanitation facilities. Additionally, only 44.8% of these health facilities had access to soap or alcohol-based hand-rub at the facilities, and 48.3% had access to sterilization equipment for medical instruments. The mean cholera-specific readiness composite score was 2.71 (SD = 0.64), indicating that health facilities were generally less prepared for cholera than the areas where their patients live.

Bivariate Associations

Bivariate analysis showed that WASH infrastructure was significantly and inversely correlated with cholera severity within the areas ($r = -0.444$, $p = .001$; Table 1). This association remained statistically significant even after including climate and health system variables (which are also associated with the presence of severe cholera). The negligible correlations between each of the independent variables indicates the lack of multicollinearity among these variables.

Table 1. Pearson Correlation Matrix and Descriptive Statistics for Composite Study Variables (N = 134)

Variable	Mean (SD)	1. WASH	2. Climate	3. Capacity	4. Severity
1. WASH infrastructure (B1)	3.01 (0.87)	1.000	—	—	—
2. Climate-induced shocks (C1)	3.62 (0.72)	−0.088	1.000	—	—
3. Health-care capacity (D1)	2.63 (0.83)	−0.048	−0.090	1.000	—
4. Cholera severity score	3.98 (1.51)	−0.444***	+0.594***	−0.442***	1.000

Note. ****p = .001 (two-tailed). WASH = WASH infrastructure composite (B1); Climate = climate-induced shocks composite (C1); Capacity = health-care system capacity composite (D1).*

Multiple Linear Regression: WASH and Cholera Severity

The model that includes these three variables accounts for 67.8% of the variance in cholera case severity ($R^2 = 0.678$; Adjusted $R^2 = 0.670$; $F\ (3,130) = 91.16$, $p = .001$). The effect of WASH infrastructure on cholera severity is statistically significant ($B = -0.730$, $SE = 0.087$, $\beta = -0.418$, $t\ (130) = -8.35$, $p = .001$; 95% CI [−0.90, −0.56]). The value of WASH infrastructure has a statistically significant association ($\beta = -0.418$) with cholera severity ($B = -0.730$), almost equal to the effect of health-care capacity ($\beta = -0.416$) but less than the effect of climate-induced shocks ($\beta = 0.520$) (Table 2). Thus, the null hypothesis H_{01} of no statistically significant effect of WASH infrastructure upon cholera incidence is rejected.

Table 2. Multiple Linear Regression of Cholera Severity Score on Three Independent Variables (N = 134)

Predictor	B	SE B	β	t	p	95% CI
Constant	+4.200	0.569	—	7.377	= .001	[3.07, 5.33]
WASH infrastructure (B1)	−0.730	0.087	−0.418	−8.353	= .001	[−0.90, −0.56]
Climate-induced shocks (C1)	+1.097	0.106	+0.520	+10.346	= .001	[+0.89, +1.31]
Health-care capacity (D1)	−0.760	0.092	−0.416	−8.293	= .001	[−0.94, −0.58]

Note. *β = standardized coefficient. $R^2 = 0.678$; Adjusted $R^2 = 0.670$; $F\ (3, 130) = 91.16$, $p = .001$.*

Binary Logistic Regression: WASH and Episode Occurrence

The model results demonstrate that the binary logistic model was statistically significant ($\chi^2\ (3) = 58.18$, $p = .001$; McFadden pseudo $R^2 = 0.462$), indicating an excellent fit of the model to the data. Furthermore, WASH infrastructure was also a statistically significant independent variable that predicted episode occurrence ($B = -2.024$, $SE = 0.515$, Wald $z = -3.93$, $p = .001$). The odds of a household experiencing a cholera or AWD episode decreased by 87% with each one-unit increase in WASH infrastructure (OR = 0.13, 95% CI [0.05, 0.36]; Table 3). When surveyed, 82.1% (n = 110) of all households in the study area had experienced at least one episode of either cholera or AWD within the past 24 months of the study. These findings are consistent with the ANOVA results, which indicated that a higher percentage of IDP households (92.3%) had experienced an episode of either cholera or AWD compared to the percentage of host community households that experienced such an episode (73.6%). These findings are statistically significant ($F\ (2, 131) = 11.09$, $p = .001$, $\eta^2 = 0.145$).

Table 3. Binary Logistic Regression: WASH Infrastructure and Cholera/AWD Episode Occurrence (N = 134)

Predictor	B	SE	Wald z	p	OR (95% CI)
Constant	+5.414	2.311	+2.343	.019	—
WASH infrastructure (B1)	−2.024	0.515	−3.932	= .001	0.13 [0.05, 0.36]
Climate-induced shocks (C1)	+2.376	0.604	+3.933	= .001	10.76 [3.29, 35.17]
Health-care capacity (D1)	−1.805	0.466	−3.875	= .001	0.16 [0.07, 0.41]

Note. *Likelihood-ratio χ^2 (3) = 58.18, p = .001; McFadden pseudo R^2 = 0.462. OR = odds ratio.*

Key Informant Perspectives

Qualitative findings from 29 KIIs across five strata indicated that the determinants of the effect of WASH infrastructure on cholera severity were threefold. First, the study found that the displacement of communities led to the disintegration of the community management committees that managed the water points in those areas, resulting in the contamination of the area's water sources. Second, the high rates of cholera in IDP settlements was found to be caused by the lack of elevated slabs or fly-proof latrines in those settlements. Third, national policy informants indicated that funds allocated to WASH were used to respond to cholera outbreaks rather than to construct WASH infrastructure; thus, infrastructure in those areas was restored to suboptimal levels only between cholera outbreak periods. These three findings each contribute to an understanding of why WASH infrastructure has an effect both upon the severity of cholera at the household level, and upon the contamination of water sources at the community level.

Discussion

The primary finding of this study is that WASH infrastructure in Somalia has a large, statistically significant, and independent effect on the severity and development of cholera at the household level. The magnitude of this effect ($\beta = -0.418$ and OR = 0.13) is similar to that of most meta-analytic and regional studies on the topic. Thus, these findings contribute to the existing literature on the topic in three distinct ways.

First, this study's findings are consistent with both the global meta-analysis of Wolfe et al. [8], which included 51 case-control studies on cholera and WASH infrastructure, and the Southwest State study by Sultan et al. [9]. However, the findings of this study differ in that it measures the effect of WASH infrastructure alongside the effects of both climate and health system variables. In both of the aforementioned studies, each of the variables was found to be significantly correlated with each of the others. The non-significance of each of these variables' correlations with one another (all $|r| \leq 0.090$) indicate that the WASH infrastructure effect is independent of both climate and health system variables. Such a measurement was not performed in previous studies in Somalia.

Second, the similar coefficients for WASH and health care ($\beta = -0.416$) indicate that these two variables have similar impacts on the severity and development of cholera. Despite the fact that most of the international response to the cholera epidemic in Somalia has been directed towards healthcare efforts and infrastructure, these findings indicate that the development and improvement of WASH infrastructure in Somalia is a similarly-important topic of consideration.

Third, the effect of WASH infrastructure can be analyzed through the lens of the Political Economy of Health Theory [10, 11]. Somalia's low WASH coverage figures (52% access to basic water and 34% rates of open defecation) result from the country's conflicts over three decades. The same can also be said of the Social-Ecological model of WASH infrastructure [12]. The failure of WASH

management committees in those communities after members were displaced indicates the importance of WASH as both institutional and physical infrastructure.

The subgroup analysis indicates a significant difference in cholera severity between IDP and host community households (mean difference in severity score = 1.20 points; $\eta^2 = 0.145$). Within this subgroup analysis, the findings were again reflected in the binary outcomes (IDPs experienced cholera at a rate of 92.3% compared to 73.6% of host community households). Thus, any WASH infrastructure initiatives that do not specifically consider IDP and returnee communities will fail to address the severe lack of WASH infrastructure among those groups.

Wolfe et al. [8] found that binary WASH infrastructure categories did not allow measurement of WASH infrastructure quality within the improved category. The 12-item WASH infrastructure score (Cronbach's $\alpha = 0.966$) addresses this and explains the significance of the WASH infrastructure effect. Future studies should utilize such a scale to measure WASH infrastructure quality.

Several limitations to this current study exist. First, the cross-sectional study does not permit for determination of causation; though the theory and previous experimental studies indicate the effect of WASH infrastructure upon cholera severity, it was not directly measured within this study. Second, the sample size of 134 households was drawn from ten districts, each selected for their accessibility to the study team; thus, it is not representative of Somalia's districts. Third, the data on the episodes of cholera and AWD were self-reported by the participants. Although these episodes were cross-validated with outpatient clinic records, they may still not be entirely accurate. Finally, the lack of a significant link between severity score and cholera (32.2%) indicates that other variables, such as conflict and health system factors, contributed to participants' severity scores.

Conclusion

WASH infrastructure in households in Somalia has a powerful and independent effect upon the severity of and the development of cholera in those individuals. The reduction of both episode rates (from 87% reduction in episodes with each unit of WASH infrastructure improvement) and severity scores (0.73 units) indicates the potential benefit of WASH infrastructure development. Additionally, the finding of the severity difference between the IDP and host community populations suggests that WASH infrastructure initiatives must target both informal settlements and residential infrastructure. Thus, to achieve the GTFCC goal of a 90% reduction in cholera deaths in Somalia by 2030, WASH infrastructure development in endemic districts should be treated as a structural development priority rather than a humanitarian response.

Conflict of Interest

The author declares no conflict of interest regarding the publication of this paper.

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Ethical Approval

The Institutional Review Board of Taxila American University approved this study. We obtained consent from the managers of the health facilities included in the study, and audio-recorded consent from individual household and key informant participants. All participants were adults who voluntarily wished to participate in the study; no incentives were

provided for their participation, and all data were stored on password-protected and encrypted servers.

Data Availability

The datasets generated and analysed during the current study are not publicly available (due to privacy considerations) but may be obtained from the author upon request and with approval from the institutional review board.

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Author Contributions

Yusuf Elmi Mohamud was the sole author of this manuscript and was responsible for study design, data collection and analysis, table preparation, and writing and revision of the manuscript.

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Sexual and Reproductive Health Rights among People with Disabilities in Juba County, South Sudan

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Abstract *The United Nations emphasizes inclusivity and leaving no one behind, advocating for universal health care, including sexual and reproductive health (SRH). However, the patterns of SRH rights among persons with disabilities remain poorly understood, with this group facing numerous barriers to accessing SRH services. We aimed to examine patterns of Sexual and Reproductive Health Rights (SRHR) among people with disabilities in South Sudan, focusing on Juba County. The study utilized qualitative methods for data collection, supplemented by in-depth quantitative secondary data. The researchers gathered qualitative data using key informant guides and observation. The study analyzed data using a master sheet. The findings revealed significant challenges in accessing SRH services, particularly in rural areas, where comprehensive services are scarcer than in urban centers. Men often mistrust family planning initiatives, viewing them as threats to their authority. Older individuals often exclude themselves from SRH relevance. Barriers such as stigma, discrimination, financial and physical constraints, limited perceived need, and gendered blame further hinder access. Gender-based violence, misconceptions, and negative associations exacerbate these challenges. Notably, comprehensive sex education in schools emerged as a critical intervention to foster liberal attitudes and self-control. In conclusion, the study underscores the exclusion of persons with disabilities from SRHR and highlights the urgent need for inclusive programs to address their specific needs. Limited access to services in rural areas, societal stigma, and misconceptions impede progress. Efforts should focus on promoting inclusive policies, enhancing awareness of SRHR for women with disabilities, and implementing comprehensive sex education. Addressing societal perceptions and fostering inclusivity are vital for advancing SRHR for persons with disabilities in South Sudan.*

Keywords *Barriers, Inclusivity, Persons with Disabilities, Sexual and Reproductive Health, South Sudan.*

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Introduction

Sexual and reproductive health rights (SRHR) represent an integral spectrum of civil, political, economic, social, and cultural rights that empower individuals to exercise autonomy over their sexuality and pursue a fulfilling sexual and reproductive life. These rights are enshrined in international human rights frameworks, including the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP). Notably, several articles within the UN Convention on the Rights of the Child (UNCRC) are relevant to the reproductive rights of marginalized groups, including individuals with disabilities [1].

Despite the Universal Health Coverage (UHC) commitment to "leave no one behind," disability remains insufficiently addressed within the UHC agenda, even though it is a crucial component of inclusive development under the Sustainable Development Goals (SDGs). At the 2019 United Nations High-Level Meeting, global leaders reaffirmed their dedication to SDG 3.8, emphasizing equitable access to sexual and reproductive health (SRH) services and information for all, including those with disabilities [2].

The 1994 International Conference on Population and Development (ICPD) Program of Action highlights that reproductive health remains inaccessible to many due to inadequate knowledge of human sexuality, insufficient or poor-quality SRH services, discriminatory social norms, and negative attitudes towards women and girls, including those with disabilities. Furthermore, the limited agency of women and girls with disabilities over their sexual and reproductive lives exacerbates their marginalization. These factors collectively contribute to the disproportionately poor SRH outcomes experienced by persons with disabilities and underscore the need for inclusive and targeted interventions. In addition to general factors, specific issues related to the collective rights of persons with disabilities, such as the principle of free, prior, and informed consent and respect for their cultural perspectives, must be acknowledged, protected, and fulfilled. This is essential to realizing the sexual and reproductive health and rights (SRHR) of disabled individuals [3].

High maternal mortality rates among people with disabilities are concerning, and although data on reproductive health and voluntary family planning in this group remain incomplete, evidence suggests lower rates of contraceptive use compared to the general population. A 2014 UN interagency statement led by WHO highlights the vulnerability of persons with disabilities to violence, including coercive sterilization, particularly in African countries like Congo and Ethiopia. Population policies in some nations have targeted women with disabilities from marginalized communities, leading to thousands undergoing sterilization without informed consent. Human rights bodies have emphasized that denying reproductive health information or failing to ensure free and informed consent for sterilization constitutes a violation of fundamental human rights and reflects multiple forms of discrimination based on gender and race [4].

Similar challenges exist in South Sudan, especially in Central Equatoria, where a significant portion of the disabled population lacks access to basic medical care. Many live in unstable environments with limited access to essential healthcare services. Structural inequalities, including gender disparities, significantly hinder the protection and exercise of SRHR and restrict access to services such as family planning and comprehensive sexual education. These barriers increase the vulnerability of persons with disabilities, placing their lives at risk, according to a WHO (2019) report [5].

Scholars note that South Sudan’s prolonged conflict and insecurity have disrupted traditional social norms and mechanisms of

accountability, exacerbating risks of death and disability. This breakdown disproportionately affects women and children, who bear the long-term consequences.

Limited access to SRHR services exposes women and adolescent girls with disabilities to HIV/AIDS, with social, economic, and sexual exploitation further compounding the issue. Additionally, there is a substantial gap in information on sexually transmitted infections and HIV/AIDS within this group WHO, 2018. Contrary to common belief, communities of disabled individuals face a disproportionately high burden of HIV and other diseases. Available data link this to stigma, discrimination, lack of sexual education, inadequate access to contraception, high levels of sexual violence, and substance abuse [6].

This study aims to examine the Pattern of Sexual and Reproductive Health Rights Among People with Disabilities in South Sudan, focusing on Juba County, Republic of South Sudan.

Materials and Methods

Research Design and Setting: This study employed a qualitative descriptive survey approach using self-administered questionnaires, expert opinions, and observations. The design was chosen to gather accurate data on behaviors, beliefs, and knowledge regarding the sexual and reproductive health rights of people with disabilities in Juba County, Central Equatoria State, South Sudan.

Study Area: The research was conducted in Juba County, Central Equatoria State, the capital city of South Sudan, focusing on patterns of sexual and reproductive health rights among people with disabilities.

Study Population: The target population included individuals with disabilities in Juba County, with data gathered from knowledgeable respondents and stakeholders.

Sampling Technique: Simple random sampling was used to ensure a representative sample for qualitative generalization.

Sampling Procedure: Respondents were selected systematically from a compiled sampling frame. Eligibility was determined through careful review, and data were collected online and analyzed using Excel to present findings in tables and graphs.

Data Collection Methods: The researcher obtained university permission and explained the study's purpose to participants. Three primary methods were used:

Observation: Verified information and captured non-verbal insights.

In-depth Interviews: Facilitated face-to-face or phone interactions to gather comprehensive insights.

Structured Questionnaires: Distributed to target groups, including open- and closed-ended questions, to ensure consistent and accurate responses.

Data Processing and Analysis: Data Processing: Included cleaning, editing, coding, and organizing data during and after collection.

Data Analysis: Employed qualitative methods to thematically organize and evaluate data using analytical reasoning.

Quality Control: Validity: Ensured through expert review and pre-testing of questionnaires to refine content.

Reliability: Used the test-retest method with a similar population to identify ambiguities and enhance the research instrument.

Ethical Considerations: The study adhered to ethical guidelines from the University of Juba, ensuring confidentiality and voluntary participation.

Study Limitations: Key challenges included limited generalizability beyond Juba County. Other challenges included high transportation costs, weather disruptions such as rainfall, and some respondents' reluctance to provide information.

Results

The study reveals diverse perceptions, beliefs, and challenges related to Sexual and Reproductive Health Services (SRHS). A significant finding is the limited access to these services, which are primarily available in urban centers, leaving rural populations underserved. Additionally, SRHS is often perceived as a privilege reserved for specific groups, such as married individuals, excluding others, including persons with disabilities.

In South Sudan, persons with disabilities face important barriers to Sexual and Reproductive Health and Rights (SRHR) services. The 2021 Population Estimation Survey reported functional difficulties among the population, with women generally experiencing higher levels than men. In Aweil South, 65.3% of persons with disabilities reported difficulties accessing humanitarian services, while 79.1% reported that HIV/VCT services were unavailable [7, 8]. These findings highlight significant gaps in accessibility, information, and service delivery for persons with disabilities.

Men's attitudes toward family planning emerged as a key obstacle, with many viewing these programs as conspiracies to undermine their authority. This suspicion fosters resistance to contraceptive use, further limiting the adoption of SRHS. Age also influences perceptions, as older individuals (40+) often associate SRHS with sexually active youth (15–24), believing these services are irrelevant to them.

The public's perceived need for SRHS is generally limited to fertility issues, with many individuals seeking these services only to confirm reproductive health status. Gendered perceptions also play a role; married women advocating for SRHS, particularly family planning, are often viewed as disrupting family harmony. In cases where women seek family planning secretly, they risk blame and domestic violence from their partners.

Persons with disabilities face significant exclusion, as some members of the public believe SRHS should not be extended to them, considering them burdensome regarding marriage, childbirth, and service access. Furthermore, social stigma prevents many individuals from seeking SRHS information and services. This stigma is compounded by low awareness and negative perceptions, leading to widespread resistance to these services.

The study also highlights how hyper-masculinity limits SRHS uptake. Disputes over these services can result in gender-based violence, as some men reject medical advice and services out of fear of being labeled as sexually dysfunctional. Misconceptions further hinder SRHS access, with some associating these services with encouraging abortion among young women or imposing restrictions on personal behaviors such as smoking and alcohol consumption.

To address these challenges, the study recommends integrating comprehensive sex education into school curricula to promote informed and liberal attitudes toward sexuality, emphasizing self-control. Persons with disabilities face additional barriers to accessing SRHS, including discrimination from service providers, lack of information, geographic and financial constraints, violations of dignity, and physical and communication barriers. Addressing these issues is critical for ensuring equitable and inclusive access to SRHS.

Discussion

This study aimed to explore patterns, perceptions, and barriers related to Sexual and Reproductive Health and Rights (SRHR) among persons with disabilities in Juba County, South Sudan. Findings from qualitative interviews with key informants and community participants demonstrate that SRHR is influenced by social norms, gender relations, disability-related stigma,

geographical access, misinformation, and limited awareness. Although sexuality is a fundamental human need and a component of human rights, participants indicated that SRHR is frequently regarded as a private or restricted matter, particularly for married people, with persons with disabilities often excluded from reproductive health decision-making and services. This finding is consistent with Pérez et al. [9], who emphasize that sexuality and emotional and physical intimacy are fundamental aspects of human wellbeing.

The findings further demonstrate substantial barriers to SRHR services among persons with disabilities in South Sudan. The 2021 Population Estimation Survey documented functional difficulties among the population, with several forms of disability reported more frequently among females than males [7]. Similarly, an assessment in Aweil South found that 65.3% of persons with disabilities experienced difficulties accessing humanitarian services, while 79.1% reported that HIV and voluntary counselling and testing services were unavailable [8]. These findings support the present study by demonstrating that disability intersects with physical accessibility, inadequate information, service availability, and socioeconomic constraints to limit access to SRHR-related services.

Negative attitudes toward family planning emerged as an important social barrier. Some participants described family planning as a threat to male authority or as an externally imposed intervention intended to reduce population growth. Such perceptions may contribute to resistance to contraception and child-spacing practices. Although the specific social and cultural context differs, this finding is consistent with earlier UNFPA evidence that suspicion among men can undermine acceptance of family-planning programmes and position men as important determinants of contraceptive decision-making [8]. In the South Sudanese context, these perceptions suggest that family-planning interventions need to engage men and community leaders rather than focusing exclusively on women.

Geographical inequality was another important finding. Participants perceived comprehensive SRHR services as more readily available in urban centres than in rural communities. This may reflect differences in health-facility availability, staffing, transport, affordability, and information. Olujide et al. [9] reported similar findings, identifying lack of awareness, perceived poor service quality, negative provider attitudes, and cost as barriers to utilization. Thus, improving physical availability alone may not be sufficient; service quality, provider attitudes, affordability, and community awareness also require attention.

Age-related perceptions also influenced SRHR utilization. Some participants aged 40 years and above perceived SRHR as primarily relevant to adolescents and young adults aged 15–24 years. This perception may result in older adults being overlooked in reproductive health programming despite continuing needs related to contraception, sexual health, sexually transmitted infections, and reproductive health information. Although interventions targeting adolescents and young men are important for promoting gender-equitable behaviours, SRHR programmes should adopt a life-course approach that responds to the needs of different age groups [8].

A particularly important finding was the perception that SRHR is primarily necessary for people experiencing fertility problems. Participants reported that some community members seek services mainly to confirm whether they have reproductive problems and discontinue care when they perceive themselves as healthy. This is consistent with evidence from Renk County, where social norms, stigma, and perceptions about fertility influenced family-planning utilization [10]. Recent evidence from Jonglei also found limited reproductive-health knowledge and

very low contraceptive use, highlighting gaps in preventive SRH engagement [11]. Therefore, SRHR should be understood as a continuum of preventive, promotive, and curative services, rather than services required only when illness or infertility occurs.

Gender and patriarchal norms were also prominent in the findings. Some participants reported that SRHR is perceived as primarily a woman's responsibility, while women who initiate discussions about family planning may be viewed as challenging male authority or family decision-making. Such norms can restrict women's reproductive autonomy and contribute to conflict within relationships. Women who use contraception covertly may also face risks if their partners discover their actions. This finding is consistent with evidence from Boyce et al. [12], which documented covert contraceptive use among women who feared opposition from partners and used strategies to conceal their family-planning practices. These findings highlight the importance of couple communication, male engagement, confidentiality, and protection from gender-based violence within SRHR programmes.

The study also identified pervasive misconceptions concerning the sexuality and reproductive capacity of persons with disabilities. Some participants believed that SRHS should not be prioritized for persons with disabilities because they were perceived as incapable of marriage, pregnancy, or independent reproductive decision-making. Such attitudes reinforce disability-related discrimination and can deny persons with disabilities their right to make informed decisions about sexuality, relationships, contraception, pregnancy, and childbirth. Ganle et al. [13] reported that women with disabilities have sexual and reproductive needs comparable to those of women without disabilities, challenging assumptions that disability eliminates sexual desire, sexual activity, or the need for family-planning services.

The perception of persons with disabilities as dependent or burdensome was another important barrier. Participants described persons with disabilities as requiring additional care and therefore being unsuitable for marriage or childbearing. Similar findings were reported by Akasreku et al. [14], who documented negative social perceptions of persons with disabilities, including the perception that disability constitutes a physical, social, or economic burden on families. Such beliefs can restrict opportunities for relationships, marriage, pregnancy, and access to reproductive health services.

Provider attitudes were also identified as a potential barrier. Participants described discriminatory or judgmental interactions between health workers and women with disabilities, including questioning why women with disabilities become pregnant. Such attitudes may discourage future health-service utilization and undermine trust in healthcare providers. Akasreku et al. [14] similarly identified negative societal attitudes and misconceptions surrounding pregnancy among women with disabilities. Ganle et al. [13] further emphasized attitudinal barriers among health and social-service providers, as well as physical barriers within healthcare facilities.

The findings additionally indicate an association between SRHR-related disagreements and gender-based violence. Participants reported that disagreements concerning contraception and reproductive-health decisions may result in conflict and violence, particularly where patriarchal norms and male control are strong. This is consistent with evidence from South Sudan showing that women who use contraception without their partner’s consent may face threats, physical violence, verbal abuse, or divorce [15, 16]. Similar evidence from South Sudanese refugee communities in Uganda found that male opposition to family planning and gendered

decision-making contributed to conflict and SGBV [17]. These findings demonstrate the importance of gender-transformative approaches, couple communication, violence prevention, and confidential SRHR services that protect the reproductive autonomy and safety of both women and men.

Misconceptions about the purpose of SRHR services were also evident. Some participants associated SRHR with promoting abortion among young women or with attempts to regulate personal behaviours such as alcohol and tobacco use. Similar findings have been reported in South Sudan, where family planning has sometimes been associated with fears of reduced fertility, opposition to cultural expectations, and concerns about its effects on family and community values [15, 18]. Such perceptions may contribute to community resistance and reduce acceptance and utilization of reproductive-health programmes. Comprehensive, accurate, and culturally appropriate health education is therefore essential to improve understanding of the purpose, benefits, risks, and rights associated with SRHR.

The study further identified limited disability awareness within communities and health services. Stigma and misconceptions about disability may result in women and girls with disabilities receiving inadequate information or inappropriate treatment. This highlights the need for disability-inclusive SRHR programming, including accessible information, trained healthcare providers, accessible facilities, communication support, confidentiality, and respect for dignity and informed consent

Gender-based violence results from disagreement over SRHS services. Likewise, Ganle et al. [13] found that negative public attitudes towards PWDs and their sexuality issues, stigma and discrimination against disabled patients/clients, sexual violence and abuse at the community level, and lack of community or family support networks to enable PWDs to access SRH services and information [19].

> *"Some men fear being declared sexually dysfunctional because of refuse medical advice and services due to hyper-masculinity."*

Our findings agree with (Ganle et al.) [13] findings, arguing that actual barriers or challenges PWDs face in accessing sexual and reproductive health services. Such barriers should relate to access to or use of sexual health education and information, family planning, contraception, abortion, ANC, health facility childbirth, and PNC services, as presented below.

> *"Some members associated SRHS with things like encouraging abortion among young women, dislike SRHS because they fear restriction from smoking and taking alcohol."*
>
> *"This refers to the development of various sex education that should be integrated into all the school syllabi that should reflect the liberal sexual attitudes that should emphasis more on self-control than the typical case."*

Evidently, there is a dearth of knowledge regarding impairments in society, which results in views that are unfavorable to those who have disabilities. The majority of medical staff tend to discriminate against women and girls with disabilities when it comes to sexual and reproductive health services; this is one of the factors that affect access to these services for women and girls with disabilities. For instance, nurses in some clinics enquire as to why women with disabilities became pregnant. Women and girls with disabilities may be deterred from using sexual and reproductive health services by such views. Similarly, according to [14], there are generally negative societal attitudes towards pregnant PWDs. The evidence suggests that a degree of prejudice and misconceptions exists towards the pregnancy of women living with disabilities. Generally, there is a public perception that

women living with disabilities cannot have a safe motherhood experience and are capable of transferring their disability to an unborn child of another pregnant woman.

The study further identified limited disability awareness within communities and health services. Stigma, discrimination, and misconceptions about disability may result in women and girls with disabilities receiving inadequate information or inappropriate treatment. This is consistent with evidence from South Sudan showing that persons with disabilities face inaccessible health facilities, negative attitudes from health workers, and inadequate accessible health information [20]. These findings highlight the need for disability-inclusive SRHR programming, including accessible information, trained providers, communication support, confidentiality, and respect for dignity and informed consent.

Overall, the findings demonstrate that barriers to SRHR among persons with disabilities in Juba County are multidimensional, involving stigma, discrimination, gender norms, misinformation, poverty, geographical barriers, limited-service availability, inadequate provider capacity, and restricted reproductive autonomy. Evidence from South Sudan similarly identifies social exclusion, stigma, and structural barriers as major constraints to access to essential services [20, 21]. A rights-based and disability-inclusive approach is therefore needed, including community awareness, engagement of men and community leaders, improved provider competencies, accessible facilities and information, and integration of disability inclusion into existing SRHR programmes.

Conclusion

The study demonstrates that persons with disabilities in South Sudan experience significant social, cultural, informational, and health-system barriers to Sexual and Reproductive Health and Rights (SRHR). The findings are consistent with evidence from South Sudan and comparable settings showing that disability-related stigma, gender inequality, provider attitudes, inadequate accessibility, and misconceptions can restrict reproductive autonomy and utilization of SRHR services. Addressing these barriers requires integrated, rights-based and disability-inclusive interventions that promote gender equality, informed decision-making, accessible information, confidentiality, and equitable access to quality SRHR services. Further research should examine the role of community leaders, healthcare providers, families, and organizations of persons with disabilities in improving SRHR knowledge, acceptance, and service utilization, including the relationship between SRHR access and gender-based violence. Collaboration among government, NGOs, disability organizations, and communities is essential to strengthen inclusive and equitable SRHR services in South Sudan.

Conflict of Interest

The authors declare no conflict of interest.

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Ethical Approval

The authors obtained ethical approval from the relevant institutional authorities before data collection. The authors obtained informed consent from all participants and ensured confidentiality and voluntary participation.

Data Availability

The data supporting this study's findings are available from the corresponding author upon reasonable request.

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Author Contributions

The authors contributed to the study conception, methodology, data collection, analysis, interpretation of findings, and preparation and review of the manuscript. All authors approved the final manuscript.

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An Explorative Assessment of Factors Associated with Vaccine Hesitancy in Rural and Urban Communities in Akwa Ibom State, Nigeria

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Abstract *Vaccine hesitancy remains a critical bottleneck to optimising immunisation coverage and herd immunity globally. In sub-Saharan Africa, particularly within Nigeria's socio-cultural landscape, vaccine deployment faces varied structural, cognitive, and contextual impediments. This study explored the multiple factors influencing vaccine hesitancy across rural and urban communities in Akwa Ibom State, Nigeria. Utilising an exploratory, cross-sectional qualitative design, 12 In-Depth Interviews (IDI) were conducted across three Urban (Uyo, Abak, Oron) and three Rural (Itu, Oruk Anam, Nsit Ibom) Local Government Areas. Participants were selected through stratified purposive sampling to reduce bias. Narratives from IDIs were transcribed, coded and interpreted using thematic analysis, incorporating both inductive and deductive approaches. Rural participants exhibited high foundational demand and positive vaccine optimism, driven primarily by perceived disease severity, and this was aided by peer-to-peer diffusion of positive vaccination experiences. However, their vulnerability stemmed from information deficits. Conversely, urban cohorts exhibited fragmented risk perceptions, deep-seated institutional mistrust, and acute sensitivity to systemic and physiological risks. Urban settings were uniquely vulnerable to digital misinformation accelerated by dense, unmediated information within their environments. Local authority structures varied fundamentally: rural areas relied heavily on centralised, culturally legitimised figures (village heads, town criers), whereas urban networks required decentralised communication modes (churches, broadcast media, digital networks). Vaccine hesitancy is highly context-specific and ecologically distinct in Akwa Ibom State. Public health interventions must discard homogeneous, top-down communication paradigms in favour of tailored, double-loop community participation strategies that embed peer-champion mechanisms and localised risk communication within existing rural and urban communities.*

Keywords *Perspectives, Qualitative Study, Urban-Rural Communities, Vaccine Hesitancy.*

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Introduction

Vaccines have become the mainstay for controlling infectious diseases globally. Epidemiological data synthesised by the World Health Organisation (WHO) regularly emphasise immunisation as the single most effective health intervention for accelerating child survival rates and reducing preventable morbidity [1]. Immunisation against diseases such as Japanese encephalitis, measles, meningitis A, diphtheria, Haemophilus Influenzae type B, polio, rotavirus, rubella, tetanus, tuberculosis, and yellow fever has resulted in a 40% reduction in infant mortality globally and a 50% reduction in the African region [1]. It is well known that the use of vaccines has led to the eradication of diseases, including smallpox [2]. The uptake of vaccines depends on access to vaccines, vaccine affordability, public awareness of the vaccine, acceptance of the vaccine, and its activation in the population in which it is administered [3]. The factors that affect vaccine uptake vary across many countries. While there has been considerable expectation around the vaccines, there remains significant hesitancy to receive them across populations worldwide, including in Nigeria.

The concept of vaccine hesitancy is complex and has been described as context-specific in relation to the vaccine, time and the environment [4]. Vaccine hesitancy is not a novel concept and has been observed across economies globally [5]. The World Health Organisation has described vaccine hesitancy as one of the ten threats to global health [4]. Vaccine hesitancy is defined as a delay in accepting or refusing vaccines despite the availability of vaccine services [4]. It occurs on the continuum between high demand for vaccines and the complete refusal of vaccines. Vaccine hesitancy may arise in various situations, ranging from systemic problems in vaccine access and delivery to limitations associated with events such as natural disasters. The determinants of vaccine acceptance, hesitancy, and outright refusal depend on numerous community factors [6].

Individual and group influences implicated in vaccine hesitancy include beliefs, attitudes, and health-related motivations. Myths and beliefs about immunisation in Nigeria have contributed to vaccine hesitancy, as exemplified by some studies [7-9]. In Nigeria, these myths and rumours constitute barriers to the uptake of immunisation services [7]. In developed economies such as Canada and the Netherlands, a sense of self-efficacy regarding the importance of vaccination was a positive driver of vaccination uptake [8, 9]. Having an immunisation card and receiving immunisation services at a health facility were associated with positive uptake of immunisation services [7]. The level of awareness individuals have about the severity of vaccine-preventable diseases is important for vaccine uptake. When the disease was perceived as less severe, this perception served as a barrier to vaccine use [10].

Contextual factors likewise play a role in vaccine hesitancy. There are contrasting opinions on whether education is a positive or negative driver of vaccine acceptance and hesitancy. In a study conducted in Italy, parents' educational status was significantly associated with vaccine refusal or acceptance [11]. Zhang and colleagues reported that higher educational status was a negative driver of vaccine acceptance [12]. This result, however, was not consistent with findings from Nigeria, which reported that higher education was a positive driver of vaccine acceptance [13]. In another study, lower education was a barrier to vaccination uptake and contributed to vaccine hesitancy [14]. Some studies have described the socioeconomic status of families as a positive and negative driver of immunisation uptake. In a study conducted in Italy, the researchers reported that rising perceived economic hardship was associated with vaccine hesitancy [11]. This finding, however, was not consistent with findings from some other Western

countries. In a study in the United States of America, high socioeconomic status was a barrier to vaccine uptake [15]. However, within the same climate, low socioeconomic status was associated with increased uptake of immunisation services [16]. In a study in Nigeria, low socioeconomic status was a negative driver for vaccine uptake [14]. The significance of regularly communicating immunisation messages to the public was an important driver of vaccine acceptance, and its eventual uptake [7, 17, 18].

In a study conducted in Nigeria, the ease of access to health facilities offering immunisation services was a driver of vaccination uptake in those areas [7]. The introduction of new interventions, as seen with COVID-19 vaccines, was often met with mistrust and concern about their effectiveness. This can cause considerable hesitancy and, on occasion, outright refusal, especially when severe complications are associated with the vaccine [19]. The objective of the study was to explore the factors affecting vaccine hesitancy in rural and urban communities in Akwa Ibom State, Nigeria. This allows for community-based exploration of these factors in these geographical areas.

Materials and Methods

Study population and design: The study population comprised household heads from rural and urban communities in Akwa Ibom State. The selected urban local governments were Uyo, Abak, and Oron, while the rural local governments were Itu, Oruk Anam, and Itu LGAs in Akwa Ibom State. These local governments were selected through simple random sampling. We used an exploratory cross-sectional qualitative design.

Sampling of participants for In-Depth Interviews: Participants were selected through stratified purposive sampling to ensure representation across educational attainment, marital status and age groups. Respondents selected must have lived in the communities for at least 6 months and be able to communicate in either English or Pidgin English.

Data Collection

Twelve in-depth interviews were conducted among selected participants from the study communities. One household head was selected from each selected urban and rural community. Selection considered gender, educational status, employment status, and duration of residence in the community. One male and one female participant were selected from each community; similarly, participants with higher education and those with secondary education or below were included. Data were collected using a structured discussion guide adapted from the National Resource Centre for Refugees, Immigrants, and Migrants [20]. The interviews explored perceptions regarding vaccination, vaccine uptake, and vaccine hesitancy among households in urban and rural communities. Interviews were conducted in English or Pidgin English by the principal investigator or trained research assistants in quiet and private settings to promote open discussion. Each interview lasted approximately 45–60 minutes and was audio-recorded with additional field notes documenting nonverbal indicators and observations.

Data Analysis

Data were analysed using thematic analysis. Audio recordings were transcribed verbatim and reviewed repeatedly to achieve familiarity with the data. Unique identifiers were used for rural and urban respondents in the study, i.e., “A” for rural respondents. Transcripts were coded. Related codes were grouped into categories and themes. Deductive and inductive approaches were used to interpret the study's findings, and categorical matrices were developed to highlight emerging patterns.

Ethical approval was obtained from the Akwa Ibom State Research Ethics Committee, State Ministry of Health

(AKHREC 07/10/25/366). Informed consent was sought from the community heads and participants before the interviews.

Results

A total of 12 in-depth interviews were conducted in both rural and urban communities. Participants' ages ranged from 22 to 55 years, and most were married and educated. All urban respondents had at least a secondary education, while one rural participant reported no formal schooling (Table 1).

Table 1. Sociodemographic Characteristics of Participants

Variables of Interest	Rural	Urban
Age (years)		
Less than 25	1(16.7)	1(16.7)
26–40	2 (33.3)	2(33.3)
41–54	2(33.3)	3 (50.0)
≥55	1(16.7)	0 (0.0)
Marital status		
Married/cohabiting	4(67.7%)	3(50.0%)
Single	2(33.3%)	3(50.0%)
Educational status		
Educated	5(83.3%)	6(100.0%)
Not educated	1(16.7%)	0(0.0%)

Rural Communities

Rural participants generally described vaccines as beneficial for preventing diseases. Several participants perceived the vaccines as beneficial and were enthusiastic about receiving them, describing them as the required intervention to minimize the spread of the virus (COVID-19). (Table 2).

Table 2. Rural Participants' Perceptions of Vaccine Use for Disease Prevention

Domain	Participants	Participants Responses	Summary of Perceptions
Perceptions about vaccine use to prevent diseases	A1	Yes, because though few people that have taken it will testify that the vaccines is good, that makes them even their children to take it	Participants show strong positive perception towards receiving the vaccines and indicated strong desire to receive the vaccines when available.
Perceptions about vaccine use to prevent diseases	A2	I think the vaccine is very good, if they bring it to us, our people here will be happy to take it.	Participants show strong positive perception towards receiving the vaccines and indicated strong desire to receive the vaccines when available.
Perceptions about vaccine use to prevent diseases	A3	We always feel happy when any opportunity comes for us to take the vaccines.	Participants show strong positive perception towards receiving the vaccines and indicated strong

			desire to receive the vaccines when available.
Perceptions about vaccine use to prevent diseases	A4	Because nobody wants to die, so we are looking for the vaccine	Participants show strong positive perception towards receiving the vaccines and indicated strong desire to receive the vaccines when available.

Rural participants reported concerns related to vaccine safety, fear of adverse outcomes, and limited awareness. Some participants stated that community members were afraid because vaccines were perceived as new, while others noted that reassurance from vaccinated relatives or community members reduced concerns (Table 3).

Table 3. Rural Participants' Misconceptions and Safety Concerns about Vaccines

Domain	Participants	Participants Responses	Summary of Perceptions
Misconceptions about the vaccines	A5	So far I have not seen any bad news, in Ona (The local community) here I have not seen in anywhere people afraid of taking vaccines. The important is that you have to enlightened them through their local dialect, the important of vaccines, and let them know there's no danger	Misconceptions are generally around vaccine safety and availability. Hesitancy is created with minimal awareness.
Misconceptions about the vaccines	A6	Most at times, people living outside the community, when they take it (the vaccines), they will call us here and inform us that the vaccines is very good in case they bring it here, will should take it.	Misconceptions are generally around vaccine safety and availability. Hesitancy is created with minimal awareness.
Misconceptions about the vaccines	A3	"…they are some people that are afraid, that if they take it, they will die, but we that are enlightened we educate those that are not educated"	Misconceptions are generally around vaccine safety and availability. Hesitancy is created with minimal awareness.
Misconceptions about the vaccines	A4	Some people express fear because it's new, there's no awareness	Misconceptions are generally around vaccine safety and availability. Hesitancy is created with minimal awareness.

Rural participants identified several channels through which vaccine information and services were communicated. These included village heads, town criers, health workers, government representatives, non-governmental organisations, phone calls, taxes and direct community engagement (Table 4).

Table 4. Rural Participants' Perspectives on Factors Influencing Vaccine Hesitancy and Communication Pathways

Domain	Participants	Participants Responses	Summary of Perceptions
Factors that affect vaccine hesitancy	A5	Through the village head or through the towncrier	Vaccine hesitancy is reduced when local resources and channels participate actively in promoting vaccination
Factors that affect vaccine hesitancy	A6	"…people are going around distributing the vaccines or you go to a health care center, to get the vaccines, through government or NGOS"	Vaccine hesitancy is reduced when local resources and channels participate actively in promoting vaccination
Factors that affect vaccine hesitancy	A3	The Government, the healthcare providers, through calls and text message	Vaccine hesitancy is reduced when local resources and channels participate actively in promoting vaccination
Factors that affect vaccine hesitancy	A4	Try talking to them, telling them that vaccine is very good to prevent diseases from entering the body	Vaccine hesitancy is reduced when local resources and channels participate actively in promoting vaccination
Factors that affect vaccine hesitancy	A1	They should explain it as a nature to them, so that they will have interest in it. I think before the vaccine is being shared, let the chief in the village, announce in the village square for everyone	Vaccine hesitancy is reduced when local resources and channels participate actively in promoting vaccination

Urban Communities

Urban participants express mixed perceptions about vaccination. Some participants describe vaccines as useful for disease prevention and reported positive experiences with vaccination. Others reported concerns about vaccine safety, particularly regarding COVID-19 vaccines (Table 5).

Table 5. Urban Participants' Perception of Vaccine Use for Disease Prevention

Domain	Participants	Participants Responses	Summary of Perceptions
Perceptions about vaccine use to prevent diseases	B1	I think the vaccines help the body; they prevent diseases	Positive perception about vaccines, with some hesitancy because of some misconceptions
Perceptions about vaccine use to prevent diseases	B2	In our village, Ediene Abak, we are so excited; we received and it was very good, and many	Positive perception about vaccines, with some hesitancy because of some misconceptions

		people that receive it, there's no bad complain about it	
Perceptions about vaccine use to prevent diseases	B3	For vaccine like COVID-19, due to the theory, people believe that the vaccine was not safe	Positive perception about vaccines, with some hesitancy because of some misconceptions
Perceptions about vaccine use to prevent diseases	B6	…when there was Covid-19, a lot of people will say, Covid-19 vaccines do kill people, that when you take the first one the second one will make you sick.	Positive perception about vaccines, with some hesitancy because of some misconceptions

Urban participants reported misconceptions about vaccines, including fears of death, severe illness, body dysfunction, and rumours that COVID-19 vaccines contain microchips. Some participants also reported concerns about side effects following vaccination (Table 6).

Table 6. Urban Participants' Misconceptions and Safety Concerns about Vaccines

Domain	Participants	Participants Responses	Summary of Perceptions
Myths and misconceptions about vaccines	B1	I think the vaccines will be good for the community, if they have opportunity to get it.	Urban communities seem to hold misconceptions that are linked to access to the vaccines, and effects following administration of the vaccines.
Myths and misconceptions about vaccines	B2	People felt that some of their body wasn't functioning well, and they couldn't perform certain duties, due to the effect of the vaccine	Urban communities seem to hold misconceptions that are linked to access to the vaccines, and effects following administration of the vaccines.
Myths and misconceptions about vaccines	B3	Some people think they might die if they take the medicine	Urban communities seem to hold misconceptions that are linked to access to the vaccines, and effects following administration of the vaccines.
Myths and misconceptions about vaccines	B4	…Like vaccine for the COVID-19 story, people being injected with microchips…	Urban communities seem to hold misconceptions that are linked to access to the vaccines, and effects

			following administration of the vaccines.
Myths and misconceptions about vaccines	B6	I don't really see the disadvantages of it, because it's for our own good, some people will think or say that when I take the vaccines I will get so so disease…	Urban communities seem to hold misconceptions that are linked to access to the vaccines, and effects following administration of the vaccines.

Urban participants identified several factors and communication channels related to vaccine hesitancy. This included misinformation, reports from people who had received vaccines, village heads, religious institutions, radio, community meetings, social media and other local communications platforms (Table 7).

Table 7. Urban Participants' Perspectives on Factors Influencing Vaccine Hesitancy and Communication Pathways

Domain	Participants	Participants Responses	Summary of Perceptions
Factors that affect vaccine hesitancy	B1	In the community they must be few people that don't want it, but the people that took it, they will spread the information, they will be so interested in taking it now, no negativity	Spread of misinformation from a few persons Participation of local community and religious leaders
Factors that affect vaccine hesitancy	B2	Village head will do the work and tell them	Spread of misinformation from a few persons. Participation of local community and religious leaders
Factors that affect vaccine hesitancy	B3	Media like Radio, community meeting, visiting churches	Spread of misinformation from a few persons. Participation of local community and religious leaders
Factors that affect vaccine hesitancy	B6	There is no disadvantages, because if you're not informed you are deformed, if you think getting vaccinated will cause you any problem you have signed your death sentence, so vaccination is pure and good.	Spread of misinformation from a few persons. Participation of local community and religious leaders

Discussion

The findings of this qualitative assessment of the factors driving vaccine hesitancy in rural and urban communities in Akwa Ibom State, Nigeria, reveal the interplay among cognitive, social, and organisational factors that form individual and community responses to vaccination. The study shows a largely positive disposition towards vaccines, especially in the context of COVID-19. It also reports factors such as persistent misconceptions, safety concerns, and information deficits as drivers of vaccine hesitancy. This evidence is consistent

with the wider literature on vaccine hesitancy in sub-Saharan Africa and corresponds with the World Health Organisation's (WHO) Strategic Advisory Group of Experts on Immunisation (SAGE) 3Cs conceptual framework, which identifies confidence, complacency, and convenience as the three primary determinants of vaccine hesitancy [21].

Misconceptions about vaccine safety were a common theme in both rural and urban communities. In urban settings in particular, participants described rumours that COVID-19 vaccines contained microchips that would cause organ dysfunction or could result in death. These outcomes mirror those reported in a scoping review of COVID-19 vaccine hesitancy in Nigeria, which documented widespread myths, including claims that vaccines were designed to cause sterility, induce illness, or cause harm [22]. This finding is not peculiar to Nigeria; Zimmerman and colleagues reported that, globally, multiple contexts have demonstrated historical medical distrust and limited health literacy [23]. This index study showed that misconceptions in rural areas were less entrenched than in urban communities because enlightened community members helped counter community members' fears by sharing their personal vaccination experiences. This peer-to-peer diffusion of positive vaccine experiences is a well-established mechanism for building social trust and reducing hesitancy, as positive peer testimonies serve as social proof that can override abstract fears [24]. There appeared to be a heightened perception of susceptibility and severity, which drove a strong positive inclination toward receiving preventive interventions. Conversely, urban cohorts manifested a more fragmented perception of severity. Although accepting the abstract benefits of immunisations, urban community participants appeared highly sensitised to institutional risks, heavily weighing the instant physiological disruptions of vaccination against the theoretical threat of the disease itself.

Access to information, especially through trusted sources, increased vaccine acceptance markedly among rural participants. Vaccine hesitancy seemed to stem from information deficits rather than active opposition to vaccination itself. This contrasted with urban respondents, who seemed to be more frequently exposed to conflicting information from electronic and social media, as well as informal interpersonal networks, resulting in a more complex and contested vaccination landscape. This aligns with evidence from a study in sub-Saharan Africa, which found significant vaccine hesitancy in Nigeria, with rural residents exhibiting different hesitancy profiles than their urban counterparts [25]. Similarly, it has been reported that urban residents faced a distinct set of hesitancy drivers compared with rural populations, with exposure to misinformation and media access acting as key differentiating factors [26]. Participants' references to fears of death, bodily harm, and government-distributed vaccines indicated wider patterns of medical mistrust that are based in historical experiences of healthcare inequity, inadequate health system performance, and perceptions of governmental self-interest. The 1996 Pfizer-Trovan clinical trial incident in Kano is a reference point for many today [27]. Dealing with these structural determinants of hesitancy requires a long-term devotion to transparent, accountable, and community-responsive health governance, rather than one-off vaccination campaigns.

The role of trusted community figures, such as traditional rulers, village heads, town criers, and religious leaders, in mediating vaccine acceptance or rejection. Respondents consistently emphasised that vaccine communication delivered through these culturally accepted and legitimate channels was more effective than messages from external health authorities or government. This finding resonates strongly with evidence from elsewhere in Nigeria and Africa. A mixed-method study of COVID-19 vaccine uptake in

Nigeria found that community trust and the involvement of local leaders were among the strongest predictors of vaccine acceptance, and that scepticism towards government messaging was a major barrier [28]. Rangi and colleagues reported that deploying trusted local advocates to promote vaccination led to considerable improvements in vaccination uptake, especially in hard-to-reach communities [29]. The results jointly indicate that vertical, government-to-community communication tactics are insufficient on their own, and that vaccine programmes must be embedded within existing community social structures to be effective. Urban respondents seemed to lack a single unifying traditional authority, with residents turning to a mixture of religious institutions, electronic broadcast media, and interactive digital networks. Urban participants highlighted that "channels like the church, electronic media, social media and so on, played major roles in reducing vaccine hesitancy". The study showed that the spread of positive feedback from early vaccine adopters who completed their schedules without complications was a key driver of wider community acceptance. As an urban respondent noted, once a small group successfully completes the procedure without issues, "they will spread the information, they will be so interested in taking it now".

The findings from this qualitative study carry important ramifications for public health policy and vaccination programme design in Akwa Ibom State and Nigeria more broadly. First, health promotion campaigns, especially those aimed at vaccination against emerging diseases, should be customised to the specific information environments and misconception profiles of rural and urban communities, rather than applying a uniform national communication strategy. Also, engaging traditional rulers and religious leaders, alongside health care workers and peer champions, during these campaigns reduces vaccine hesitancy. It is important that health literacy actions that address common myths and misconceptions in the local dialect are integrated into routine community outreach, notably in rural areas where access to verified health information is limited. Peer testimonies and community-level social proof should be harnessed by structured peer ambassador programmes, as evidenced by both this current study and community champion research from sub-Saharan Africa [29]. This study has its limitations, as it relies on responses from a small group of individuals in rural and urban communities, whose personal experiences may not generalise well to other contexts. The findings, however, provide an experiential path for identifying the causes of vaccine hesitancy and resolving them.

Conclusion

This study demonstrates that vaccine hesitancy is a complex, context-specific issue influenced by distinct environmental and social factors. Rural hesitancy is largely driven by clear information gaps, yet remains highly receptive to traditional, centralised leadership and positive peer feedback. Urban hesitancy, by contrast, is shaped by complex risk-benefit calculations, institutional mistrust, and exposure to digital misinformation within a highly fragmented communication landscape.

To improve vaccine uptake, future immunisation strategies must consider localised, adaptive programs that respect and integrate the unique social and cultural structures of both rural and urban communities.

Conflicts of Interest

None to declare.

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Ethical Approval

Ethical approval was received from the Akwa Ibom State Ethical Review Board in October 2025.

Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Author Contributions

- **Idongesit Nta Wilson:** Conceptualisation, Implementation/fieldwork, Data curation, Data management, and writing.
- **Emmanuel Edward:** Implementation/Field work, Data management.
- **Elizabeth Adedire:** Conceptualisation, writing.

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High HIV Prevalence among Female Refugee Sex Workers in Kampala, Uganda, Linked to Behavioural and Structural Risks

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Abstract *Female sex workers bear a disproportionate burden of HIV globally, yet little is known about HIV epidemiology among refugee sex workers in urban African settings. This study estimated HIV prevalence and examined behavioral and structural factors associated with HIV among female refugee sex workers in Kampala, Uganda. We conducted a cross-sectional study of 686 female refugee sex workers recruited through hotspot-based outreach and peer-referral networks in February and March 2026. Participants completed structured questionnaires and underwent HIV testing in accordance with national guidelines. Overall HIV prevalence was 21.0% (144/686; 95% CI: 18.1–24.3). HIV prevalence increased with age ($\chi^2 = 11.52$, $p = 0.003$) and duration in sex work ($\chi^2 = 7.86$, $p = 0.02$). In multivariable models, inconsistent condom use (APR = 1.87, 95% CI: 1.42–2.46), higher client volume (APR = 1.52, 95% CI: 1.12–2.05), alcohol use before sex (APR = 1.32, 95% CI: 1.04–1.67), exposure to work-related violence (APR = 1.39, 95% CI: 1.08–1.80), and police harassment (APR = 1.28, 95% CI: 1.00–1.63) were associated with HIV infection. These findings align with previous evidence that condomless sex, violence, alcohol use, stigma, and punitive work environments increase HIV vulnerability among female sex workers. Female refugee sex workers in Kampala face a substantial HIV burden driven by intersecting behavioral and structural vulnerabilities. Interventions addressing violence, substance use, and condom negotiation may reduce HIV risk in this population.*

Keywords *HIV Prevalence, Refugees, Sex Work, Structural Vulnerability, Uganda*

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Introduction

HIV remains a major global public health challenge, despite substantial progress in testing, treatment, and prevention. The burden of infection is not evenly distributed across populations. Female sex workers continue to face a disproportionate risk of HIV due to multiple, overlapping vulnerabilities, including economic dependence on sex work, difficulty negotiating condom use, exposure to violence, stigma, criminalization, and limited access to friendly health services [1-3]. In sub-Saharan Africa, these vulnerabilities are often worsened by poverty, mobility, alcohol use, and punitive legal or social environments that make HIV prevention, treatment, and care less accessible [4, 5].

Refugees and forcibly displaced persons face additional challenges that may increase HIV vulnerability. Displacement can disrupt family networks, income sources, education, housing, and access to healthcare [6, 7]. In urban settings, refugees may live outside formal settlements and may be less visible to humanitarian and public health programmes. Women who engage in sex work after displacement may do so under conditions of economic pressure, insecure housing, language barriers, fear of arrest, police harassment, and limited social protection [8, 9]. These conditions can make it harder to refuse unsafe sex, report violence, negotiate condom use, or maintain regular engagement with HIV prevention and treatment services.

Problem Statement

Uganda hosts a large refugee population and has made important progress in HIV prevention and treatment. However, female refugee sex workers remain underrepresented in routine HIV surveillance and research. Most available evidence on sex workers focuses on citizens or mixed groups of sex workers, without clearly identifying refugee status. As a result, programs may overlook the specific realities of women who are both refugees and sex workers. This evidence gap can weaken targeted HIV prevention, reduce service equity, and leave structural drivers of infection unaddressed.

Study Rationale

Understanding HIV prevalence and its determinants among female refugee sex workers is essential to designing inclusive and equitable HIV programs. While individual behaviors, such as condom use, number of clients, and alcohol use before sex, are important, they occur within a broader risk environment shaped by violence, policing, stigma, poverty, and economic insecurity [10, 11]. A narrow focus on individual behavior alone may blame women for risks that are partly produced by structural conditions. This study therefore, estimated HIV prevalence and examined behavioral and structural factors associated with HIV among female refugee sex workers in Kampala, Uganda.

Study Objective

The primary objective was to estimate HIV prevalence and identify behavioral and structural determinants of HIV among female refugee sex workers in Kampala, Uganda.

Specific Objectives

1. To describe the sociodemographic, behavioral, and structural characteristics of female refugee sex workers in Greater Kampala.
2. To estimate HIV prevalence among female refugee sex workers.
3. To assess factors associated with HIV infection using bivariate and multivariable analysis.
4. To estimate the potential contribution of selected exposures to HIV burden using population attributable fraction analysis.

Methods

Study Design

This study employed a mixed-methods approach, combining a cross-sectional design with quantitative and qualitative interviews.

Phase 1 (Quantitative): A cross-sectional survey was conducted with approximately 686 female refugee sex workers (FRSWs) in Kampala. Participants were recruited at popular locations known as hotspots (hotspot: a geographic location where high-risk activities occur or are concentrated, or where female refugee sex workers gather or operate, such as pick-up points or locations where sex work takes place). Recruitment occurred at sites serviced by the MARPI clinic, including outreach sites and refugee sex workers accessing HIV services at the clinic, through snowball sampling. Participants completed a brief questionnaire, and those with unknown HIV status provided a blood sample for testing. Phase 2 (Qualitative): This phase included about 20 in-depth or key informant interviews and 10 focus group discussions. Participants were purposively selected from Phase 1 to explore and clarify key quantitative findings (e.g., HIV prevalence). Insights from the survey guided the purposive selection of participants and topics for the qualitative phase, using quantitative results to inform and shape the inquiry.

Study Site

This study was conducted in Greater Kampala, which includes the Kampala, Wakiso, and Mukono Districts. These three districts form the main urban and peri-urban area of central Uganda and together host the largest number of refugees living outside formal settlements. Greater Kampala is also the country's primary commercial and transportation hub, creating conditions that attract both internal and refugee sex workers because of the availability of clients, nightlife, and informal economic spaces. In these districts, the study focused on mapped sex-work hotspots and the MARPI clinic, where female refugee sex workers commonly operate, live, or seek services. Key hotspots include Kabalagala, Kisenyi, Rubaga, and other locations identified through consultations with peer educators, outreach teams, and local partners such as MARPI. These hotspots were selected for their high concentration of refugee sex workers, active nightlife, and ongoing interventions, making them significant points for sampling and engagement.

Study Population

The study population consisted of female refugee sex workers (FRSWs) aged 18 years or older who reside and work in Greater Kampala (Kampala, Wakiso, and Mukono). This study defines a female refugee sex worker as a woman who:

1. Born outside Uganda and currently living in the country as a recognized refugee, asylum seeker, or with a pending asylum application (self-report is accepted to avoid excluding undocumented refugees).
2. Has exchanged sexual services for money, goods, or other material benefits within the past three months; and
3. Is 18 years of age or older.

The study also included service providers, peer educators, and key informants from institutions such as the Ministry of Health, the Uganda AIDS Commission, the Kampala Capital City Authority, MARPI, and implementing partners. These informants provided contextual information on policies, service delivery, and structural factors that affect refugee sex workers' access to HIV services.

Population and Sample Size Computation

We used the Kish Leslie formula (1965) for a quantitative study, with a 95% confidence interval and a 5% margin of error. Z is 1.96, corresponding to the 95% confidence level of the standard normal distribution, while D is the tolerable sampling error of 5%.

If p = 50, because the prevalence of HIV among refugee sex workers is unknown, the following is the calculation.

Confidence level: 95% $\rightarrow Z = 1.96$

Anticipated prevalence:

$p = 0.50 \rightarrow q = 1 - p = 0.50$ (not 0.67)
Precision: $d = 0.05$
Non-response: 10% (i.e., 90% response rate)

$$n_0 = \frac{Z^2 pq}{d^2}$$

$$= \frac{1.96^2 \times 0.50 \times 0.50}{0.05^2}$$

$$= \frac{3.8416 \times 0.25}{0.0025}$$

$$= 384.16 \approx 384$$

However, because recruitment occured through hotspots, outreach venues, and snowball/referral mechanisms rather than simple random sampling, a design effect of 1.5 was applied to account for clustering within recruitment chains. This increases the sample size to:

nDEFF = 384×1.5 = 576

To accommodate potential non-response, incomplete interviews, or mobility-related attrition, an additional 10% inflation factor was included by dividing the adjusted sample by 0.9:

$$n_{final} = \frac{576}{0.9} \approx 640$$

Sampling for Female Refugee Sex Worker

Stage 1: Identification of Sites and Hotspots

In collaboration with known service providers and peer educators from MARPI, all districts within the greater Kampala area (Kampala, Wakiso, and Mukono) where MARPI is implementing the HIV prevention, care, and treatment intervention for female sex workers were included in the study. These districts were selected because MARPI actively implements HIV prevention, care, and treatment interventions for female sex workers in these areas. Within each district, all mapped hotspots, outreach points, and designated MARPI clinic sites where refugee sex workers regularly operate or seek services were included. Hotspots were identified through existing MARPI outreach data, peer-led mapping, and consultation with community-based organizations working with FSWs.

Stage 2: Approach to Potential Participants

Selection of refuge FSW hotspots or outreach sites: All refuge hotspots, outreach sites, and MARPI clinics that provide HIV prevention, care, and treatment services to refugee FSWs in each district were included. At each hotspot, outreach site, or MARPI clinic, trained peer educators and trusted service providers approached potential participants during the data collection period (February to March 2026). All locations where MARPI routinely engages refuge sex workers, whether through outreach, drop-in services, or daytime clinic visits, served as recruitment points to minimize selection bias by recruiting participants from multiple operational environments.

Stage 3: Eligibility Screening

All eligible female refugee sex workers present at selected hotspots or outreach locations during the approximately one-month data collection period who agreed to be approached were invited to participate in the study. Each woman first underwent a brief eligibility screening conducted by a trusted service provider or a trained peer educator from MARPI. The screening confirmed that she is at least 18 years old, identifies as a refugee, and has engaged in sex work within the past six months.

Women who met the eligibility criteria received clear information about the study in a language they understood: English, Luganda, or their preferred home language (Kinyarwanda, Kirundi, Tigrinya, French, or Swahili). Those who expressed interest were guided through the informed consent process by a trained data collector in a private, safe space at the outreach site or the MARPI clinic. Only participants who

provided written consent for both the interview and the optional biological testing were included in the study.

Once consent was received, interviews were conducted in a private, secure space at the hotspot or outreach location. All women who met the inclusion criteria: female refugee sex workers aged 18 or older who have sold sex in the past six months and can communicate in any of the translated languages are eligible to participate. Women who did not meet these criteria or chose not to give consent were thanked and did not take part in the survey.

Participant Eligibility Criteria

Willing clients were screened for eligibility by study staff using the 'Participant Screening Form'. The interviewer obtained informed consent by reading the consent form in the client's preferred language (English, Luganda, or their native language: Kinyarwanda, Kirundi (Burundian), Tigrinya (Eritrean), French, Swahili) in a private, safe place. All eligible participants were provided informed consent before joining the study.

Inclusion Criteria

1. Female refugee.
2. Aged 18 years or older.
3. Has received money or goods in exchange for sexual services, regularly or occasionally, in the past 6 months.
4. Able to communicate in English, Luganda or in their native language: Kinyarwanda, Kirundi (Burundian), Tigrinya (Eritrean), French, Swahili, including English and Luganda.

Exclusion Criteria

1. Inability to provide informed consent.
2. Any person who is too sick to be interviewed.
3. Any mentally impaired person.
4. Inability to comprehend the questions.

Participant Recruitment Process

Recruitment proceeded consecutively with clients who arrived at designated service delivery points or outreach activities. When a client arrived, the known service provider conducted a brief eligibility screening using the Participant Screening Form.

Clients who met the eligibility criteria were invited to participate in the study. For those interested, the study team directed them to a private, secure space either within the facility or, during community outreach, to a location that ensured proper confidentiality.

The study team clearly explained the purpose of the study, addressed any questions or concerns the client had, and then requested informed consent before starting the interview. Individuals who chose not to participate were respectfully recorded as having declined. If they were comfortable, they were asked to provide the reason for their refusal, which was noted on the consent form. They were thanked for their time, with no repercussions for declining.

Participants who gave written informed consent were moved on to the interview in a private and confidential setting.

Consecutive Recruitment of Clients Attending Selected Services

During the one-month recruitment period (Feb to March 2026), all female refugee sex workers who visited the MARPI clinic or were reached through community outreach activities were invited to participate in the study, provided they met the eligibility criteria.

Snowball (Chain Referral) Recruitment

All study participants recruited through HIV services, either during service delivery at MARPI or through outreach activities, received four to five referral coupons to share with individuals in their network who have not yet participated in the study and have not been in contact with HIV programs or outreach services. Once eligibility was confirmed, participants

were read the consent form in their preferred language, and informed consent was obtained. All eligible participants who completed the interview were awarded transportation compensation of UGX 5,000.($1.35).

When a person with a study coupon visited a recruitment or outreach site to participate, a designated staff member administered the Participant Screening Form. If eligible, informed consent was secured; ineligible individuals were documented.

Consent

Once eligibility was confirmed, interviewers obtained written informed consent from participants. Eligible participants either read the consent form in their preferred language or had it read aloud to them by the interviewer. Interviewers received training on how to obtain written informed consent and how to address any questions participants may have.

During the consent process, participants were informed about the purpose of the survey, which is to fulfill the academic requirements for a PhD at Texila American University. It also aims to generate evidence on access to and utilization of HIV prevention and treatment services among refugee female sex workers in greater Kampala, to inform both academic understanding and potential improvements in services. The details of the survey procedures, potential risks and benefits, and contact information for reporting complaints or concerns were provided. They were also notified that a biological sample would be collected for HIV-related testing as part of the study and that the information obtained from the test and survey would be used by the Ministry of Health to improve health outcomes in Uganda.

Participants were assured that their participation would remain confidential and voluntary, with the right to withdraw at any time without providing a reason. They were given the opportunity to separately consent to completing the survey and to providing a biological specimen for testing. A copy of the information and consent forms was provided to participants who wished to keep them.

For individuals who choose not to provide informed consent, interviewers would complete a refusal form documenting their reasons for refusal, if they were willing to share them. This data was used to monitor refusal rates and to understand reasons for non-participation.

Questionnaire

A structured questionnaire was administered to participants under the supervision of an interviewer. The questionnaire covered a range of topics, including demographics, sex work history, knowledge of HIV and services, attitudes and beliefs, risk perception, , and use of HIV prevention and testing services. The interview lasted between 30 and 45 minutes.

To ensure accuracy and cultural relevance, the questionnaires underwent a translation and back-translation process. Additionally, they were pretested before field implementation to account for language, cultural, and peer norms.

The questions included in the questionnaire were carefully selected and aligned with the study's objectives.

Biological Sample

Healthcare providers at MARPI conducted HIV testing in accordance with Ugandan national guidelines. The study participants were asked about their HIV serostatus. For those whose HIV status was known to be positive and who were in care on ART, their suppression rate was ascertained from the source ART care card or viral load test result form during a review of their medical/treatment history. Those with unknown status expressed interest in HIV testing. Those who consented to HIV testing had up to 1 mL of venous blood drawn from the ring finger or the arm. The blood was used to test for HIV using the rapid HIV testing procedure (Figure 1). The remainder of the blood was discarded after the test.

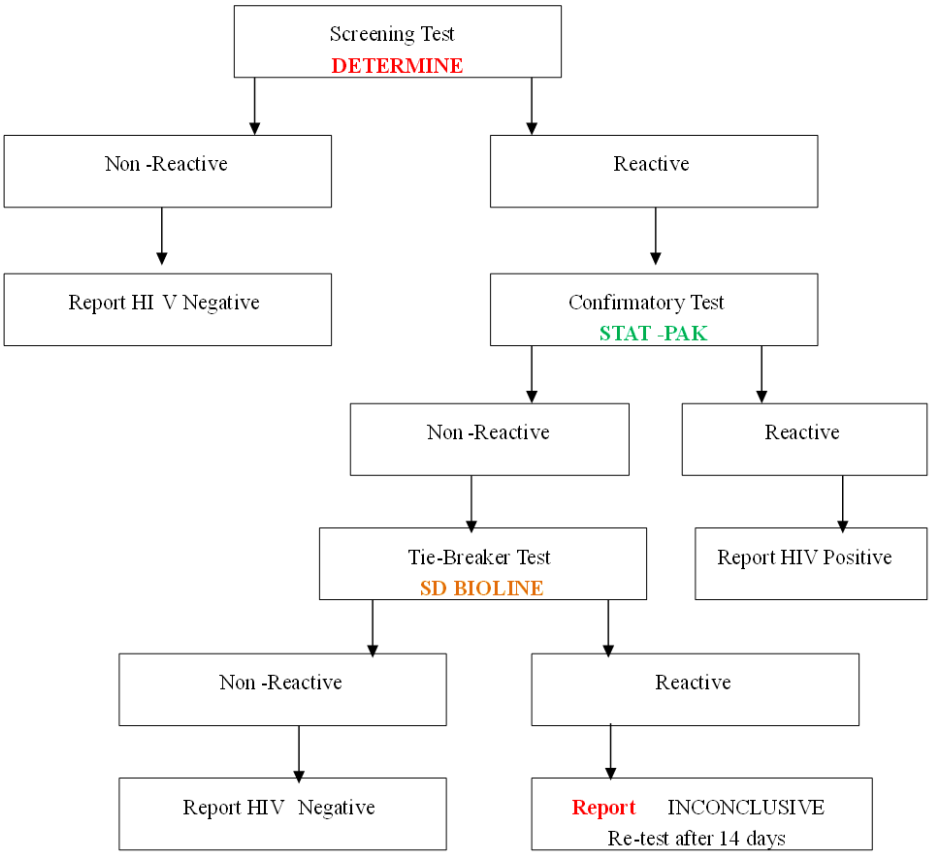


Figure 1. The National HIV Testing Algorithm

National guidelines will be followed for providing test results and post-test counselling.

Counselling and Referral

Post-test HIV counselling: Post-test counseling messages were tailored to recruits' HIV results and risk profiles. Uganda MOH guidelines for counseling were followed for HIV counseling, testing, and referral services. Post-test counseling included goals, means, and strategies for behavioral risk reduction, maintenance of risk reduction, and explanations of risk reduction methods (e.g., condom use, drug use). Counseling for HIV-infected participants included an assessment of psychosocial needs, a discussion of living with HIV infection, treatment and care, and issues related to discrimination. The risk of HIV transmission to partners was discussed, and strategies for behavioral change were addressed. Counseling was performed face-to-face. PrEP, STI commodities, condoms, and lubricants (as available) were provided.

Dependent Variable

HIV Status

1. Measured through voluntary HIV testing following national algorithms OR self-reported HIV status where testing is declined.
2. Categorised as: *Positive / Negative*.

Associated Factors (Independent Variables)

Measured through structured questionnaire items: All associated factors will be examined using bivariate and multivariable regression to identify predictors of HIV positivity.

1. **Demographic Variables**
   - Age (continuous / categories)
   - Nationality (categorical)
   - Education level (categorical)
   - Marital status (categorical)
2. **Behavioural Variables**
   - Number of clients per week (continuous / categories)

- Condom use consistency (Always / Sometimes / Never)
- Substance use (Yes/No; frequency scale)
- Experience of violence (Yes/No; perpetrator type)

3. **Contextual Variables**
   - Duration in Uganda (continuous / categories)
   - Living conditions (categories)
   - Police encounters / harassment (Yes/No)

Survey Period

The recruitment period for the consecutive survey-based recruitment was 4 weeks (February to March 2026) in length, with an additional 2 weeks during which individuals were referred through snowball.

Data Collection Techniques and Instruments

To collect data, we recruited and trained 10 interviewers with experience working with key populations, including refugee female sex workers and other HIV-vulnerable groups. The interviewers received orientation and sensitivity training to prepare them for effective engagement and rapport-building with these groups.

These data collectors were responsible for establishing relationships and trust with refugee female sex workers, screening for eligibility, recruiting participants, obtaining consent, providing transportation refunds, and collecting blood samples for HIV testing. They also administered questionnaires, directed clients during specimen collection for HIV screening, initiated antiretroviral therapy (ART) or pre-exposure prophylaxis (PrEP) as needed, and facilitated linkages to care, which were handled by an outreach health worker from MARPI.

HIV testing and counseling were offered on-site to individuals with unknown HIV status, following the national testing algorithm. Each team leader was responsible for maintaining a registration log that recorded all invited individuals, including the number of eligible participants and those who declined.

Interviews were conducted face-to-face at selected hotspots or outreach sites using questionnaires created in Kobo Collect, a mobile data collection app. The app was configured with field validation to prevent errors and included skip patterns. Data was entered directly into tablets during interviews and uploaded daily to the Kobo Collect server via Wi-Fi. The survey team then retrieved the data from the server for further processing and analysis.

Selection of Data Collectors

Research assistants fluent in English and their native languages (Kinyarwanda, Kirundi [Burundian], Tigrinya [Eritrean], French, and Swahili) with prior experience working with sex workers, especially refugee sex workers, in each hotspot were identified. These research assistants were thoroughly trained on study aims, research protocol, interview skills, data management, and research ethics.

Quality Control and Assurance for Quantitative

Data collectors participated in a three-day training program focused on collecting high-quality data. The training highlighted research ethics, especially the need to protect the privacy and sensitivity of female refugee sex workers during interviews. To ensure the reliability and consistency of the data collection tools, they were pretested in Kampala at one of the hotspots that was not included in the study area. Repetitions, vague questions, overlapping response options, and other inconsistencies in the tools were identified and corrected. Findings from the pretesting process were used to guide editing of the tools to enhance their validity. To improve data quality and completeness, the data collection tools included checks and restrictions. Both virtual and in-person meetings were held daily to verify

consistency and completeness and to ensure proper data collection.

HIV Testing, Referral, and Linkage

All HIV-infected post-test-counseling recruits were provided with a referral form for services and linked to the preferred point of care. We collaborated with health care providers willing to accept these referral letters and to provide further care and treatment as necessary. On a case-by-case basis, study staff offered to accompany participants to obtain highly needed referral services (examples: HIV treatment services, gender-based violence services, etc.). Clinics to which HIV-positive persons were linked were asked to retain the referral forms received. A system was put in place to track the number of people who were offered, accepted, and were escorted to a treatment facility (table below). An explanation for why each of the events did not occur was documented.

Participant ID	Was the Participant Offered an Escort?	Did the Participant Accept?	Was the Participant Escorted?
	□ Yes □ No, why? _____	□ Yes □ No, why? _____	□ Yes □ No, why? _____
	□ Yes □ No, why? _____	□ Yes □ No, why? _____	□ Yes □ No, why? _____

Potential Risks

The blood draw could involve minimal risk, including pain from injection-site injury. The risk of pain at the venipuncture site was minimized by the use of appropriate MOH and WHO infection control and testing procedures. Physical discomfort at the venipuncture site was minimal. However, participants who experienced mild pain were reassured that this was temporary and would subside within a few minutes. Participants who experienced any other untoward effect after leaving the study site were encouraged to seek medical advice at the nearest health facility and/or get in touch with the provided contact details for any further help.

Participants who learn of their HIV infection through survey participation may experience psychological and emotional problems, ongoing uncertainty about their health, and worries about having infected others. In this study, post-test counseling was offered by study-trained staff to address the concerns of participants who tested positive. The team referred and linked newly HIV-positive participants to ART treatment initiation and further care and support at the client's preferred point of care.

HIV serostatus and disclosure of sex work use may also subject participants to stigma, discrimination, and potential legal sanctions. To minimize the risk of these disclosures, the survey restricted access to study materials. Only the Principal Investigator had access to participants' information, and no other study team member did.

Potential Benefits

Direct benefits of participating in this survey included learning your HIV status. If you tested positive, referrals to care and treatment were provided. Study staff also connected you with appropriate organizations for other issues, as needed. For some participants, taking part in the survey might have been their first opportunity to access HIV services or to reconnect with them.

Confidentiality

Confidentiality was a key priority in this study because refugee female sex workers face high levels of stigma, legal vulnerability, and social risks. To protect participants, all screening, consent, and interviews were conducted in private, secure locations, either in facility rooms or in discreet settings during outreach, ensuring conversations could not be overheard. Participants were not asked for names or any direct identifying information; instead, each refugee sex worker was assigned a unique study ID code used for all data.

Collection Tools

Consent forms were stored separately from interview data to prevent linking identities to responses. All screening, consent, and interviewing were conducted by trusted peer educators, community outreach workers, or known service providers with established relationships with the refugee sex work community. These staff members received training in confidentiality, trauma-informed communication, research ethics, and the sensitive handling of personal information. Interviews were conducted in the participant's preferred language, including English, Luganda, Kinyarwanda, Kirundi, Tigrinya, French, or Swahili, to avoid the need for untrained interpreters and minimize the risk of accidental disclosure.

Study staff consistently ensured that participants' identities remained secure, preventing accidental disclosures of their relationships with those they referred to the study and of their status as female refugee sex workers (FRSW). To this end, all staff members signed confidentiality agreements.

Data was uploaded using a unique study ID, which was used in the data uploaded to the database and on laboratory forms. This allows test results to be linked to participants' survey data while keeping their identities confidential. No personally identifiable information was included in the data uploaded to the database, further protecting participants' confidentiality.

Identifying, Managing, and Reporting Adverse Events

No adverse events were expected from this study, but participants might have experienced emotional distress after receiving a new HIV diagnosis. To address this, trained counselors were available at all study sites for support. During sample collection, although the risk was low, there was a possibility of adverse events related to blood collection, such as infection or minor bleeding from heel-stick or finger-prick procedures. The Principal Investigator was responsible for reporting any adverse events to the Ministry of Health and to relevant ethics review groups, including the National Institutional Review Board.

There was a potential risk of data loss if a device used for data collection was lost or stolen. To address this risk, study personnel were required to immediately report any such incident to the study coordinator, including details of when and where it occurred. The study coordinator would then notify the Principal Investigator and the data manager to ensure that the affected device was disabled and replaced promptly. In addition, the Principal Investigator would report the incident to the Ministry of Health and the relevant ethics committees.

Although data loss was possible under such circumstances, the study minimized this risk by uploading data in real time or at regular intervals whenever internet connectivity was available. Any data that could not be recovered would have been treated as missing data during analysis. Furthermore, no identifiable participant information was stored on the devices, thereby ensuring that participant confidentiality would not be compromised in the event of device loss or theft. During the course of this study, no data were lost.

Participants received the Principal Investigator's contact information for any

study-related questions or concerns. They were also given contact details for the Research Ethics Committee to report any adverse events. The study team was expected to report any unexpected or adverse events to the Principal Investigator within 24 hours and to the relevant ethics committees within 5 to 10 days, depending on severity and the need for additional information. Follow-up reports were submitted as needed. However, no events were reported during the study period.

Survey staff and the principal investigator oversee protocol monitoring and compliance to ensure adherence to study protocols and ethical standards.

Data Processing and Information Analysis

Quantitative Data Management

To improve data security, the KoboCollect data collection tool was configured to use encryption. A public key was included in the XLS form uploaded to KoboCollect, while the private key was used locally with ODK Briefcase to decrypt data after downloading from the server. The private key, kept confidential by the principal investigator and data manager, ensured secure access. The tool was designed to automatically encrypt data on mobile devices once survey assistants marked it as finalized. Submitted data was stored encrypted on the KoboToolbox server and was accessible only with the private key.

Data Analysis

Descriptive Analysis: Descriptive statistics were used to summarize participants' socio-demographic characteristics, HIV testing history, knowledge about HIV and related services, attitudes and beliefs, risk perception.

Bivariate Analysis: Chi-square or Fisher's exact tests was used assess associations between socio-demographic factors.

Multivariate Analysis: Logistic regression may be used to identify factors HIV prevalence among female refugee sex workers in greater Kampala.

Qualitative Perspective

Data Collection Methods and Techniques

Socio-demographic: Socio-demographic characteristics of participants included age in complete years (continuous), marital status (never married, married, divorced, widowed, or separated), and the highest level of education attained (no education or primary, secondary, university, or tertiary). Other characteristics included occupation, defined as the primary means by which the participant supports themselves. Surveys: Structured surveys were administered to explain findings, such as HIV prevalence.

Methods and Techniques for Data Processing and Information Analysis

We processed and analyzed qualitative data using a systematic, rigorous approach that ensured accuracy and depth. Our process includes:

Transcription and Data Cleaning

We transcribed all audio-recorded interviews and focus group discussions verbatim. Transcripts were reviewed and cleaned to ensure accuracy and to remove any identifying information.

Coding

We applied an iterative coding process using qualitative data analysis software (e.g., NVivo or Atlas.ti). Initial open coding identified key concepts, which we then refined through axial coding to organize related codes into broader categories.

Thematic Analysis

We conducted a thematic analysis by examining the coded data to identify recurring themes and patterns. This process involved constant comparison, allowing us to capture both anticipated and emergent themes that

elucidate barriers and facilitators to accessibility of HIV prevention, care, and treatment.

Interpretative Analysis

We analyzed the data contextually, interpreting how social, cultural, and structural factors influence participants' experiences. We triangulate insights from in-depth interviews, focus groups, and key informant discussions to validate our findings.

Member Checking and Validation

We incorporated feedback from participants (member checking) and peer debriefing sessions to enhance the credibility and trustworthiness of the analysis. This step ensured that the interpretations accurately reflected the participants' perspectives.

Ethical Considerations

To conduct the survey, ethical approval was obtained from the Kabale University Institutional Review Board and the survey was registered with the Uganda National Council of Science and Technology (UNCST). Additionally, permission was secured from the Most at Risk Population Initiative (MARPI). Participation in the survey was voluntary, and participants were fully informed about the study procedures, including the use of the ODK tool for quantitative data and audio recorders for qualitative data. Written informed consent was obtained from all participants using consent forms before any data collection interviews.

Measures were taken to safeguard personal identifiers and survey data involving human subjects. Participants' names were not linked to their responses, and all data files were stored on password-protected devices accessible only to authorized members of the survey team. All staff involved in the study completed training and certification through the Collaborative Institutional Training Initiative (CITI), specifically the Information Privacy & Security (IPS) module and other relevant modules, such as Good Clinical Practice (GCP). Survey assistants without prior GCP training were required to complete it before participating in data collection training to ensure compliance with ethical standards throughout the survey.

Survey assistants also received training in interviewing techniques tailored for key and priority populations, with a focus on creating a supportive environment for interviews. All collected data will be securely stored and destroyed five years after the completion of survey activities.

Results

Socio-Demographic Characteristics

The socio-demographic characteristics of the respondents are shown in Table 1 below.

Table 1. Sociodemographic, Behavioral, and Structural Characteristics of Female Refugee Sex Workers in Greater Kampala (N = 686)

Characteristic	N	%
Age group (years)		
18–24	208	30.3
25–34	321	46.8
≥35	157	22.9
Nationality		
Democratic Republic of Congo	286	41.7
South Sudan	173	25.2
Rwanda	112	16.3
Burundi	79	11.5
Other	36	5.3
Education level		

No formal education	96	14.0
Primary education	283	41.3
Secondary education	259	37.8
Post-secondary	48	7.0
Clients per day		
1–2 clients	295	43.0
3–5 clients	274	39.9
≥6 clients	117	17.1
Condom use with clients		
Always	338	49.3
Sometimes	271	39.5
Never	77	11.2
Alcohol use before sex		
Yes	327	47.7
No	359	52.3
Drug use before sex		
Yes	104	15.2
No	582	84.8
Experienced work-related violence		
Yes	308	44.9
No	378	55.1
Police harassment related to sex work		
Yes	261	38.0
No	425	62.0

A total of 686 female refugee sex workers participated in the study. Nearly half, 46.8% (321/686), were between 25 and 34 years old; 30.3% (208/686) were between 18 and 24 years old; and 22.9% (157/686) were 35 years or older. The median age was 27 years (IQR 22–33). Participants primarily originated from the Democratic Republic of Congo (41.7%, 286/686), South Sudan (25.2%, 173/686), Rwanda (16.3%, 112/686), Burundi (11.5%, 79/686), and other countries, such as Ethiopia and Eritrea (5.3%, 36/686). A good number of the refugee sex workers had primary education (41.3%, 283/686); secondary education (37.8%, 259/686); 14% (96/686) had no formal education; and 7.0% (48/686) had attained post-secondary education. Nearly half, 43.0% (295/686), of the participants reported having sex with 1–2 clients per day; a good number, 39.5% (274/686), reported having sex with 3–5 clients per day; and about 17.1% (117/686) reported having sex with 6 or more clients per day. Less than half, 49.3% (338/686), reported consistent condom use with clients; about 39.5% (271/686) reported inconsistent use of condoms; and 11.2% (77/686) never used condoms while selling sex. Almost half, 47.7% (327/686), of the respondents reported alcohol use before work. A good number, 44.9% (308/686), reported work-related violence, and 38.0% (261/686) reported experiencing police harassment during sex work.

Prevalence of HIV Among Refugee Sex Workers

The overall HIV prevalence was 21.0% (144/686; 95% CI: 18.1–24.3), as shown in Table 2.

Table 2. HIV Prevalence by Participant Characteristics

Variable	Total (N)	HIV Positive n (%)	χ^2	p-value
Age group			11.52	0.003
18–24	208	31 (14.9)		
25–34	321	71 (22.1)		
≥35	157	42 (26.8)		
Duration in sex work			7.86	0.020
<2 years	214	31 (14.5)		
2–5 years	268	59 (22.0)		
>5 years	204	54 (26.5)		
Condom use with clients			32.44	<0.001
Always	338	45 (13.3)		
Sometimes	271	70 (25.8)		
Never	77	29 (37.7)		
Clients per day			14.78	<0.001
1–2	295	48 (16.3)		
3–5	274	62 (22.6)		
≥6	117	34 (29.1)		
Alcohol use before sex			8.36	0.004
Yes	327	83 (25.4)		
No	359	61 (17.0)		
Drug use before sex			10.49	0.001
Yes	104	33 (31.7)		
No	582	111 (19.1)		
Work-related violence			10.11	0.002
Yes	308	82 (26.6)		
No	378	62 (16.4)		
Police harassment			8.71	0.003
Yes	261	71 (27.2)		
No	425	73 (17.2)		

HIV prevalence increased with age ($\chi^2 = 11.52$, $p = 0.003$), duration in sex work ($\chi^2 = 7.86$, $p = 0.02$), condom use in sex work ($\chi^2 = 32.44$, $p = 0.001$), the number of clients per day ($\chi^2 = 14.78$, $p = 0.001$), alcohol use during sex work ($\chi^2 = 8.36$, $p = 0.004$), drug use before sex ($\chi^2 = 49$, $p = 0.001$), experience of work-related violence ($\chi^2 = 11$, $p = 0.002$), and police harassment ($\chi^2 = 8.71$, $p = 0.003$). These factors were also significantly associated with HIV positivity.

Sequential Modified Poisson Regression Models of Factors Associated with HIV Infection

The sequential modified Poisson regression models examining factors associated with HIV prevalence is presented in Table 3.

Table 3. Sequential Modified Poisson Regression Models of Factors Associated with HIV Infection

Variable	Model 1 APR (95% CI)	Model 2 APR (95% CI)	Model 3 APR (95% CI)
Age ≥35 years	1.72 (1.28–2.32)	1.63 (1.20–2.22)	1.58 (1.18–2.12)
No formal education	1.49 (1.11–2.00)	1.46 (1.08–1.96)	1.44 (1.07–1.93)
≥6 clients/day	–	1.61 (1.20–2.17)	1.52 (1.12–2.05)
Inconsistent condom use	–	2.03 (1.55–2.66)	1.87 (1.42–2.46)
Alcohol use before sex	–	1.39 (1.10–1.75)	1.32 (1.04–1.67)
Drug use before sex	–	1.41 (1.05–1.90)	1.36 (1.01–1.84)
Work-related violence	–	–	1.39 (1.08–1.80)
Police harassment	–	–	1.28 (1.00–1.63)
Notes: Model 1: demographic variables Model 2: demographic + behavioral variables Model 3: demographic + behavioral + structural variables APR = Adjusted prevalence ratio			

In Model 1, which included only demographic variables, participants aged 35 years and older had a significantly higher HIV prevalence than those under 35 (APR = 1.72, 95% CI: 1.28–2.32). Likewise, participants with no formal education had higher HIV prevalence than those with some education (APR = 1.49, 95% CI: 1.11–2.00).

In Model 2, after adjusting for behavioral factors, age ≥35 years (APR = 1.63, 95% CI: 1.20–2.22) and lack of formal education (APR = 1.46, 95% CI: 1.08–1.96) remained significantly associated with HIV infection. Behavioral factors, including having six or more clients per day (APR = 1.61, 95% CI: 1.20–2.17), inconsistent condom use (APR = 2.03, 95% CI: 1.55–2.66), alcohol use before sex (APR = 1.39, 95% CI: 1.10–1.75), and drug use before sex (APR = 1.41, 95% CI: 1.05–1.90), were also notably associated with higher HIV prevalence.

In the final model (Model 3), which included demographic, behavioral, and structural variables, age ≥35 years (APR = 1.58, 95% CI: 1.18–2.12) and lack of formal education (APR = 1.44, 95% CI: 1.07–1.93) remained significantly associated with HIV infection. Behavioral factors such as ≥6 clients per day (APR = 1.52, 95% CI: 1.12–2.05), inconsistent condom use (APR = 1.87, 95% CI: 1.42–2.46), alcohol use before sex (APR = 1.32, 95% CI: 1.04–1.67), and drug use before sex (APR = 1.36, 95% CI: 1.01–1.84) also remained significant predictors. Additionally, structural factors such as work-related violence (APR = 1.39, 95% CI: 1.08–1.80) and police harassment (APR = 1.28, 95% CI: 1.00–1.63) were independently associated with higher HIV prevalence.

Population Attribution Fractions for Selected HIV Risk Factors

The population attribution fractions for selected HIV risk factors are shown in Table 4 below.

Table 4. Population Attributable Fractions for Selected HIV Risk Factors

Exposure	Prevalence of Exposure (%)	APR	Population Attributable Fraction (%)
Inconsistent condom use	50.7	1.87	30
Violence exposure	44.9	1.39	24
Alcohol use before sex	47.7	1.32	22

Presents the estimated contribution of selected risk factors to HIV infection in the study population. Inconsistent condom use had the highest exposure prevalence (50.7%) and the highest adjusted prevalence ratio (APR = 1.87). It also had the largest population attributable fraction (PAF) of 30%, suggesting that nearly one-third of HIV infections in this population could be prevented if inconsistent condom use were eliminated, assuming a causal relationship. Violence exposure was also common, reported by 44.9% of participants. It had an APR of 1.39 and a PAF of 24%, indicating that violence may be an important structural and social driver of HIV risk. This finding highlights the need to integrate violence prevention, protection, and response services into HIV prevention and care programs.

Alcohol use before sex was reported by 47.7% of participants and was associated with higher HIV prevalence (APR = 1.32). Its PAF was 22%, suggesting that reducing alcohol-related sexual risk behaviors could meaningfully reduce HIV infections.

Overall, the table shows that inconsistent condom use, exposure to violence, and alcohol use before sex are important contributors to HIV risk. These findings support the need for combination HIV prevention strategies that address individual behaviors, such as condom use and alcohol-related risk, as well as broader structural factors, such as violence.

Interaction Between Violence Exposure and Condom Use in Relation to HIV Infection

The Interaction Between Violence Exposure and Condom Use in Relation to HIV Infection is shown in Table 5.

Table 5. Interaction Between Violence Exposure and Condom Use in Relation to HIV Infection

Condom Use	Violence Exposure	HIV Positive n/N (%)	Adjusted PR	95% CI
Always	No	20/184 (10.9)	Reference	–
Always	Yes	25/154 (16.2)	1.44	0.85–2.44
Sometimes	No	28/138 (20.3)	1.78	1.05–3.02
Sometimes	Yes	42/137 (30.6)	2.94	1.72–5.03
Never	No	17/60 (28.4)	2.31	1.19–4.48
Never	Yes	12/28 (42.9)	4.86	2.41–9.82

Interaction term p = 0.01

HIV positivity increased as condom use decreased, and the risk was higher among participants who had experienced violence. The lowest HIV prevalence was observed among participants who always used condoms and had no violence exposure, at 10.9%, which served as the reference group.

Participants who sometimes used condoms had higher HIV prevalence, especially when they had also experienced violence. HIV

positivity increased from 20.3% among those with no violence exposure to 30.6% among those exposed to violence. Similarly, among participants who never used condoms, HIV positivity was much higher among those exposed to violence, at 42.9%, compared with 28.4% among those not exposed to violence.

The adjusted prevalence ratios show the same pattern. The highest HIV risk was observed among participants who never used condoms and had experienced violence, with an adjusted PR of 4.86. This means they had nearly five times the prevalence of HIV compared with those who always used condoms and had no violence exposure.

The significant interaction term, $p = 0.01$, suggests that violence exposure strengthens the relationship between inconsistent condom use and HIV infection. These findings indicate the need for HIV prevention interventions that combine condom promotion with violence prevention and response services.

Discussion

This study found a high burden of HIV infection among female refugee sex workers in Greater Kampala, Uganda. The overall HIV prevalence was 21.0%, substantially higher than the 5.1% reported among adults aged 15 years and older in the general population in Uganda, according to the Uganda Population-based HIV Impact Assessment 2020–2021 [1]. This large difference indicates that female refugee sex workers continue to experience a much higher HIV burden than the general population. However, the HIV prevalence observed in this study was lower than the 33% prevalence previously reported among female sex workers in Kampala by the Crane Survey conducted by Makerere University School of Public Health and the Ministry of Health [2]. This difference may reflect variations in study populations, sampling methods, geographic settings, refugee status, age structure, duration in sex work, and access to HIV prevention and treatment services. Some refugee sex workers in this study may also have been younger or had spent fewer years in sex work than those included in earlier Kampala-based surveys. However, an HIV prevalence of 21.0% remains very high and represents a serious public health concern.

This finding confirms that female refugee sex workers remain a highly vulnerable population within Uganda's national HIV response. Their vulnerability stems not only from sexual behavior but also from displacement, poverty, limited education, violence, alcohol and drug use, police harassment, stigma, and reduced power to negotiate safer sex. These overlapping challenges create an environment in which HIV risk is not simply a matter of individual choice. A woman may understand the importance of condom use yet still be unable to use condoms consistently because of client pressure, fear of violence, financial need, alcohol use, or harassment by law enforcement. This finding aligns with global evidence showing that female sex workers bear a disproportionate HIV burden due to structural determinants such as violence, criminalization, stigma, unsafe working conditions, and limited access to quality health services [3, 4, 12, 20].

The qualitative findings provide important context for understanding these quantitative results. Participants linked HIV vulnerability to the conditions of being refugee women with limited livelihood options. Many explained that they entered sex work not because they wanted to, but because they needed to survive, feed children, pay rent, or meet basic needs. One participant explained that refugee women are at higher risk because they often lack social support and may face language barriers: "*A refugee who doesn't know the language very well can be used without knowing what they have negotiated… even if she says that she wants to take the person to police, he will win her because she will not speak the language*." Another participant described how poverty pushes women into unsafe sex: "*Most of the sex*

workers do it not because they want but they are looking for a living, so that is how most of them acquired HIV." These accounts show that HIV risk is strongly linked to social and economic hardship. Hunger, rent, school fees, lack of employment, and the responsibility of caring for children limit women's ability to protect themselves.

The participants' refugee status is therefore important for interpreting these findings. Refugees and forcibly displaced persons may experience disrupted family networks, loss of income, unstable housing, food insecurity, language barriers, limited livelihood options, and reduced access to health information and services [7, 8]. For women who enter sex work after displacement, these vulnerabilities may be intensified by economic pressure, insecure living conditions, social exclusion, and a lack of legal protection. In such circumstances, the ability to refuse unsafe sex, insist on condom use, report violence, or access health facilities may be limited. Therefore, HIV prevention messages that focus only on individual behavior are insufficient. Interventions must also address the broader realities of displacement, poverty, stigma, and insecurity.

Inconsistent condom use was among the strongest factors associated with HIV infection in this study. Participants who used condoms inconsistently had a higher prevalence of HIV than those who used them consistently. In the final adjusted model, inconsistent condom use remained independently associated with HIV prevalence. The population attributable fraction analysis also showed that inconsistent condom use accounted for the largest share of HIV infections among the selected risk factors. This suggests that improving consistent condom use could prevent a substantial proportion of HIV infections in this population.

However, condom use among sex workers should not be viewed as a simple matter of personal decision-making. Condom negotiation is often shaped by unequal power dynamics between sex workers and clients, client refusal, offers of higher payment for condomless sex, alcohol use, fear of violence, and pressure to meet daily survival needs [9, 10, 13]. In addition, police harassment may make it unsafe for sex workers to carry condoms, especially where condoms are treated as evidence of sex work. Therefore, condom programming should go beyond condom distribution. It should include peer-led risk-reduction counseling, negotiation skills, client engagement, access to lubricants, PrEP, post-exposure prophylaxis, and safer working environments.

The study also found that HIV prevalence increased as condom use declined. HIV positivity was lowest among women who always used condoms and highest among those who never used them. This finding is biologically plausible and consistent with evidence that correct and consistent condom use reduces heterosexual transmission of HIV and other sexually transmitted infections [11]. In sex work settings, where women may have repeated sexual exposure with multiple clients, even occasional condomless sex can increase cumulative risk. Therefore, continuous availability of condoms and lubricants at hotspots, clinics, drop-in centers, refugee-serving organizations, and community outreach points is essential.

Exposure to violence was another important factor associated with HIV infection. Nearly half of participants reported work-related violence, and those who experienced violence had higher HIV prevalence than those who did not. This finding aligns with previous studies showing that violence against sex workers increases HIV vulnerability and undermines prevention efforts [12, 13]. Violence can increase HIV risk directly through forced sex, condomless sex, and genital trauma. It can also increase risk indirectly by reducing a woman's ability to negotiate condom use, lowering self-esteem, increasing fear, discouraging service uptake, and contributing to harmful alcohol or drug use.

The qualitative findings further demonstrate how violence increases HIV vulnerability. Participants described serious experiences of sexual violence, deception, and abuse from clients. Some women reported being taken by one client but later finding several men waiting to have sex with them. In such situations, they were often unable to refuse, escape, or negotiate condom use. One participant explained: "*You can go with one person, and he says that we are going to my home, but when you reach there, you find more than 6 people, and automatically they all have sex with you… None will put on a condom."* Another participant described being trapped in a room: "*You find some under the bed, others behind the door. You have entered, and there is nowhere to exit. They locked it and kept the keys*." These accounts show that HIV risk is strongly connected to violence and lack of control during sexual encounters. The women's vulnerability is not only due to condomless sex, but also to coercion, group sexual violence, non-payment, and inability to seek justice.

The interaction between violence exposure and condom use is one of the study's most important findings. HIV prevalence was lowest among participants who always used condoms and had no exposure to violence. However, HIV prevalence increased sharply among women who used condoms sometimes or never, especially when they had also experienced violence. The highest HIV prevalence was observed among women who never used condoms and had experienced violence. These women had almost five times the HIV prevalence of those who always used condoms and had no exposure to violence. The significant interaction term suggests that violence amplifies the harmful effect of inconsistent condom use on HIV infection.

This finding has important program implications. It suggests that condom promotion alone may not adequately protect women who continue to work in violent conditions. A sex worker may understand HIV prevention messages and even prefer to use condoms, but violence can strip her of the power to negotiate safer sex. HIV prevention among female refugee sex workers must therefore treat violence prevention and response as central components of HIV programming, not as separate or optional services. Programs should include routine screening for violence, emergency post-violence care, post-exposure prophylaxis, psychosocial support, legal aid, safe reporting systems, and confidential, nonjudgmental referral pathways.

Alcohol use before sex was also independently associated with HIV infection. Almost half of the participants reported drinking before sex, and those who did so had higher HIV prevalence than those who did not. Alcohol can increase HIV risk by impairing judgment, reducing condom negotiation, increasing exposure to violent clients, and making it harder for women to leave unsafe situations [14, 15]. However, alcohol use should be interpreted with empathy. For some women, alcohol may be used to cope with stress, trauma, stigma, fear, or the emotional burden of sex work. Others may work in bars, lodges, or entertainment venues where alcohol use is part of client interactions. Interventions should therefore avoid blame and instead offer harm-reduction counselling, mental health support, safer-sex planning, and referrals to friendly substance-use services.

The qualitative findings support this interpretation. Alcohol was described both as a coping mechanism and as a risk factor. Some participants reported drinking before sex work to reduce fear, stress, or shame. However, alcohol also reduced their ability to negotiate condom use or assess unsafe situations. One issue raised during focus group discussions was summarized as follows: "*We drink alcohol because we don't want to be sober while engaging in this business of sex work, which makes it hard for you to think about putting on a condom when you are drunk.*" Another

participant described a situation in which alcohol was involved before unprotected sex: "*Within this week… I was with a man. We first boozed, then went to his place, and he told me we were going to have sex. I asked for condoms, but the client did not have any. Because of money, I ended up doing it, though I didn't want to*." This shows that alcohol, poverty, and client refusal to use condoms interact to increase HIV risk.

Drug use before sex was also associated with HIV infection. Although fewer participants reported drug use than alcohol use, those who did had a higher prevalence of HIV. Drug use may increase vulnerability by reducing risk perception, weakening condom negotiation, increasing dependence on clients or partners, and exposing women to unsafe environments [16]. HIV services for key populations should therefore include screening for harmful alcohol and drug use, brief counseling, referral to treatment where needed, and non-stigmatizing harm-reduction support [6].

Older age was significantly associated with HIV infection. Participants aged 35 years and older had higher HIV prevalence than younger participants. This may reflect cumulative exposure to HIV risk over time, longer duration in sex work, repeated exposure to condomless sex, and prior experiences of violence or sexually transmitted infections. Older sex workers may also face reduced bargaining power in some settings, especially where clients prefer younger women or where older women have fewer livelihood alternatives. Similar patterns have been observed in other studies, with HIV prevalence increasing with age among female sex workers [2, 17].

Lack of formal education was also independently associated with HIV infection. Participants with no formal education had higher HIV prevalence than those with some education. Education may influence HIV vulnerability through access to health information, the ability to understand prevention messages, economic opportunities, self-confidence, and the power to negotiate safer sex [18]. Low education may also limit access to formal employment, increasing dependence on sex work for survival. HIV programs for this population should therefore use clear, simple, culturally appropriate, and language-sensitive communication approaches. Peer-led discussions, visual materials, local languages, and repeated interpersonal counseling may be more effective than written messages alone.

Having six or more clients per day was associated with higher HIV prevalence. A higher number of clients increases the number of potential HIV exposure events, especially in settings where condom use is inconsistent or where violence, alcohol use, and police harassment are present. However, high client volume may also reflect economic pressure. Refugee sex workers may accept more clients because they need money for rent, food, school fees, transportation, healthcare, or support for family members. This finding suggests that HIV prevention should be linked with economic strengthening, social protection, and livelihood support where possible [19].

Police harassment was also independently associated with HIV infection. This finding highlights the role of the legal and social environment in shaping HIV vulnerability. Police harassment can drive sex work into hidden and unsafe settings, disrupt peer outreach, increase fear, reduce condom carrying, and deter women from seeking help after violence [12, 20]. Criminalization and punitive policing have been shown to increase HIV vulnerability among sex workers by limiting access to prevention and care services [21]. In this study, police harassment should therefore be understood not only as a human rights concern but also as a public health issue.

Qualitative interviews showed that fear of arrest and lack of justice were key structural barriers. Some women feared moving freely because sex workers are often suspected of theft or other criminal activity. Others reported that

when they experienced violence or non-payment by clients, police did not support them. One participant said: "*We walk in fear of being arrested because people know that we sex workers are thieves*." She added that reporting clients to police was difficult: "*You can go to police to report a client… he didn't give me my money and they are like no, as long as they see that you are a refugee." Another participant described being arrested while pregnant: "They caught me and arrested me… I asked them that what if I am hungry, can't my child in the womb die, I have to get what to eat."* These findings show that criminalization, police harassment, and lack of legal protection increase vulnerability. When women cannot report violence safely, abusive clients continue to exploit them, and women remain exposed to forced sex, condomless sex, and untreated injuries or infections.

The population attributable fraction findings offer useful guidance for programming. Inconsistent condom use had the highest population attributable fraction, followed by exposure to violence and alcohol use before sex. This suggests that addressing these three factors could meaningfully reduce HIV infections among female refugee sex workers. However, these risk factors are interconnected. Alcohol use may increase vulnerability to violence; violence may reduce condom negotiation; police harassment may push women into unsafe working conditions; and poverty may make it difficult to refuse condomless sex when clients offer more money. Therefore, HIV risk among female refugee sex workers should be understood as a cluster of overlapping vulnerabilities rather than as isolated behaviors.

The findings support the need for combination HIV prevention. For female refugee sex workers, combination prevention should include condoms and lubricants, HIV testing, antiretroviral therapy, PrEP, post-exposure prophylaxis, sexually transmitted infection screening and treatment, contraception, violence response services, mental health support, harm-reduction services, legal support, and social protection [6, 22, 23]. These services should be delivered through accessible and acceptable models for refugee sex workers, including peer-led outreach, drop-in centers, mobile clinics, hotspot-based services, and differentiated service delivery.

The study also has important implications for PrEP programming. Women who report inconsistent condom use, exposure to violence, alcohol or drug use before sex, high client volume, or police harassment may benefit from intensified PrEP counseling and access. PrEP is particularly important because some women may not always be able to control condom use. However, PrEP should not replace condoms, as condoms also prevent other sexually transmitted infections and unintended pregnancy [23]. PrEP services should therefore be integrated with condom promotion, STI services, contraception, HIV testing, and violence response.

Trauma-informed care is also essential. Many refugee sex workers may have experienced violence before, during, and after displacement. Some may have experienced conflict-related trauma, intimate partner violence, client violence, police abuse, or community stigma. Health services should therefore be delivered in ways that promote safety, privacy, trust, choice, and respect. Judgmental treatment by health workers may discourage women from returning for HIV testing, ART refills, PrEP follow-up, STI treatment, or post-violence care. Therefore, training health workers in stigma reduction, key population-friendly care, and trauma-informed service delivery is necessary.

Some participants reported in qualitative interviews that health workers treated them badly because they were refugees, sex workers, or living with HIV. These experiences caused shame, fear, and avoidance of health facilities. One participant described a painful encounter at a health facility: "*I went to Naguru, I found a*

health worker… she said that 'Of what importance are you Congolese to Uganda? Why don't you die?'"" The participant explained that after being humiliated, she left without receiving services: "*I got ashamed and actually I left without getting them."* Another participant described how health workers sometimes abuse refugee women publicly: *"When some health workers get to know that you are a refugee, they abuse you before people, when everyone is hearing especially if you are positive*." Participants also reported being denied or discouraged from receiving services because of their nationality or sex work status. One participant who had gone for PEP said: "*I had gone to get PEP but she saw a Rwandese in me, she said that you Rwandese take our men… I left without getting it*." These experiences show that stigma and discrimination are major barriers to HIV prevention and treatment. Women may avoid services not because they do not need them, but because they fear humiliation, abuse, and exposure.

From a policy perspective, the study calls for stronger integration among HIV services, refugee health services, and protection systems. Female refugee sex workers often fall through the cracks of these systems. Refugee services may not be designed to address sex work-related risks, while key population programs may not fully address refugee-specific barriers such as documentation, language, mobility, and displacement-related trauma. Therefore, collaboration is needed among the Ministry of Health, Uganda AIDS Commission, Office of the Prime Minister, UNHCR, district health teams, implementing partners, sex worker-led organizations, and refugee-led organizations.

The findings also support community empowerment approaches. Evidence shows that community-led and community-empowerment interventions can improve condom use, increase service uptake, reduce violence, and strengthen collective agency among sex workers [10, 24]. For refugee sex workers, empowerment should include peer education, leadership development, legal literacy, savings groups, emergency support systems, safe spaces, and linkage to friendly health and protection services. Such approaches are important because they position sex workers not only as beneficiaries of services, but also as leaders in designing and implementing HIV prevention responses.

In conclusion, HIV prevalence among female refugee sex workers in Greater Kampala was high. Although lower than the 33% previously reported among female sex workers in Kampala, it remained much higher than in Uganda's general adult population. HIV prevalence was associated with inconsistent condom use, exposure to violence, alcohol use before sex, drug use before sex, high client volume, police harassment, older age, and lack of formal education. The interaction between violence and condom use showed that women who experienced violence and did not consistently use condoms had the highest HIV burden. These findings show that HIV prevention cannot succeed by focusing on individual behavior alone. Effective prevention must also reduce violence, protect rights, improve safety, address alcohol and drug use, reduce stigma, and ensure refugee-sensitive access to HIV services.

Strengths and Limitations

This study has several strengths. First, it focuses on female refugee sex workers, a highly vulnerable and often under-researched population within the HIV response. By examining HIV prevalence among refugee sex workers in Kampala, the study provides important evidence for a group that may be missed by both general refugee health programs and key population HIV programs.

Second, the study had a relatively large sample of 686 participants, which strengthens the reliability of the findings and enables meaningful analysis of demographic, behavioral, and structural factors associated with HIV infection. The inclusion of several

important variables, such as condom use, alcohol use before sex, drug use before sex, work-related violence, police harassment, and number of clients, provides a broad understanding of HIV vulnerability in this population.

Despite these strengths, the study also has limitations. First, the cross-sectional design limits the ability to establish causal relationships between the identified factors and HIV infection. The study can show that factors such as inconsistent condom use, exposure to violence, alcohol use, drug use, and police harassment are associated with HIV infection, but it cannot confirm that these factors directly caused HIV infection.

Second, some variables were self-reported, including condom use, alcohol use before sex, drug use before sex, exposure to violence, and police harassment. Because these are sensitive issues, participants may have underreported or overreported some experiences due to fear, stigma, recall difficulties, or social desirability bias. This may have affected the Overall, despite these limitations, the study provides valuable evidence on HIV prevalence among female refugee sex workers in Kampala. The findings inform targeted, rights-based, refugee-sensitive, and combination HIV prevention interventions.

Recommendations

1. Based on this study's findings, HIV prevention programs for female refugee sex workers in Kampala should adopt a comprehensive, rights-based, and refugee-sensitive approach. The high HIV prevalence observed in this population indicates that routine HIV services alone may be insufficient. Interventions should address both individual risk behaviors and the broader social and structural conditions that increase vulnerability to HIV infection.
2. HIV prevention services should expand access to condoms and lubricants. Because inconsistent condom use was strongly associated with HIV infection and had the highest population attributable fraction, programs should ensure a continuous supply of free condoms and lubricants at hotspots, drop-in centers, refugee-serving organizations, health facilities, and through peer educators. Condom promotion should also include practical counseling on condom negotiation, especially in situations where clients offer more money for condomless sex.
3. HIV programs should integrate violence prevention and response services. The study found that exposure to violence was associated with higher HIV prevalence and strengthened the link between inconsistent condom use and HIV infection. Therefore, services for female refugee sex workers should include routine screening for violence, post-violence care, post-exposure prophylaxis, psychosocial support, legal aid, and safe referral pathways. Health workers and peer educators should be trained to identify and support survivors of violence in a confidential, nonjudgmental manner.
4. Pre-exposure prophylaxis should be expanded among female refugee sex workers, especially those reporting inconsistent condom use, exposure to violence, alcohol or drug use before sex, high client volume, or police harassment. PrEP can provide additional protection for women who may not always be able to negotiate condom use. However, PrEP should be offered as part of combination prevention and should not replace condom use, STI screening, contraception, or regular HIV testing.
5. HIV services should address alcohol and drug use in a supportive, non-stigmatizing manner. Because alcohol and drug use before sex are associated with HIV infection, programs should include brief risk-reduction counseling, mental health support, harm-reduction messages, and

referrals to substance-use services as needed. Interventions should recognize that some women may use alcohol or drugs as a coping mechanism for stress, trauma, stigma, or difficult working conditions.

6. Peer-led and community-based interventions should be strengthened. Female refugee sex workers may be more willing to receive services from trusted peers who understand their lived realities. Peer educators can support HIV testing, condom and lubricant distribution, PrEP referral, ART adherence, STI screening, violence reporting, and psychosocial support. Programmes should also build the leadership capacity of refugee sex workers so that they participate meaningfully in designing, implementing, and monitoring HIV interventions.
7. Health services should be made more refugee-sensitive and more friendly to key populations. Health workers should be trained in stigma reduction, confidentiality, trauma-informed care, and respectful service delivery for sex workers and refugees. Services should be offered in accessible locations and, where possible, in languages understood by refugee communities. Mobile clinics, outreach services, flexible clinic hours, and drop-in centers may help reduce barriers to accessing services.
8. Programs should address police harassment and other human rights violations. Because police harassment is linked to HIV infection, there is a need to sensitize law enforcement officers on HIV prevention, human rights, gender-based violence, and the public health impact of punitive policing. Stronger collaboration is needed among health programs, legal aid providers, sex worker-led organizations, refugee-led organizations, and protection actors to ensure that female refugee sex workers can access services and report violence without fear.
9. HIV interventions should include economic strengthening and social protection support. Some refugee sex workers may accept unsafe sex or multiple clients because of financial pressure. Programmes should therefore explore linkages to livelihood training, savings groups, emergency support, food assistance, childcare support, and other social protection services. Although economic support alone may not eliminate HIV risk, it can reduce vulnerability and increase women's ability to make safer choices.

Conflict of Interest

The authors declare that they have no competing interests.

Acknowledgments

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Ethical Approval

To conduct the survey, ethical approval was obtained from the Kabale University Institutional Review Board and the survey was registered with the Uganda National Council of Science and Technology (UNCST). Additionally, permission was secured from the Most at Risk Population Initiative (MARPI). Participation in the survey was voluntary, and participants were fully informed about the study procedures, including the use of the ODK tool for quantitative data and audio recorders for qualitative data. Written informed consent was obtained from all participants using consent forms before any data collection interviews.

Measures were taken to safeguard personal identifiers and survey data involving human subjects. Participants' names were not linked to their responses, and all data files were stored on password-protected devices accessible only to

authorized members of the survey team. All staff involved in the study completed training and certification through the Collaborative Institutional Training Initiative (CITI), specifically the Information Privacy & Security (IPS) module and other relevant modules, such as Good Clinical Practice (GCP). Survey assistants without prior GCP training were required to complete it before participating in data collection training to ensure compliance with ethical standards throughout the survey.

Survey assistants also received training in interviewing techniques tailored for key and priority populations, with a focus on creating a supportive environment for interviews. All collected data will be securely stored and destroyed five years after the completion of survey activities.

Authors' Contributions

Pande Gerald conceptualized the study, prepared data collection instruments, collected data, and entered and analyzed it. Gerald also conceptualized the manuscript idea and took the lead in writing the manuscript.

Isunju John Bosco, Atulomah Nnodimele Onuigb, Kadama Herbert, Kyambadde Peter,Matsiko Livingstone, provided technical support during the protocol writing, data collection, entry and analysis. Isunju Jonhn Bosco, Mudiope Peter, Hudson Baliadawa participated in manuscript writing and reviewed the manuscript for intellectual content and scientific integrity. All authors read and approved the final manuscript.

Consent for Publication

The participants gave consent for direct quotes from their interviews to be published in the manuscript.

Data Availability

The datasets used and analyzed during this study are under the custody of the Principal Investigator, who is also the corresponding author. The data are not publicly available due to confidentiality and ethical considerations. However, anonymized data may be made available from the corresponding author upon reasonable request and subject to relevant ethical and institutional approvals.

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Applying Fuzzy Logic to Assess Socio-Technical Transitions Shaping WASH Sustainability in Lower Omo Valley, Ethiopia

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Abstract *This study applies a fuzzy logic modelling framework within a convergent mixed-methods design to assess the socio-technical determinants of water, sanitation, and hygiene (WASH) sustainability in Dassenech Woreda, South Omo Zone, Ethiopia. Sustainable WASH access remains a critical challenge across Sub-Saharan Africa due to environmental variability, weak governance systems, and socio-cultural complexity. To address these challenges, the study integrates quantitative data from 430 household surveys with qualitative insights derived from key informant interviews, focus group discussions, and ethnographic observation. A Mamdani-type fuzzy inference system was developed to model nonlinear interactions between technology appropriateness, community engagement, and institutional support. The results demonstrate that technology appropriateness is the most influential predictor of sustainability, although optimal outcomes occur only when all socio-technical variables interact synergistically. Defuzzification outputs reveal strong threshold effects, particularly when technology appropriateness exceeds 0.6. Qualitative findings further validate these results, emphasizing the critical role of indigenous governance systems in maintaining functionality and social legitimacy. This study contributes a novel methodological framework for analysing WASH sustainability under uncertainty and provides policy-relevant insights for climate-vulnerable pastoralist systems.*

Keywords *Ethiopia, Fuzzy Logic, Mixed Methods, Pastoralist Communities, Socio-Technical Systems, WASH Sustainability.*

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Introduction

Sustainable access to water, sanitation, and hygiene (WASH) services remains a persistent challenge across Sub-Saharan Africa, particularly in pastoralist regions characterized by high climatic variability, mobility patterns, and institutional fragility [2, 3]. In Dassenech Woreda, repeated failures of water supply systems highlight the limits of infrastructure-centric approaches that fail to integrate social, cultural, and governance dimensions. Environmental stressors such as droughts and floods, combined with weak service delivery systems, exacerbate the vulnerability of rural water infrastructure [9, 16].

Existing literature shows that rural WASH systems often fail because of weak governance, limited community ownership, and inappropriate technology selection [5, 11, 15].

Behavioural and socio-cultural factors further influence the adoption and sustainability of hygiene practices [7, 8, 19]. However, most prior studies rely on linear statistical models that cannot capture the inherent complexity, feedback loops, and threshold effects in socio-technical systems. These models often fail to represent uncertainty and nonlinear interactions among sustainability determinants.

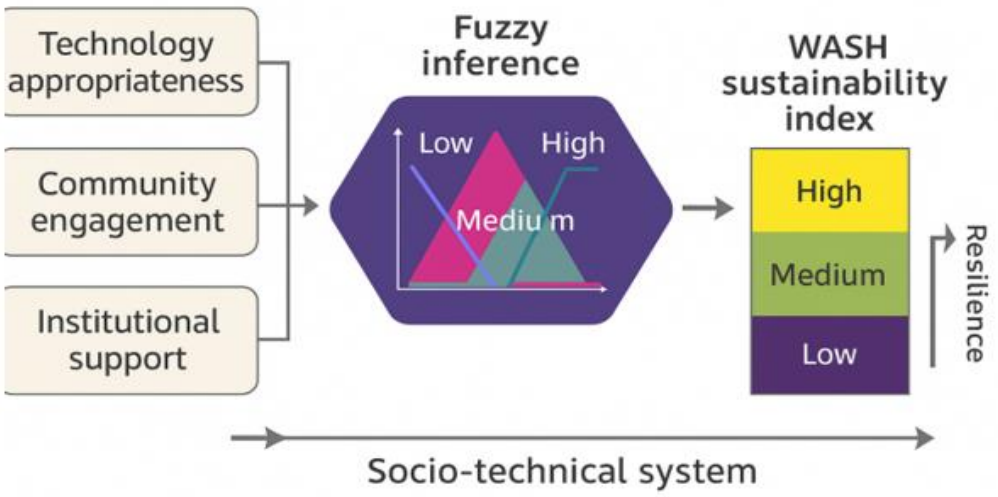


Figure 1. Sustainability Response Surface

This study addresses this methodological and empirical gap by applying fuzzy logic, originally conceptualized by Zadeh [1, 4], to model nonlinear socio-technical interactions. By integrating fuzzy logic with socio-technical systems (STS) theory [18] and a convergent mixed-methods approach, the research provides a comprehensive and context-sensitive framework for understanding WASH sustainability in pastoralist environments Figure 1. The study advances both theoretical and practical knowledge by demonstrating how adaptive, systems-based approaches can improve sustainability outcomes in resource-constrained and climate-sensitive settings.

Materials and Methods

Study Area and Context

The study was conducted in Dassenech Woreda, located in the South Omo Zone of southwestern Ethiopia. The region is predominantly inhabited by pastoralist and agro-pastoralist communities whose livelihoods depend on livestock mobility, seasonal water availability, and adaptive resource management strategies [3, 17]. The area experiences significant climatic variability, including recurrent droughts and flooding events, which contribute to infrastructure degradation and service disruption [9, 21].

Water supply systems in the region include boreholes, shallow wells, and river abstraction schemes. Despite ongoing development efforts, many of these systems experience frequent functionality failures due to environmental stress, inadequate maintenance capacity, and weak institutional support structures [10, 15]. Public health challenges such as diarrheal diseases and sanitation-related illnesses remain prevalent, underscoring the importance of sustainable WASH interventions [20, 22].

Study Design

A convergent parallel mixed-methods design enabled simultaneous collection and analysis of quantitative and qualitative data. This approach enables methodological triangulation, where qualitative insights contextualize and validate statistical findings. Quantitative data provide measurable relationships among key variables, while qualitative data capture the underlying social, cultural, and institutional dynamics that influence system performance.

The integration of these datasets at the interpretation stage enhances both analytical rigor and contextual validity. This design is particularly appropriate for complex socio-technical systems where purely quantitative or qualitative approaches would be insufficient to capture system behaviour.

Sampling Strategy and Sample Size

Quantitative Sampling

A total of 430 households were selected using a stratified random sampling technique to ensure representation across diverse socio-economic and geographic contexts. Stratification was based on proximity to water sources, livelihood type (pastoralist versus agro-pastoralist), and level of access to WASH infrastructure. This approach ensured statistical reliability and minimized sampling bias across heterogeneous population groups.

Qualitative Sampling

A purposive sampling strategy was employed to select participants with relevant expertise and lived experience. The sample included local government officials, water committee members, community elders, and representatives of women and youth groups. This ensured diverse perspectives, particularly from those involved in governance, system maintenance, and daily WASH practices.

Data Collection Methods

Household Survey

Quantitative data were collected through a structured questionnaire designed to assess system functionality, user satisfaction, community participation, perceived institutional support, and technology suitability. Responses were measured using Likert scales and subsequently normalized to a continuous range between 0 and 1 to ensure compatibility with fuzzy modelling techniques.

Qualitative Data Collection

Qualitative data were collected through key informant interviews, focus group discussions, and ethnographic observation. Interviews focused on governance structures, institutional challenges, and system management practices, while focus groups explored community perceptions and behavioural dynamics. Ethnographic observation provided insights into real-world usage patterns, maintenance behaviours, and informal governance mechanisms. All qualitative data were transcribed and analysed using thematic coding.

Variable Definition and Operationalization

The study examines three independent variables—technology appropriateness, community engagement, and institutional support—and one dependent variable, WASH sustainability. Technology appropriateness reflects how well infrastructure aligns with

environmental conditions, technical capacity, and user needs. Community engagement captures the extent of participation in planning, implementation, and maintenance processes. Institutional support refers to the availability of governance structures, financing mechanisms, and technical assistance.

WASH sustainability is conceptualized as a composite indicator encompassing system functionality, reliability, user satisfaction, and long-term operability. All variables were normalized to a continuous scale between 0 and 1 to facilitate integration into the fuzzy inference system.

Fuzzy Inference System Design

A Mamdani-type fuzzy inference system was developed to model nonlinear relationships among variables, consistent with established fuzzy logic methodologies [4]. Each variable was represented using triangular membership functions categorized into low, medium, and high linguistic levels. These functions were defined over the normalized interval to capture gradual transitions between states.

The rule base consisted of 12 IF–THEN rules derived from empirical data, expert knowledge, and qualitative insights. These rules capture interaction effects and conditional dependencies among variables. The inference mechanism employed the minimum operator for rule activation and the maximum operator for aggregation. Defuzzification was performed using the centroid method, producing a crisp output representing overall sustainability.

Statistical Analysis

Multiple linear regression analysis was conducted to estimate the relative contribution of each independent variable and to provide a baseline comparison with the fuzzy model. Regression coefficients were used to rank predictor importance and assess the consistency of findings across analytical approaches.

Data Integration and Validation

Quantitative and qualitative findings were integrated through triangulation. Statistical results identified dominant variables and threshold effects, while qualitative insights explained underlying mechanisms and contextual factors. Model validity was assessed through consistency between regression and fuzzy outputs, as well as alignment with field observations and stakeholder perspectives.

Ethical Considerations

The study adhered to established ethical standards. The study obtained informed consent from all participants, maintained confidentiality and anonymity, and allowed voluntary participation with the option to withdraw at any time.

Results

Regression Analysis

Regression analysis indicates that technology appropriateness is the strongest predictor of WASH sustainability ($\beta = 0.49$), followed by community engagement ($\beta = 0.42$) and institutional support ($\beta = 0.37$). These coefficients not only establish the relative importance of each variable but also demonstrate that sustainability outcomes are influenced by a combination of technical, social, and institutional dimensions rather than any single factor in isolation. The relatively higher coefficient for technology appropriateness suggests that the physical and operational suitability of WASH infrastructure—such as durability under climatic stress, ease of maintenance, and compatibility with local environmental conditions—plays a foundational role in determining whether systems remain functional over time.

Further interpretation of the regression model reveals that community engagement contributes significantly to improving system performance by fostering a sense of ownership,

enhancing routine maintenance practices, and facilitating collective action in resource management. However, its lower coefficient compared to technology appropriateness indicates that social participation alone cannot compensate for poorly designed or contextually inappropriate technologies. Institutional support, while ranking third, remains critical in providing technical expertise, financial resources, and governance oversight, which collectively enable system stabilization and long-term operability.

The combined explanatory power of the regression model highlights a multi-dimensional dependency structure, where improvements in one variable yield diminishing returns unless complemented by progress in others. This reinforces the premise that WASH sustainability is not linear but contingent upon balanced development across socio-technical domains.

Fuzzy Model Outputs

The fuzzy model reveals complex nonlinear dynamics that conventional regression analysis does not fully capture. Unlike linear models that assume proportional relationships, the fuzzy inference system identifies threshold effects and interaction patterns among variables, demonstrating that sustainability outcomes increase disproportionately once certain critical levels are achieved. In particular, the model shows that when technology appropriateness exceeds a threshold value of approximately 0.6, there is a marked and accelerated improvement in sustainability outcomes.

This nonlinear behaviour reflects the presence of tipping points within the system, beyond which incremental improvements produce significantly larger impacts. For example, moderate improvements in community engagement or institutional support yield limited benefits when technology appropriateness remains low.

However, once technological suitability reaches a functional threshold, the same levels of social and institutional inputs generate substantially higher sustainability outcomes. This indicates strong interaction effects, where variables reinforce each other rather than operating independently.

Additionally, the fuzzy model captures asymmetrical relationships, suggesting that deficiencies in one variable can disproportionately undermine overall system performance. For instance, high community engagement cannot offset the negative effects of unreliable or unsuitable infrastructure, while strong institutional support may fail to produce meaningful improvements in the absence of community participation. These findings underscore the importance of coordinated interventions that address all key determinants simultaneously rather than sequentially.

Defuzzification Results

Table 1. Defuzzification Results

T	C	I	Sustainability
0.2	0.3	0.2	0.25
0.6	0.5	0.4	0.52
0.7	0.7	0.6	0.68
0.9	0.8	0.8	0.87
0.4	0.8	0.7	0.60

The defuzzification results provide concrete numerical representations of sustainability outcomes under different combinations of input variables. These results illustrate the progressive improvement in sustainability as technology appropriateness, community

engagement, and institutional support increase. At low input levels (e.g., T = 0.2, C = 0.3, I = 0.2), sustainability remains minimal (0.25), reflecting fragile systems with high failure risk as mentioned Table 1.

As inputs reach moderate levels (T = 0.6, C = 0.5, I = 0.4), sustainability improves to 0.52, indicating partial functionality but still limited resilience. A more balanced and higher combination of inputs (T = 0.7, C = 0.7, I = 0.6) results in a substantial increase in sustainability (0.68), demonstrating the importance of synergy among variables. The highest observed sustainability value (0.87) occurs when all variables are simultaneously high, confirming that optimal outcomes depend on the alignment of technical, social, and institutional factors.

Interestingly, the scenario where community engagement and institutional support are relatively high (C = 0.8, I = 0.7) but technology appropriateness remains moderate (T = 0.4) yields only moderate sustainability (0.60). This further reinforces the dominant role of technology appropriateness and highlights the limitations of relying solely on social and institutional interventions without addressing technical suitability Figure 2.

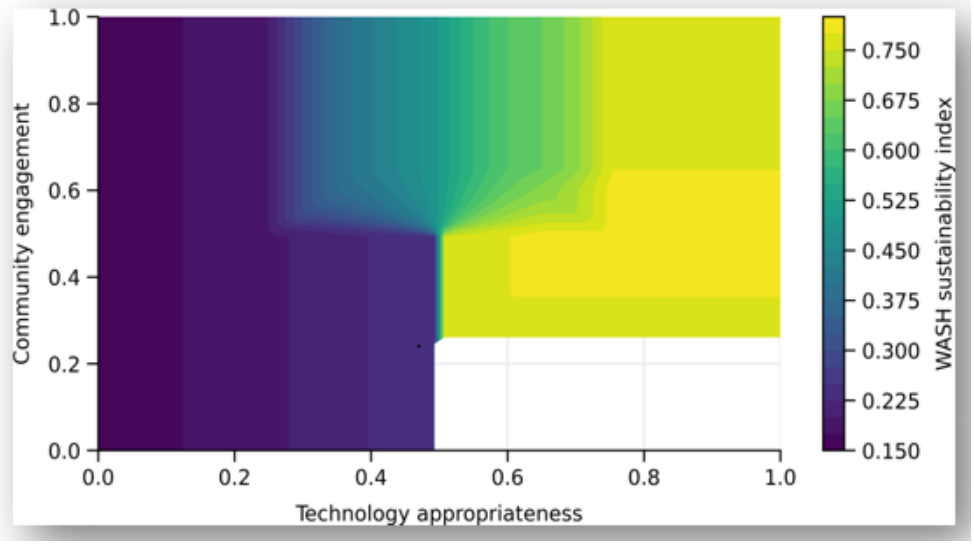


Figure 2. Sustainability Response Surface Showing the Interaction between Technology Appropriateness and Community Engagement at Institutional Support I = 0.6

Discussion

This study demonstrates that WASH sustainability in pastoralist systems is inherently nonlinear and context-dependent, reinforcing socio-technical systems theory [18]. The integration of regression and fuzzy modelling provides a more comprehensive understanding of system behaviour by capturing both linear trends and nonlinear interaction effects. The findings confirm that sustainability outcomes emerge from the interplay between technological, social, and institutional dimensions rather than from isolated interventions.

The dominance of technology appropriateness aligns with global evidence identifying inappropriate technologies as a major cause of rural water system failure [5, 6]. However, this study extends existing knowledge by showing that technological suitability alone is insufficient unless it is embedded within socially legitimate and contextually relevant governance systems. Technologies that fail to align with local capacities, environmental conditions, and user preferences are unlikely to be maintained, regardless of their technical sophistication.

Community engagement emerges as a necessary but insufficient condition for

sustainability. While active participation enhances ownership, accountability, and routine maintenance, it cannot compensate for fundamentally flawed infrastructure. This challenges widely held assumptions in development practice that community mobilization alone can ensure long-term system functionality [11, 12]. Instead, engagement must be complemented by appropriate technological design and institutional backing.

Institutional support functions as a critical enabling factor that stabilizes system performance under conditions of environmental and socio-economic stress. By providing technical expertise, regulatory oversight, and financial resources, institutions enhance the resilience and adaptability of WASH systems. Importantly, the fuzzy model demonstrates that institutional support amplifies the positive effects of both technology and community engagement rather than acting independently.

Qualitative findings further emphasize the importance of indigenous governance systems, particularly elder-based institutions, in regulating access, resolving conflicts, and ensuring compliance with maintenance norms. These culturally embedded structures provide legitimacy and continuity that formal institutions often lack, making them indispensable for sustainable WASH service delivery in pastoralist contexts [16, 17].

Global Comparison

Evidence from other pastoralist and semi-arid regions strongly supports and contextualizes these findings. In northern Kenya, sustainability outcomes improve significantly when water technologies are adapted to pastoral mobility patterns and supported by reliable supply chains, although externally imposed governance systems often lead to system breakdowns [6]. In Tanzania, community-managed water schemes demonstrate higher functionality when governance structures are embedded within customary institutions, highlighting the importance of aligning formal interventions with local socio-cultural systems [12].

Across the Sahel region, including countries such as Niger and Mali, climate variability exacerbates infrastructure failure risks, particularly in areas with weak institutional capacity. Programs that integrate climate-resilient technologies with strong local governance mechanisms consistently outperform infrastructure-focused interventions [13, 14]. Compared to these contexts, the Lower Omo case exhibits more pronounced threshold effects, likely due to extreme environmental variability and higher dependence on mobility-based livelihoods. These cross-regional comparisons reinforce the conclusion that sustainable WASH outcomes depend on the alignment of technology, governance, and community systems.

Policy Implications

The findings indicate that WASH interventions must move beyond linear and sector-specific planning models toward adaptive, systems-based approaches that account for complexity and uncertainty. Policymakers should prioritize achieving minimum thresholds of technology appropriateness before scaling up interventions, as suboptimal technologies significantly limit the effectiveness of social and institutional investments.

Investment strategies should emphasize climate-resilient, durable, and locally maintainable systems that align with the environmental and socio-economic realities of pastoralist communities. Strengthening linkages between indigenous governance structures and formal institutions is essential for improving accountability, legitimacy, and long-term sustainability. Furthermore, integrated socio-technical planning frameworks should be adopted to ensure that interventions simultaneously address technical, social, and institutional dimensions rather than treating them as separate components.

Methodological Contribution

This study demonstrates the practical applicability of fuzzy logic as an analytical tool in public health and development research, particularly in contexts characterized by uncertainty, data limitations, and complex system interactions. By integrating fuzzy modelling with conventional regression analysis, the study enhances both explanatory depth and analytical robustness.

The approach allows for the identification of nonlinear relationships, threshold effects, and interaction dynamics that are often overlooked in traditional statistical models. As such, it provides a more realistic representation of socio-technical systems and offers valuable insights for evidence-based policymaking and intervention design.

Limitations and Future Research

Despite its contributions, the study has several limitations. The use of simplified triangular membership functions may not fully capture the complexity and variability of real-world conditions. Additionally, the finite rule base limits the ability of the model to represent all possible interaction scenarios. The cross-sectional nature of the data also restricts the analysis of temporal dynamics and long-term system evolution.

Future research should incorporate sensitivity analysis to assess the robustness of model outputs under varying assumptions. Exploring alternative membership functions, such as Gaussian or trapezoidal forms, could improve model precision. Longitudinal datasets would enable the analysis of system dynamics over time, while integration with system dynamics or agent-based modelling approaches could further enhance predictive capability and policy relevance.

Conclusion

WASH sustainability in pastoralist systems is driven by complex and nonlinear interactions among socio-technical variables. This study demonstrates that fuzzy logic provides a robust and flexible framework for capturing these dynamics and translating them into actionable policy insights. The findings highlight that sustainable outcomes cannot be achieved through isolated interventions but require the coordinated alignment of appropriate technology, strong community engagement, and supportive institutional frameworks.

By advancing both methodological and empirical understanding, this research contributes to the development of more effective and context-sensitive strategies for improving WASH sustainability in climate-vulnerable and resource-constrained environments.

Conflict of Interest

The author declares no conflict of interest regarding the research, authorship, and/or publication of this article.

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Ethical Approval

This study was conducted in accordance with established ethical standards for research involving human participants. Ethical approval was obtained from the relevant institutional review board prior to data collection. Permission to conduct the study was also secured from the Dassenech Woreda administrative and sectoral offices, including the Water and Health Offices. Informed consent was obtained from all participants before their inclusion in the study, and respondents were assured of confidentiality, anonymity, and their right to withdraw at any stage without consequence.

Author Contributions

The author was solely responsible for the conception and design of the study, data collection, analysis and interpretation of results, and manuscript preparation. The author also approved the final version of the manuscript for publication.

Data Availability

The datasets generated and/or analysed during the current study are not publicly available due to confidentiality agreements with participants and local authorities but are available from the corresponding author on reasonable request. Qualitative data, including interview transcripts and focus group discussions, have been anonymized to protect participant identity.

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Systemic and Institutional Determinants of Cholera Transmission and Control in the Rohingya Refugee Camps, Cox's Bazar, Bangladesh

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Abstract *Cholera has persisted and periodically surged in the Rohingya refugee camps of Cox's Bazar, Bangladesh, despite sustained humanitarian investment, raising questions about the systemic factors that mitigate or enhance transmission. This study characterised the institutional and infrastructural determinants of cholera transmission and control through a synthesis of surveillance and programmatic data and a documentary review of the response architecture, 2018–2026. A multi-layered surveillance system combining community-based surveillance, indicator-based syndromic surveillance, sentinel rapid testing and laboratory confirmation underpinned outbreak detection. The syndromic burden of acute watery diarrhoea declined steadily, from approximately 231,000 cases in 2018 to approximately 122,000 in 2025, reflecting maturing water, sanitation and hygiene services. Culture-confirmed cholera nonetheless remained endemic with recurrent upsurges, the largest in 2024 (534 cases), demonstrating that infrastructural investment alone is insufficient. Rapid diagnostic test–positive counts exceeded but tracked culture-confirmed counts, indicating substantial laboratory confirmation capacity. Integrated reactive oral cholera vaccination, with coverage exceeding 90% in the 2025 campaign, was associated with rapid outbreak suppression. Persistent transmission was attributed to the fragility of water, sanitation, and hygiene gains against monsoon damage, residual point-of-use and foodborne pathways, a predominantly reactive posture, and funding volatility in a protracted crisis. The findings support a shift towards anticipatory, spatially and temporally targeted, integrated control, including environmental surveillance and preventive vaccination, sustained by predictable multi-year financing and strengthened health and water-sector coordination.*

Keywords *Cholera, Humanitarian Settings, Oral Cholera Vaccine, Rohingya Refugees, Surveillance, Water and Sanitation.*

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Introduction

Cholera in displaced populations is shaped not only by individual behaviour and the surrounding environment, but also by systemic factors: the adequacy and maintenance of water, sanitation and hygiene (WASH) infrastructure; the capacity and integration of surveillance; the timeliness and coverage of vaccination; the strength of intersectoral coordination; and the predictability of funding [1, 2]. The Rohingya refugee camps of Cox's Bazar, Bangladesh, which host approximately 1.2 million displaced people across 33 congested camps, have experienced endemic cholera with recurrent outbreaks since 2019, despite substantial and sustained humanitarian intervention [3, 4].

Following the influx in August 2017, WHO, in collaboration with the Civil Surgeon's Office, the Refugee Relief and Repatriation Commissioner, and the Health and WASH Sectors, established an Early Warning, Alert and Response System (EWARS) for acute watery diarrhoea (AWD) alert response; a joint assessment and response team led by the health and WASH sectors across camps, anchored in scenario-based multisectoral AWD/cholera preparedness and response plans; and a multilayered surveillance architecture for priority epidemic-prone diseases, including AWD and cholera [5, 6]. Substantial investment has also been made in WASH infrastructure, repeated oral cholera vaccination (OCV) campaigns, and coordinated outbreak response [7, 8]. Yet cholera has not only persisted but surged, with the 2024 outbreak the largest on record. This indicates that the systemic determinants of transmission and control are not fully understood [9].

Understanding these systemic determinants is essential because the effectiveness of interventions that interrupt cholera—surveillance, safe water, sanitation, hygiene, community-led and culturally appropriate risk communication, community engagement, and oral cholera vaccination—depends on the institutional capacity to deliver and sustain them [10, 11]. This study therefore characterised the systemic, institutional and infrastructural factors that mitigate or amplify cholera transmission and recurrent outbreaks in the Rohingya camps, drawing on a desk review of existing refugee camp-based surveillance data and programmatic reports, and a review of the response architecture based on structured key informant interviews with experts from humanitarian actors and local authorities, programme coordinators and field response teams, to inform a more anticipatory model for prevention and control.

Materials and Methods

Study Design and Setting

This study used a mixed-methods design, combining desk review and analysis of routine surveillance and programmatic reports with a documentary review of the surveillance and response architecture. Key informant interviews were conducted with programme designers, coordinators, and implementers from local authorities and humanitarian organizations involved in the Rohingya refugee crisis response in Cox's Bazar District, from 2018 to 2026. The camps are characterized by extreme density and fragile WASH services on flood-prone terrain [4].

Data Sources

Quantitative data comprised weekly acute watery diarrhoea (AWD) counts from indicator-based syndromic surveillance, weekly culture-confirmed cholera cases from laboratory surveillance, rapid diagnostic test (RDT)-positive AWD/suspected cholera case counts from sentinel surveillance, and programmatic records of oral cholera vaccine (OCV) campaigns. The documentary component reviewed the structure and functioning of the multi-layered surveillance system, WASH service delivery and maintenance, vaccination, and coordination

arrangements, triangulated with surveillance data.

Analysis

Surveillance data were cleaned and aggregated to annual totals to characterise long-term trends in AWD and confirmed cholera. We compared annual RDT-positive AWD/cholera suspects with culture-confirmed counts to assess diagnostic confirmation patterns. OCV coverage was summarised from campaign records and survey data. The surveillance architecture was described and mapped against the socio-ecological framework, which positions cholera transmission within nested household, community, institutional, and structural domains [12]. Descriptive results were cross-checked against operational WHO epidemiological bulletins. domains [12].

Results

The Multi-layered Surveillance and Early-warning System

The cornerstone systemic asset for cholera control was the multi-layered surveillance and response architecture established by WHO and partners (Figure 1; Table 1). The system integrated four complementary layers, each compensating for the weaknesses of the others: community-based surveillance, which extended reach into households and supplied timeliness; indicator-based syndromic surveillance through EWARS, which provided sensitive but non-specific trend signals; sentinel surveillance with RDT testing, which improved specificity; and laboratory culture confirmation, which improved specificity and definitive cholera diagnosis at the local Institute of Epidemiology, Disease Control and Research(IEDCR) field lab in Cox's Bazar [5, 6]. This integrated architecture was credited with relatively rapid outbreak detection and containment, while each layer retained its characteristic limitations in sensitivity, specificity, cost, or delay [13].

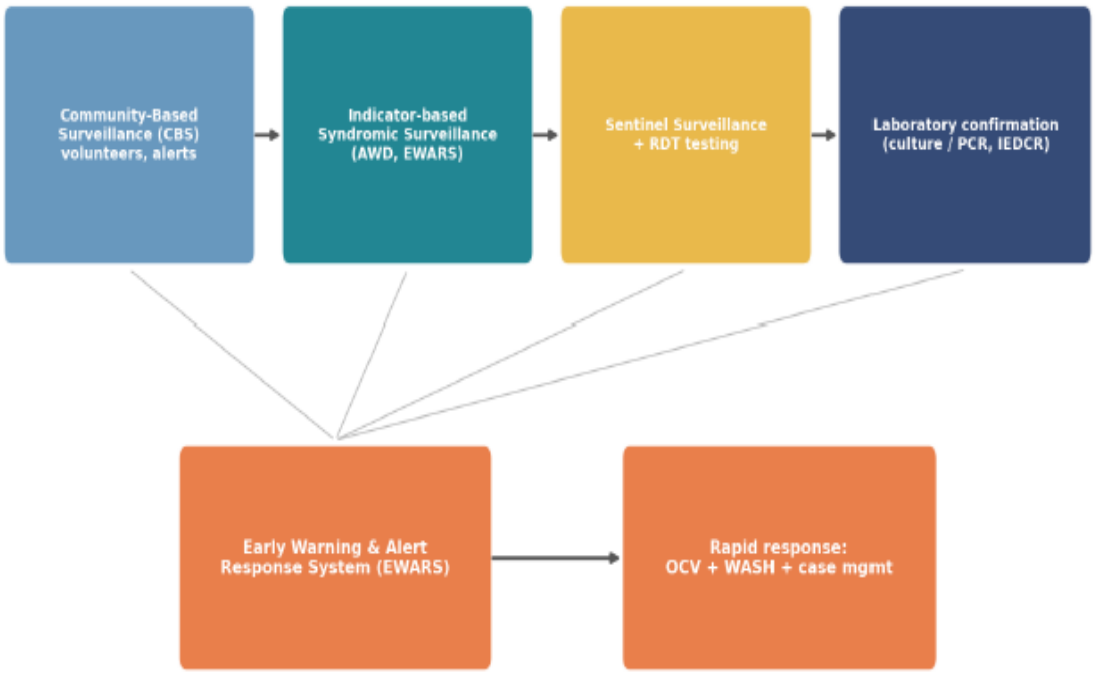


Figure 1. Multi-Layered Cholera Surveillance and Response Architecture, Rohingya Refugee Camps

Table 1. Layers of the Cholera Surveillance and Response System and their Functions

Surveillance Layer	Principal Function	Key Limitation
Community-based surveillance	Household-level signal detection: timeliness and wider population reach	Low specificity
Indicator-based syndrome (EWARS)	Weekly AWD trend monitoring: a sensitive signal	Non-specific
Sentinel surveillance with RDT	Point-of-care testing at designated sentinel testing sites, detection of suspected cholera cases, and a key trigger for alert response by joint assessment and response teams	Inadequate geographical coverage, gaps with testing positivity rates, and over-utilization of kits to test cases
Laboratory (culture)	Definitive confirmation of *Vibrio cholerae* is key for the indicator for the calibration of alert, action, and epidemic thresholds and outbreak declaration	Resource-intensive; delay; authorities reluctant to declare an outbreak once the epidemic threshold is surpassed
Environmental (wastewater) pilot	Early population-level warning signal	Logistics: scale-up needed, cost-benefit analysis must be explored

EWARS = Early Warning, Alert and Response System; RDT = rapid diagnostic test; AWD = acute watery diarrhea.

Water, Sanitation, and Hygiene Service Delivery

The steady decline in AWD over the study period was the clearest systemic success of the response (Figure 2; Table 2). Annual AWD fell from approximately 231,000 cases in 2018, when WASH services were in the early stage of development, to approximately 122,000 in 2025, a reduction of nearly half, attributable to the cumulative maturation of WASH infrastructure and services, robust preparedness and surveillance systems, expanded chlorination, improved latrine utilization, and sustained hygiene promotion [10]. However, culture-confirmed cholera remained endemic with recurrent upsurges, with the largest reported in 2024 (534 cases). This demonstrates that WASH infrastructure and services, emergency preparedness, and response-related investments alone are insufficient to extinguish cholera-specific transmission. The persistence of confirmed cholera despite falling AWD indicates residual transmission pathways—point-of-use recontamination, unsafe water and food at the point of consumption, and person-to-person spread that infrastructure alone could not close [11, 14].

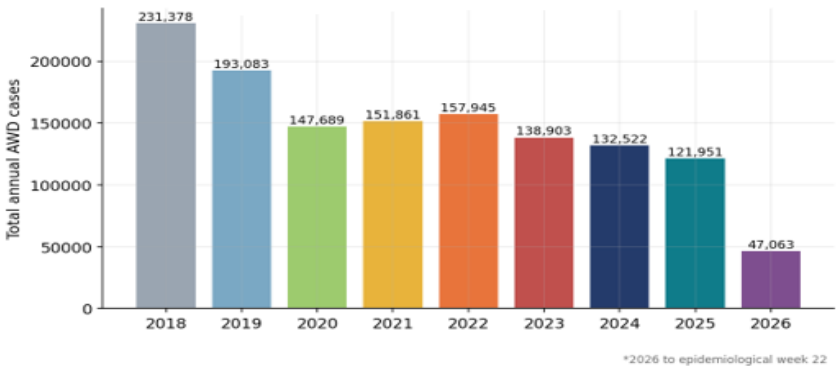


Figure 2. Annual Acute Watery Diarrhea Case Burden, 2018–2026

Table 2. Annual Acute Watery Diarrhea and Culture-Confirmed Cholera Burden, 2018–2026

Year	AWD Cases	Confirmed Cholera	RDT-Positive (Approx.)
2018	231,378	—	—
2019	193,083	183	260
2020	147,689	5	20
2021	151,861	136	210
2022	157,945	70	120
2023	138,903	81	140
2024	132,522	534	760
2025	121,951	59	95
2026*	47,063	8	15

**2026 data are partial (to epidemiological week 22). RDT = rapid diagnostic test; figures are approximate. AWD declined steadily while confirmed cholera fluctuated episodically.*

Diagnostic Confirmation Capacity

A comparison of annual RDT-positive and culture-confirmed counts clarified the diagnostic confirmation pathway (Figure 3). RDT-positive counts consistently exceeded culture-confirmed counts, as expected given the higher sensitivity but lower specificity of rapid testing, but the two series tracked one another closely, both rising sharply in 2024. This indicates that the culture-confirmed series reliably reflected the underlying epidemic dynamics while providing the specificity required for surveillance, and it further quantifies the substantial laboratory confirmation burden borne by the system during outbreak periods [13].

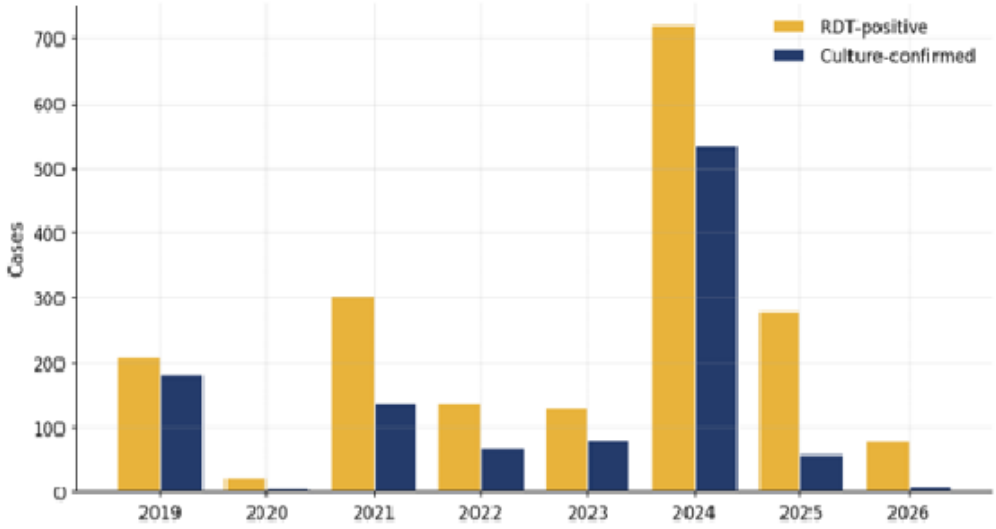


Figure 3. Rapid Diagnostic Test–Positive Versus Culture-Confirmed Cholera, by Year

Oral Cholera Vaccination

Oral cholera vaccine (OCV) was a decisive reactive tool. During the 2021 and 2024–2025 outbreaks, WHO-led health-sector teams rapidly deployed OCV campaigns closely integrated with water, sanitation, and hygiene (WASH) interventions, suppressing transmission within two to three weeks of campaign completion in affected camps [7, 8]. These campaigns achieved high administrative coverage: approximately 77–81% in 2021 and approximately 93–94% in January 2025.

Notably, these high coverage levels, although sustained for a few years, were gradually reduced by continued seeding of confirmed cases in camps. This is consistent with projected time-bound waning protection by OCV within a three-year window, pockets of children initially ineligible for vaccination who gradually entered the susceptible population over time, and a new influx of susceptible people during the 2024 wave with unverified vaccination status. This was further aggravated by suboptimal WASH infrastructure and services below SPHERE standards, reinforcing the well-established perspective that OCV is not a single magic bullet for cholera control and is most effective when integrated with appropriate WASH interventions rather than deployed alone [15, 16]. Documented seasonal transmission patterns support a shift from a predominantly reactive to an anticipatory vaccination strategy, timed to precede the high-risk season in the highest-burden camps [17].

Coordination, Governance, and Systemic Fragility

The response operated within a complex governance architecture involving the Government of Bangladesh, United Nations agencies, and numerous non-governmental partners coordinated through the Health and WASH Sectors [18]. Effective inter-sectoral coordination—particularly the integration of joint health and WASH assessment and response mechanisms at camp levels, the utilization of the early warning and alert response system (EWARS) data for rapid alert response, and seamless flow of tested samples from sentinel testing sites to the local field laboratory for confirmatory detection —was a critical enabler of rapid containment. The trusted and dedicated surveillance networks established by the WHO, a large pool of 1700 community health workers coordinated by community health working group partners, were indispensable to both surveillance and risk communication, complemented by the critical roles of hygiene promoters [19]. However, the study noted some unresolved gaps in the coordination of WASH and Health sectors, highlighted erratic coordination of joint WASH and health sectors' quarterly performance review meetings, and inconsistent sharing of surveillance data across the two sectors, limited engagement of the nutrition sector in cholera response, and a completely missing role of the meteorology department in plugging climate data to strengthen the early warning and surveillance information. Nevertheless, the Health Sector, through epidemiology, case management, and Infection Prevention and Control TWGs, has maintained the central coordination mechanism in AWD and cholera preparedness and response in close collaboration with the district civil surgeon for Cox's Bazar district, the Refugee Relief and Repatriation Commission (RRRC), the Directorate of Public Health Engineering, and the WASH sector. The second layer of AWD and cholera response comprises the emergency preparedness and response committee that domiciles the emergency mobile medical teams(eMMTs) and is closely linked to the district health emergency operation center (HEOC) to coordinate disaster risk management with secondary response to diseases like AWD and cholera after monsoon rainfall storms floods, and landslides in camps. These two sectors have an established linkage with community health working groups to coordinate community-level surveillance and community case management of AWD, and a risk communication and community engagement committee that rapidly develops and deploys culturally appropriate government-endorsed risk communication messages on cholera and other priority communicable diseases through various platforms that effectively reach the refugee population. The final consequential response piece is scaling up the OCV campaign, led jointly by the WHO's Immunization and Vaccines Development (IVD) unit, with support from epidemiology

and surveillance, communicable diseases services, local health authorities, and partners. The socio-ecological framework (Figure 4) situates these institutional factors between the structural conditions of displacement and climate and the proximate household behaviours, clarifying how systemic capacity mediates the translation of structural risk into protection. Across this, funding volatility and the crisis's protracted nature made systemic gains reversible: the camps' flood-prone terrain exposed WASH infrastructure to recurrent monsoon damage, and the sustainability of maintenance, surveillance, vaccination, and community engagement depended on predictable financing [20].



Figure 4. Socio-Ecological Framework of Cholera Transmission in Refugee Camps, Showing Nested Structural, Institutional, Community, and Household Domains

Discussion

This analysis explains why cholera has persisted despite genuine systemic progress. The decline in AWD demonstrates that WASH investment works; the persistence of confirmed cholera demonstrates that infrastructure alone is insufficient [10, 11]. The camps' flood-prone terrain renders WASH gains fragile and reversible, and the residual transmission pathways lie partly beyond the reach of infrastructure. The multi-layered surveillance system has enabled rapid detection and containment, and integrated reactive OCV has suppressed outbreaks quickly, but the predominantly reactive posture leaves the system perpetually responding to, rather than pre-empting, transmission [13, 17].

A central systemic insight is that WASH protection is not a stock but a flow: it must be continuously produced through chlorination, repair, desludging, and monitoring, and it degrades rapidly when any component lapses [14, 21]. The monsoon imposes an annual shock that degrades the system as transmission conditions build, so the protective margin is thinnest in the run-up to the high-risk season. Maintenance capacity – the human and financial resources dedicated to keeping the system functioning through the monsoon – is therefore as important a determinant of transmission as the capital infrastructure itself

and should be resourced and monitored accordingly [22].

Two enhancements to the surveillance architecture follow from the findings. First, environmental (wastewater) surveillance, piloted in selected camps, can provide an earlier, population-level warning signal by detecting *V. cholerae* shed by mild and asymptomatic infections that never reach the health system [23, 24]. Second, incorporating seasonal and climatic risk information as a predictive input could prime the system ahead of the high-risk season [17]. The protracted nature of the crisis creates tension between emergency and development modes of operation: effective interventions must be sustained, integrated, and anticipatory, yet the funding environment favours short, reactive cycles [20, 25]. Bridging this gap requires multiyear financing, institutionalised surveillance and WASH maintenance capacity, and planning horizons matched to the recurrent, seasonal nature of the threat. This study is limited by its reliance on routine surveillance data subject to under-ascertainment and by the descriptive, thematic nature of the systemic synthesis.

The community health-worker network warrants particular emphasis as a systemic asset that links the surveillance, WASH, vaccination, and risk communication functions at the household level where transmission ultimately occurs. Embedded within the community, these workers detect the earliest alerts, deliver targeted risk communication, support household water treatment and hygiene, and facilitate case-area interventions around confirmed cases [19]. Their effectiveness, however, depends not only on their presence but on the continuity of their training, supervision, supply, and remuneration, similarly to the surveillance networks that deliver technical response and support supervision in camps, all of which are vulnerable to the funding volatility that characterises the response. Investment in these networks is therefore a high-leverage component of an anticipatory strategy, because it operationalises the integrated control that the systemic analysis identifies as necessary. Sustaining it through predictable financing would convert an intermittently resourced asset into a durable backbone for cholera prevention and for epidemic preparedness more broadly.

Conclusion

A multi-layered surveillance architecture has enabled relatively rapid detection and containment of cholera outbreaks in the Rohingya camps, and integrated reactive vaccination has suppressed outbreaks quickly. Maturing WASH service delivery drove a steady decline in acute watery diarrhoea, but infrastructural gains remain fragile against monsoon damage and insufficient on their own to close point-of-use and foodborne transmission pathways, so confirmed cholera has remained endemic with recurrent upsurges. Effective health–WASH coordination and community engagement were critical enablers, while funding volatility and the protracted crisis rendered systemic gains reversible. The findings support a shift from reactive to anticipatory, spatially and temporally targeted, integrated control—incorporating environmental surveillance and preventive vaccination—sustained by predictable multi-year financing and strengthened coordination [17, 24]. Strengthening the maintenance capacity that keeps WASH systems functioning through the monsoon is as important as the capital infrastructure itself.

Conflict of Interest

The authors declare no conflict of interest.

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Author Contributions

David Odhiambo Otieno conceptualized the study, assembled and analysed the data, and drafted the manuscript. M. F. Khan and Manzur M contributed to the review of data collection tools and critical revision of the manuscript. R. Apolot, K. S. Kaddu and P. Abiodun contributed to interpretation and final revisions. All authors read and approved the final manuscript.

Ethical Approval

The study used routine, de-identified surveillance and programmatic data generated through the operations of the World Health Organization and partner institutions, used with appropriate authorisation for academic purposes. Ethical approval was secured from Cox's Medical College's Research and Ethics Committee and the Refugee Relief and Repatriation Commission (RRRC).

Data Availability

The aggregated surveillance and programmatic data analysed in this study are available from the corresponding author on reasonable request, subject to the data-sharing policies of the responsible institutions.

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Inadequate Housing and Physical Health Impairment among Low-Income Households: Evidence from a Pre-Intervention Study in Guyana

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Abstract *Housing conditions are important determinants of physical health, yet evidence from rapidly developing settings with persistent housing deficits remains scarce. We conducted a cross-sectional study to assess the housing adequacy factors associated with physical health impairment (PHI) among low-income households targeted for relocation under Guyana's Adequate Housing and Urban Accessibility Programme (AHUAP). We used pre-relocation data obtained from 127 applicants approved for the programme's Core Home subsidy from July 2025 to April 2026. PHI was defined as a Physical Component Summary (PCS-12) score ≤ 50. Associations were evaluated through chi-square analyses and multivariable logistic regression using a hierarchical modeling approach. The prevalence of PHI was 66.1% (95% CI: 57.8–74.5), while mean PCS-12 score was 42.0 ± 11.9. Most socio-demographic factors were not significantly associated with PHI ($p > 0.05$). However, males had lower odds of impairment than females (AOR=0.35, 95% CI: 0.14–0.90; $p = 0.028$), while households with vulnerable members had higher odds (AOR=2.67, 95% CI: 1.10–6.44; $p = 0.029$). Lack of durable material and poor structure quality (AOR=3.67, 95% CI: 1.48–9.14; $p = 0.005$) and insecure tenure (AOR = 2.76, 95% CI: 1.15–6.66; $p = 0.023$) were independently associated with impairment. Lack of electricity showed a strong association but was excluded from the final multivariable model due to complete separation. These findings underscore the importance of structural housing quality, tenure security, and social vulnerability to physical health outcomes. Longitudinal research is warranted to evaluate changes following relocation.*

Keywords *Guyana, Housing Inadequacy, Physical Health, Social Determinants of Health, Structural Housing Quality, Tenure Security.*

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Introduction

The relationship between living conditions and physical health remains a central concern in public health, particularly among low-income populations where environmental exposures and material deprivation are most pronounced. Housing conditions influence physical health not only through direct environmental risks, but also by shaping daily functions such as hygiene, nutrition, and exposure to disease [1]. While housing is widely recognized as a social determinant of health, much of the existing research has focused on general or mental health outcomes, with comparatively less emphasis on functional physical health status measured using standardized instruments such as the Physical Component Summary (PCS-12) of the Short Form-12 Health Survey (SF-12) [2, 3].

Globally, housing inadequacies continue to affect a substantial proportion of the population, with the greatest burden occurring in low- and middle-income communities where structural, infrastructural, and tenure-related deficits persist [4]. These inadequacies often manifest as poor structural quality, insufficient living space, insecure tenure arrangements, and limited access to essential services such as electricity, water, and sanitation. Such conditions create environments that facilitate the spread of infectious diseases, increase the risk of injury, and constrain the ability of individuals to maintain health-supporting behaviours [2]. Insecure tenure further limits households' capacity to invest in housing improvements, perpetuating exposure to unsafe living environments [5].

The pathways linking housing conditions to physical health are both direct and cumulative and may be modified by underlying social and household vulnerabilities. Substandard building materials expose occupants to environmental hazards such as dampness, extreme temperatures, and structural instability [6]. Overcrowding increases the likelihood of respiratory and infectious disease transmission, while inadequate water and sanitation contribute to gastrointestinal illness and other preventable conditions [7-9]. Limited access to electricity and clean fuel further compromises indoor air quality and food security, with implications for physical health outcomes [10-11]. These risks may be amplified in households with vulnerable members or among individuals with limited adaptive capacity, contributing to unequal health outcomes within similar housing environments.

In the Latin America and Caribbean region, rapid urban expansion has outpaced adequate housing provision, resulting in persistent infrastructure deficits in peri-urban communities [12]. A significant proportion of households continue to live in conditions that do not meet minimum adequacy standards, contributing to the burden of preventable diseases, including respiratory infections, vector-borne diseases, injuries, and gastrointestinal illnesses [13]. Despite ongoing investments in housing and urban development, empirical evidence linking housing conditions to measurable physical health outcomes remains limited.

In Guyana, these challenges are particularly evident in peri-urban areas, where low-income households often face structural inadequacies, overcrowding, insecure tenure, and exposure to flooding [14]. These conditions contribute to heightened vulnerability to disease and physical health impairment (PHI). National housing initiatives, such as the AHUAP, aim to address these deficits; however, evidence on baseline physical health status and its association with housing conditions remains scarce.

Existing studies frequently assess isolated housing characteristics, limiting understanding of how multiple deficiencies interact to influence physical health. Moreover, few studies have applied standardized health-related quality of life measures, such as the PCS-12, to examine these associations in low-income and rapidly transforming contexts. Accordingly, this study investigated the association between

the conditions of housing adequacy and PHI among low-income households in Guyana before relocation under a national housing programme. This studies therefore provides baseline empirical evidence to inform housing policy and intervention strategies that shape physical health outcomes in vulnerable settings.

Materials and Methods

Study Design and Settings

A baseline cross-sectional study was undertaken among low-income households approved for the Core Home subsidy under Guyana's AHUAP. Pre-relocation data were analyzed to investigate the association between housing adequacy and PHI among beneficiaries before relocating to their new Core Home unit.

Data collection was conducted between July 2025 and April 2026 across peri-urban communities within Regions 3 and 4. In Region 4, the study locations comprised Haslington, Good Hope, Vryheid's Lust, Industry, Sparendaam, Cummings Lodge along the East Bank Demerara (ECD), and Riverview, Mocha-Arcadia, Herstelling, Peter's Hall, Farm, Covent Garden, Prospect, Diamond, Grove along the East Bank Demerara (EBD). The study locations in Region 3 comprised La Parfaite Harmonie, Onderneeming, Recht door Zee, Westminster, and Lust-en-Rust along the West Bank Demerara (WBD).

The Central Housing and Planning Authority (CH&PA) delivers the programme's Core Home initiative, funded by the Inter-American Development Bank. The AHUAP targets vulnerable, low-income households residing in inadequate or uninhabitable dwellings. At the time of data collection, approximately 156 households, representing an estimated 504 individuals, were approved for a Core Home unit but had not yet relocated. This includes 57 households in WBD, 56 in EBD, and 43 in ECD.

The study communities experience a range of housing and infrastructure deficiencies, including overcrowding, insecure land tenure, lack of improved sanitation, poor structural housing quality, restricted access to essential services, and elevated environmental risks associated with environments that are vulnerable to flooding. These conditions provide a relevant context for investigating the association between housing adequacy and physical health outcomes before relocation.

The selected communities are characterized by multiple housing and infrastructure challenges, including overcrowding, insecure tenure arrangements, inadequate sanitation, substandard structural housing conditions, limited access to basic services, and heightened environmental risk associated with low-lying, flood-prone areas. These conditions provide a relevant context for examining the association between housing adequacy and physical health outcomes prior to relocation.

Study Population and Procedures

Study participants comprised principal applicants approved for a Core Home subsidy under the AHUAP who remained in their existing residences and had not yet relocated to their allocated housing units when data collection occurred. Information was collected through a one-time structured interview administered either face-to-face or by telephone according to each participant's preference.

Data were collected using a two-part questionnaire consisting of the Adequate Housing and Demographic (AHD) Survey and the SF-12 Health Survey. The AHD Survey gathered information on housing adequacy together with relevant sociodemographic and socioeconomic factors. Development of this instrument was informed by the World Bank's methodological framework for estimating adequate housing deficits within and across emerging economies [3]. Physical health was evaluated using the SF-12 Health Survey, from which PCS-12 scores were calculated [15].

Participants who had died or were unreachable because of inaccurate or obsolete contact details were excluded from the analysis.

Informed consent was obtained from all eligible participants before data collection commenced. To ensure that the findings represented pre-intervention conditions, all interviews were completed before participants relocated to their assigned housing units.

A complete list of eligible participants was obtained from the CH&PA and was periodically reviewed during this study to ensure the accuracy of participant contact details. Interviews were completed during regular working hours (Monday–Friday, 8:00 am – 4:00 pm).

Independent Variables

Independent variables were selected based on previous research examining the association between socioeconomic factors, housing conditions, and health outcomes. For analytical purposes, these variables were grouped into two categories: (1) sociodemographic factors and (2) housing adequacy conditions.

The sociodemographic factors evaluated in this study comprised age (24–35, 36–44, 45–54, 55–64, and ≥65 years), total size of household (1–3, 4–5, and ≥6 persons), gender (female or male), presence of vulnerable household members (yes/no), monthly household income (USD) (<300, 300–412, 413–600, and >600), employment status (employed or unemployed), household composition (extended, nuclear, or single-adult), and residence type (owner, renter, squatter, or residing with relatives or friends) [16-23].

The housing adequacy domain included seven indicators: improved water access (yes/no), improved sanitation access (yes/no), adequate living space (yes/no), durable material and good structural quality (yes/no), security of tenure (yes/no), electricity access (yes/no), and clean cooking access (yes/no) [10, 24-29].

Outcomes

Physical health status served as the primary study outcome and was assessed using the Physical Component Summary (PCS-12) score derived from the SF-12 instrument [30]. Scores were calculated and standardized according to established scoring procedures [15], yielding values that range from 0 to 100 units. Higher scores reflect better physical health.

For analyses, PCS-12 scores were dichotomized using a recommended cut-off [31]. Participants with scores ≤50 were classified as having PHI (coded as 1), while those with scores >50 were categorized as having better-than-average physical health (coded as 0).

Statistical Analysis

Descriptive statistics were generated for all variables included in the analysis. Continuous variables are presented as means, while categorical variables are summarized as proportions. The prevalence of PHI (PCS-12 ≤ 50) across independent variables was examined using chi-square analyses, which were also used to assess associations between the outcome and explanatory variables.

To assess the association between independent variables and PHI, binomial logistic regression analysis was conducted. The analysis followed a hierarchical modeling approach based on a conceptual framework, with stepwise variable selection used to guide model development [14]. The framework was structured into two levels to reflect the association between sociodemographic factors (Level 1) and housing adequacy conditions (Level 2) in influencing physical health outcomes (Figure 1).

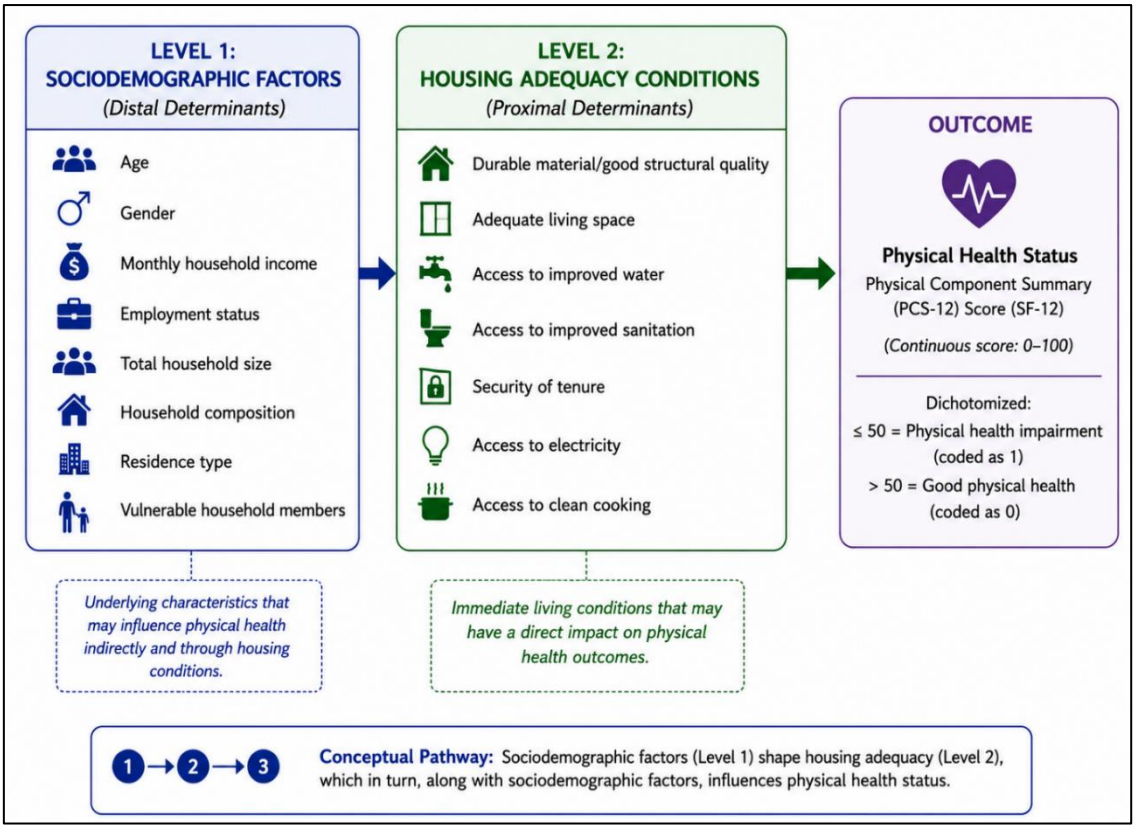


Figure 1. Conceptual Pathway Exploring the Association between Household Sociodemographic Factors, Housing Adequacy Conditions, and Physical Health

At Level 1, all sociodemographic variables were entered into the regression model. Variables with p-values <0.20 were retained, whereas those with p-values > 0.20 were removed sequentially, starting with the variable that had the largest p-value [14]. The resulting reduced Level 1 model, with retained variables, were carried forward to the next stage.

At Level 2, the sociodemographic variables retained from Level 1 were entered into the regression model together with the housing adequacy variables. The same stepwise selection procedure was then applied to derive the final model, with Level 1 variables retained irrespective of subsequent changes in statistical significance.

All statistical tests were two-tailed, with statistical significance set at $p < 0.05$. Multicollinearity among independent variables included in the final multivariate model was assessed using the Variance Inflation Factor (VIF). All VIF values ranged from 1.01 to 1.06, indicating no evidence of multicollinearity. All analyses were conducted using jamovi statistical software [32].

All statistical analyses were two-tailed, with statistical significance defined as $p < 0.05$. Multicollinearity among the independent variables retained in the final multivariate model was evaluated using the Variance Inflation Factor (VIF). VIF values ranged from 1.01 to 1.06, indicating that multicollinearity was not present. Statistical analyses were performed using jamovi statistical software [32].

Results

Between July 2025 and April 2026, 156 applicants were approved to receive a Core Home Subsidy but had not yet relocated under the AHUAP. One applicant (0.6%) was deceased, while 23 (14.7%) could not be contacted because of invalid contact information and were excluded from the study. The remaining 132 eligible applicants were

invited to participate, of whom 5 (3.8%) declined. Consequently, the final analytical sample comprised 127 participants, representing a response rate of 96.2%.

Table 1 summarizes the characteristics of the participants included in the study as well as the prevalence of PHI (PCS-12) according to each independent variable. The median age of participants was 55 years (IQR: 45–62), with a median monthly household income of USD 368 (IQR: 253–478) and a median household size of 3 persons (IQR: 2–5). The majority of participants were female (77.2%) and employed (66.9%), while 68.5% reported having at least one vulnerable member in the household. Most participants resided in nuclear households (44.1%) or lived with relatives or friends (40.9%).

In terms of housing conditions, most participants had access to improved water (86.6%) and improved sanitation (86.6%). However, substantial housing inadequacies remained: 74.8% lacked adequate living space, 74.8% lived in dwellings of poor structural quality, and 58.3% lacked security of tenure. Access to electricity (89.0%) and clean cooking (72.4%) were relatively high (Table 1).

Table 1 also shows that access to basic housing services was generally high, with 86.6% of participants reporting access to improved water and improved sanitation, and 89.0% and 72.4% having access to electricity and clean cooking, respectively. Despite these favorable indicators, housing inadequacies remained common. More than half of participants lacked adequate living space (53.5%), 74.8% lived in dwellings constructed of non-durable materials or with poor structural quality, and 58.3% lacked security of tenure.

The mean PCS-12 score was 42.0 ± 11.9. Overall, the prevalence of PHI (PCS-12 ≤ 50) was 66.1% (95% CI: 57.8–74.5).

Bivariate chi-square analyses showed no statistically significant association between PHI and the sociodemographic variables examined, specifically age, gender, income level, employment status, household size, and residence type ($p > 0.05$). However, there was demonstrated higher prevalence of PHI among females (70.4%) compared to males (51.7%) ($p = 0.075$), and among households with vulnerable members (71.3%) compared to those without (55.0%) ($p = 0.106$). Although these associations were not statistically significant ($p > 0.05$) they were retained for further analyses ($p < .20$). Differences were observed across household composition; however, these were not statistically significant ($p = 0.177$).

In contrast, several housing adequacy conditions demonstrated statistically significant associations with physical health outcomes. Participants living in dwellings made of non-durable materials and of poor structural quality had a significantly higher prevalence of PHI (71.6%) than those in durable housing of good structural quality (50.0%) ($p = 0.032$). Lack of access to electricity was also strongly associated with PHI, with all participants without electricity classified as impaired (100.0%) compared to 61.9% among those with access ($p = 0.002$). Security of tenure showed a borderline association with PHI ($p = 0.060$), with a higher prevalence among participants without secure tenure (73.0%) compared to those with secure tenure (56.6%).

Other housing adequacy variables, including access to improved water (65.5% vs. 70.6%; $p = 0.788$), improved sanitation (65.5% vs. 70.6%; $p = 0.788$), adequate living space (64.4% vs. 67.6%; $p = 0.711$), and clean cooking access (64.1% vs. 71.4%; $p = 0.531$), were not significantly associated with PHI.

Table 1. Sample Characteristics According to the Prevalence of PHI (July 2025 – April 2026).

Independent Variables	Description N (%)	Prevalence of Physical Health Impairment N (%)	p-value
Age			p = .910
24–35	8 (6.3)	5 (62.5)	
36–44	24 (18.9)	14 (58.3)	
45–54	26 (20.5)	18 (69.2)	
55–64	39 (30.7)	27 (69.2)	
>65	30 (23.6)	20 (66.7)	
Total Household Size			p = .826
1–3	65 (51.2)	39 (60.0)	
4–5	35 (27.6)	19 (54.3)	
>6	27 (21.3)	18 (66.7)	
Gender			p = .075
Female (0)	98 (77.2)	69 (70.4)	
Male (1)	29 (22.8)	15 (51.7)	
Vulnerable Household Members			p = .106
Yes (1)	87 (68.5)	62 (71.3)	
No (0)	40 (31.5)	22 (55.0)	
Monthly Household Income (USD)			
<300	47 (37)	35 (74.5)	p = .380
300–412	38 (29)	25 (65.8)	
413–600	32 (25.2)	18 (56.3)	
>600	10 (7.9)	6 (60.0)	
Employment Status			p = .693
Employed (1)	85 (66.9)	55 (64.7)	
Unemployed (0)	42 (33.1)	29 (69.0)	
Household Composition			p = .177
Extended Family	51 (40.2)	33 (64.7)	
Nuclear Family	56 (44.1)	41 (73.2)	
Single Adult Household	20 (15.7)	10 (50.0)	
Residence Type			p = .622
Reside with Friends or Relatives	52 (40.9)	36 (69.2)	
Owner	43 (33.9)	29 (67.4)	
Renter	27 (21.3)	15 (55.6)	
Squatter	5 (3.9)	4 (80.0)	
Improved Water Access			p = .788
Yes (1)	110 (86.6)	72 (65.5)	

No (0)	17 (13.4)	12 (70.6)	
Improved Sanitation Access			p = .788
Yes (1)	110 (86.6)	72 (65.5)	
No (0)	17 (13.4)	12 (70.6)	
Adequate Living Space			p = .711
Yes (1)	59 (46.5)	38 (64.4)	
No (0)	68 (53.5)	46 (67.6)	
Durable Material & Good Structural Quality			
Yes (1)	32 (25.2)	16 (50.0)	p = .032
No (0)	95 (74.8)	68 (71.6)	
Security of Tenure			
Yes (1)	53 (41.7)	30 (56.6)	p = .060
No (0)	74 (58.3)	54 (73.0)	
Electricity Access			
Yes (1)	113 (89.0)	70 (61.9)	p = .002
No (0)	14 (11.0)	14 (100.0)	
Clean Cooking Access			
Yes (1)	92 (72.4)	59 (64.1)	p = .531
No (0)	35 (27.6)	25 (71.4)	

Fisher Exact test was used to calculate the p-value.

The mean PCS-12 score in the study was 42.0 ± 11.9 units (Figure 2). The prevalence of PHI (PCS-12 ≤ 50) was 66.1% (95% CI: 57.8–74.5).

Multivariable logistic regression analysis (Table 2) identified several independent predictors of PHI. Among sociodemographic variables, the presence of vulnerable members in the household was significantly associated with increased odds of impairment (AOR = 2.67, 95% CI: 1.10–6.44; p = 0.029). Gender was also significantly associated with physical health outcomes, with males demonstrating lower odds of impairment compared to females (AOR = 0.35, 95% CI: 0.14–0.90; p = 0.028). Other sociodemographic variables were not significantly associated with PHI in the adjusted analysis.

Among housing adequacy conditions, lack of durable material and poor structural quality was a significant predictor of PHI, with participants residing in such dwellings exhibiting higher odds of impairment compared to those in in housing that is made of durable materials and has good structural quality (AOR = 3.67, 95% CI: 1.48–9.14; p = 0.005). Similarly, absence of secure tenure was independently associated with increased odds of impairment (AOR = 2.76, 95% CI: 1.15–6.66; p = 0.023).

Although lack of access to electricity demonstrated a strong association in chi-square analysis, it was not retained in the multivariable model due to complete separation, which prevented reliable estimation of adjusted effects.

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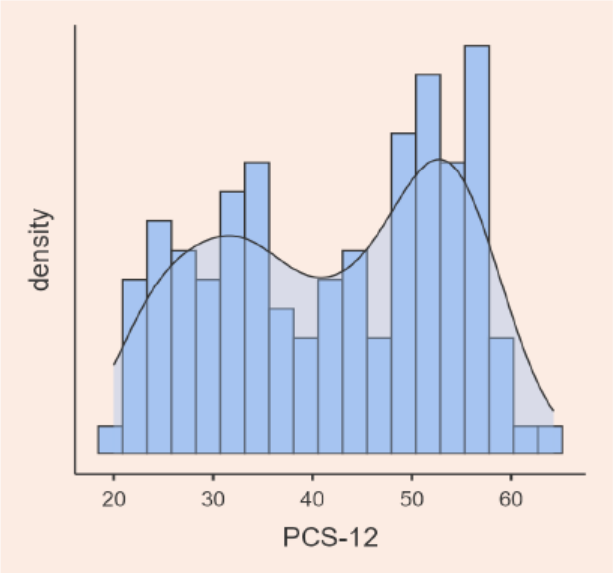


Figure 2. Distribution of PCS-12 Scores Among Participants between July 2025 and April 2026. Although the Shapiro–Wilk Test Indicated a Statistically Significant Departure from Normality (W = 0.939, p < 0.001), the Distribution Exhibited only Slight Negative Skewness (skewness = −0.174), Suggesting an Approximately Normal Distribution

Table 2. Logistic Regression Odds Ratios for Variables Associated with PHI

Independent Variables	COR (95 percent CI)	p-value	AOR (95 percent CI)	p-value
Age				
24–35	ref	.915		
36–44	0.84 (0.16–4.35)			
45–54	1.35 (0.26–7.07)			
55–64	1.35 (0.28–6.58)			
>65	1.20 (0.24–6.06)			
Total Household Size				
1–3	ref	.824		
4–5	0.87 (0.37–2.04)			
>6	1.22 (0.46–3.21)			
Gender				
Female (0)	ref	.065	ref	.028
Male (1)	0.45 (0.193–1.05)		0.35 (0.14–0.90)	
Vulnerable Household Members				
Yes (1)	2.03 (0.93–4.41)	.074	2.67 (1.10–6.44)	.029
No (0)	ref		ref	
Monthly Household Income (USD)				
<300	ref	.386		
300–412	0.66 (0.26–1.68)			
413–600	0.44 (0.17–1.15)			
Employment Status				
Employed (1)	ref	.627		
Unemployed (0)	1.22 (0.55–2.68)			

Household Composition				
Extended Family	0.67 (0.29–1.53)	.170		
Nuclear Family	ref			
Single Adult Household	0.37 (0.13–1.05)			
Residence Type				
Reside with Friends or Relatives	1.09 (0.46–2.59)	.568		
Owner	ref			
Renter	0.60 (0.22–1.63)			
Squatter	1.93 8 (0.20–18.92)			
Improved Water Access				
Yes (1)	ref	.678		
No (0)	1.27 (0.42–3.86)			
Improved Sanitation Access				
Yes (1)	ref	.678		
No (0)	1.27 (0.42–3.86)			
Adequate Living Space				
Yes (1)	ref	.700		
No (0)	1.16 (0.55–2.41)			
Durable Material & Good Structural Quality				
Yes (1)	ref	.028	ref	.005
No (0)	2.52 (1.11–5.74)		3.67 (1.48–9.14)	
Security of Tenure				
Yes (1)	ref	.056	ref	.023
No (0)	2.07 (0.98–4.37)		2.76 (1.15–6.66	
Adequate Electricity Access				
Yes (1)	ref	.987		
No (0)	2.61e+7 (0.00–∞)			
Clean Cooking Access				
Yes (1)	ref	.438		
No (0)	1.40 (0.60–3.27)			

Only variables with a p-value < 0.20 in the bivariate analysis were considered eligible for inclusion in the multivariable model.

Discussion

Our study provides baseline evidence on the association between housing adequacy and physical health among low-income households in Guyana prior to relocation under a national housing intervention programme. The findings indicate a substantial burden of PHI, with over two-thirds of participants classified as having PCS-12 scores ≤50 units.

Housing-related factors, particularly structural quality of the dwelling and security of tenure, emerged as significant predictors of physical health outcomes, while most sociodemographic factors showed limited influence. These findings reinforce the role of housing conditions as key determinants of physical health in resource-constrained settings [2-3].

The association between poor structural housing quality and PHI is consistent with existing evidence linking substandard construction materials and unsafe housing environments to adverse health outcomes. Dwellings constructed, which are of poor structural quality and constructed with non-

durable materials expose occupants to environmental hazards such as dampness, heat stress, and injury risks, all of which can impair physical functioning. Intervention studies, including programmes that upgrade flooring and structural components, have demonstrated reductions in parasitic infections, respiratory illness, and overall morbidity [33-34]. These findings support structural quality as a critical pathway through which housing conditions influence physical health.

Security of tenure also emerged as a significant determinant of physical health, highlighting the importance of residential stability and control over living conditions. Households lacking tenure security may face constraints in improving their dwellings or accessing basic services, thereby sustaining exposure to substandard environments. Empirical studies have shown that tenure security is associated with increased household investment in housing improvements, enhanced access to infrastructure, and improved health outcomes [35-36]. These findings reinforce the need to consider tenure security as a core dimension of housing adequacy.

The strong association observed between households that lack electricity access and PHI further underscores the importance of basic service provision. Although complete separation prevented reliable estimation of the adjusted effect, the finding that all participants without electricity were classified as physically impaired suggests a critical association. Access to electricity supports essential household functions, including lighting, food storage, and safe cooking practices, and has been linked to improved health outcomes [11, 37].

In contrast, other housing adequacy variables, including improved water and sanitation access and adequate living space, were not significantly associated with physical health outcomes. This may reflect the relatively high coverage of Government-led water and sanitation improvement programmes benefiting participants in Guyana [38], as well as reduced variability in household conditions, including declining household size [39], which may have limited the statistical power to detect differences. Still, extensive evidence demonstrates that water and sanitation improvements are strongly associated with reductions in infectious disease burden [8-9, 24], suggesting that their importance should not be discounted despite the lack of statistical significance observed in this study.

Sociodemographic factors showed limited influence on physical health outcomes in the adjusted analysis, apart from the presence of vulnerable members in the household, which was associated with increased odds of impairment. This may reflect the additional physical and resource demands placed on households with dependents, potentially affecting the health status of household members who assume caregiving responsibilities [40]. Gender was also significantly associated with PHI, with males exhibiting lower odds of impairment compared to females. This finding suggests that females may experience a greater burden of PHI, consistent with evidence that the health impacts of housing conditions may differ across genders due to underlying housing-related social and structural inequalities [18].

Taken together, these findings highlight the multidimensional nature of housing as a determinant of physical health. Structural quality, tenure security, and access to essential services operate through distinct but interconnected pathways to influence physical functioning. The results underscore the need for integrated housing policies that address both the physical attributes of dwellings and the institutional conditions governing access to housing and services [3-4].

From a policy perspective, these baseline findings provide critical insight into the pre-relocation conditions of beneficiaries targeted under national housing programmes implemented by the CH&PA. Rather than reflecting programme outcomes, the results

identify the structural and service-related deficits from which households are transitioning, thereby highlighting priority areas for intervention.

The association between inadequate structural quality and PHI underscores the importance of ensuring that newly delivered housing units meet minimum standards for durability and construction integrity. This reinforces the need for rigorous quality assurance during implementation, supported by systematic post-construction verification.

Similarly, the link between insecure tenure and poorer health outcomes highlights the importance of incorporating legally recognized, secure occupancy arrangements into housing delivery frameworks to promote long-term residential stability.

Access to essential services, particularly electricity, further underscores the need to provide integrated infrastructure alongside housing development. In peri-urban expansion areas, delays in utility access may limit potential health gains. Integrating health-sensitive housing indicators into programme design and monitoring systems would support evidence-based planning and strengthen the evaluation of post-relocation outcomes.

Limitations

This study is subject to several limitations. First, the cross-sectional design precludes causal inference between housing conditions and physical health outcomes. Second, the small number of participants in certain exposure categories, particularly those without access to electricity, may have reduced the precision of the estimated associations, resulting in wider confidence intervals in the regression models.

Third, although lack of access to electricity demonstrated a strong association with PHI in chi-square analysis, it was not retained in the multivariable model, primarily due to complete separation, which prevented reliable estimation of adjusted effects. Fourth, reliance on self-reported data introduces the potential for reporting bias, including inaccuracies in assessing physical health status. Finally, because the study was limited to applicants enrolled in a specific national housing programme, the findings may not be directly applicable to low-income populations outside comparable housing intervention settings.

Despite these limitations, this study contributes important baseline evidence from a rapidly developing setting where housing deficits remain substantial and empirical research examining the association between housing conditions and physical health remains scarce. These findings establish a benchmark for future longitudinal studies evaluating the health effects of housing interventions after relocation.

Conclusion

A substantial burden of physical health impairment was observed among low-income households awaiting relocation through Guyana's AHUAP, national housing intervention programme. Housing adequacy conditions, particularly durable materials and good structural quality, and security of tenure, emerged as key predictors of physical health outcomes, while most sociodemographic factors showed limited influence. However, the increased risk observed among female participants and households with vulnerable members indicates that physical health outcomes are not uniformly experienced, even within similar housing conditions, and should therefore be explicitly considered in the housing–health relationship.

These findings provide important baseline evidence from a rapidly developing context where housing-related disparities persist. They underscore the need to integrate structural housing quality and durability, and tenure security into national housing and development strategies, with particular attention to vulnerable groups. The study also lays the groundwork for future longitudinal analyses to

assess changes in physical health after relocation to improved housing conditions.

Conflict of Interest

The authors declare no conflict of interest.

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Ethical Approval

The Ministry of Health Institutional Review Board (MOH-IRB), Guyana (Protocol #101/2025), the Research Committee of Texila American University (Guyana Campus), and the Central Housing and Planning Authority granted ethical approval. The study adhered to all applicable ethical standards governing research involving human participants. We obtained informed consent from all participants before participation.

Author Contributions

SG conceptualized and designed the study, conducted the analysis, interpreted the findings, and drafted the manuscript. MOT contributed to the critical review of the manuscript and approved the final version.

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Data Availability

The dataset generated and analyzed during the current study has been de-identified and is available from the corresponding author upon reasonable request, in accordance with institutional data governance policies and ethical approval conditions.

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When Incident Rates Mislead: An Integrated Safety and Quality Analysis of FP/PAC Services in Sierra Leone

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Abstract *Safety monitoring in family planning (FP) and post-abortion care (PAC) services in low- and middle-income countries (LMICs) relies on safety flags and incident rates, yet these indicators are rarely interpreted together. This creates a risk that incident rate differences between service delivery channels may be misread as quality deficits when they reflect differences in service scope and case complexity. This study examined safety flags, incident rates, and quality assessment performance in an integrated framework across centre-based facilities and outreach teams in a Sierra Leone FP/PAC programme. A longitudinal observational analysis used 108 Quality Technical Assessment (QTA) records from 23 paired service delivery points across 14 districts (2019–2022). Safety flags and safety domain scores were compared between remote and in-person assessment modalities using chi-square and Mann-Whitney U tests. Clinical and product incident rates per 1,000 couple-years of protection (CYP) were compared between channels. Domain-specific QTA scores were compared across eight quality domains. Safety flags did not differ significantly between modalities ($p = .740$). Centre-based facilities showed significantly higher incident rates than outreach services ($U = 0.00$, $Z = -2.309$, $p = .021$, $r = -0.82$). Despite this, no significant channel differences were observed in composite QTA final scores ($p = .448$) or in any of the eight quality domains. The divergence between higher incident rates at centres and equivalent quality scores indicates the difference reflects structural differences in service scope and case complexity rather than quality deficits. These findings support integrated safety frameworks in reproductive health programme monitoring.*

Keywords *Incident Rates, Integrated Analysis, Post-Abortion Care, Quality Assessment, Safety Flags, Sierra Leone.*

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Introduction

Safety monitoring is a fundamental component of quality assurance in family planning (FP) and post-abortion care (PAC) services [6, 15]. In LMICs, service delivery spans heterogeneous channels—including hospital-level facilities, primary health centres, and community-based outreach teams—and safety data are routinely collected alongside structured quality assessments to provide a composite picture of service performance [1, 2].

Two categories of safety data are commonly collected in FP/PAC quality assurance systems: safety flags, which are assessor-identified observations of protocol deviations or risk conditions at the time of a supervisory visit; and incident rates, which are retrospective counts of adverse clinical or product events per unit of reproductive activity, expressed per 1,000 couple-years of protection (CYP) [3]. These indicators capture different dimensions of safety performance: safety flags reflect conditions for safe practice at the point of assessment, while incident rates reflect adverse outcome frequency across a service delivery period. Both are informative, but their interpretation can be misleading when analysed independently rather than in relation to each other and to the structural characteristics of the channels generating the data.

A particularly important interpretive challenge arises when incident rates differ across service delivery channels in programmes that simultaneously assess quality performance. If incident rates are higher at centre-based facilities compared with outreach teams, a naive interpretation might conclude that quality is worse at centres. However, this fails to account for systematic differences in clinical complexity, patient acuity, referral burden, and service scope [4, 5]. Centre-based facilities typically provide a broader range of clinical services, including surgical procedures, management of complex and referred cases, and care for clients with complicating factors that preclude community-based delivery. These structural differences generate higher incident counts that reflect service complexity rather than quality deficits [12].

The risk of misinterpreting incident rate differentials as quality differentials is amplified where these indicators are reported separately without analytical integration. Programme managers reviewing incident data without quality scores may draw incorrect conclusions that misdirect supervisory resources or trigger inappropriate corrective action at high-performing but clinically complex facilities [16].

Sierra Leone presents an important context for examining these questions. The country has a geographically dispersed health system across 16 districts, with FP and PAC services delivered through both static facilities and community-based outreach teams [13]. FP and PAC quality assurance in Sierra Leone has relied on structured Quality Technical Assessments (QTAs) conducted through both remote and in-person modalities [17].

This study addresses three specific questions using data from a Sierra Leone FP/PAC quality assurance programme. First, do safety flags or safety domain scores differ between remote and in-person assessment modalities? Second, do clinical and product incident rates differ between centre-based and outreach channels? Third, if incident rates differ by channel, are those differences accompanied by corresponding differences in quality assessment performance?

Materials and Methods

Study Design and Setting

This study used a longitudinal observational design, drawing on routine programme data from a quality assurance programme for FP and PAC services in Sierra Leone [13]. The programme covered 23 service delivery points over 2019 to 2022: 9 static health facilities (centre-based) and 14 community-based outreach teams across 14 active programme districts. Centre-based facilities provide the full

clinical scope of FP and PAC services, including surgical PAC procedures, implant and intrauterine device (IUD) insertion, and management of complex or referred cases. Outreach teams provide medical PAC, counselling, and non-surgical FP methods, and refer clients requiring surgical management to centre-based facilities or public-sector hospitals.

Data Sources and Variables

Three programme data sources were linked. The Quality Technical Assessment (QTA) dataset provided assessment-level safety flag records and domain-specific quality scores, including a composite QTA final score, across 108 facility-year-channel records. Safety flags were defined as assessor-identified deviations from protocol or risk conditions observed during the structured quality assessment visit. Incident data were derived from programme safety records capturing clinical incidents — defined as adverse events during or attributable to a clinical procedure — and product incidents, expressed as rates per 1,000 CYP by service delivery point, channel, and year. Assessment modality (remote versus in-person) was recorded for each QTA assessment cycle.

Statistical Analysis

Safety flags were compared between remote and in-person assessment modalities using Pearson chi-square analysis for presence or absence, and the Mann-Whitney U test for continuous safety domain scores and percentage of high-risk services observed. Incident rates were compared between centre-based and outreach channels using the Mann-Whitney U test, with effect size calculated as $r = Z/\sqrt{N}$. Domain-specific QTA scores were compared by channel across all eight quality domains using the Mann-Whitney U test. Statistical significance was set at $p < .05$. An integrated interpretation was applied by examining incident rate differences alongside quality performance simultaneously to assess whether higher incident rates were associated with lower quality scores in the same channel. All analyses were conducted using IBM SPSS Statistics.

Ethical Considerations

Ethical approval was granted by the Sierra Leone Ethics and Scientific Review Committee (SLESRC), Ministry of Health and Sanitation, Government of Sierra Leone (Reference No: 008/09/2022, extended to 20 July 2023). All data were de-identified secondary programme records. No individual-level client, provider, or assessor data are reported.

Results

Safety Flags by Assessment Modality

Safety flags were present in 28 of 72 in-person assessments (38.9%) and 12 of 36 remote assessments (33.3%). The difference was not statistically significant ($\chi^2 = 0.354$, $p = .740$), indicating that supervisory modality did not systematically influence whether safety issues were identified during assessment. Safety domain scores were also comparable between modalities ($M = 91.4$ for in-person versus $M = 92.8$ for remote; $U = 1{,}182.5$, $p = .312$), as were the percentage of high-risk services observed (14.2% versus 13.7%; $U = 1{,}254.0$, $p = .929$). Table 1 presents the full comparison.

Table 1. Safety Flags and Safety Domain Performance by Assessment Modality (N = 108)

Variable	In-Person (n = 72)	Remote (n = 36)	Statistic	p
Safety flags present, n (%)	28 (38.9%)	12 (33.3%)	$\chi^2 = 0.354$	.740
Safety domain score, M (SD)	91.4 (6.2)	92.8 (5.4)	U = 1,182.5	.312
% High-risk services observed, M (SD)	14.2 (8.9)	13.7 (9.1)	U = 1,254.0	.929

Note: *U = Mann-Whitney U statistic; χ^2 = chi-square. No statistically significant differences between modalities across any safety indicator.*

Incident Rates by Service Delivery Channel

Centre-based facilities showed significantly higher incident rates than outreach services across all four study years (U = 0.00, Z = −2.309, p = .021, r = −0.82, a large effect). Clinical incident rates at centre-based facilities ranged from 0.19 to 0.28 per 1,000 CYP across study years, compared with 0.01 to 0.02 per 1,000 CYP at outreach services. Product incident rates were consistently lower than clinical incident rates in both channels and near-zero at outreach settings. Table 2 presents incident rates by channel and year.

Table 2. Clinical and Product Incident Rates per 1,000 CYP by Service Delivery Channel and Year (2019–2022)

Channel / Year	Clinical / 1,000 CYP	Product / 1,000 CYP	Total / 1,000 CYP	n
Centre-based — 2019	0.21	0.04	0.25	9
Centre-based — 2020	0.19	0.02	0.21	9
Centre-based — 2021	0.28	0.03	0.31	9
Centre-based — 2022	0.24	0.02	0.26	9
Outreach — 2019	0.02	0.01	0.03	14
Outreach — 2020	0.01	0.01	0.02	14
Outreach — 2021	0.01	0.00	0.01	14
Outreach — 2022	0.01	0.00	0.01	14
Channel comparison (U test)	U=0.00, Z=−2.309	—	p=.021*, r=−0.82	—

Note: *CYP = couple-years of protection. *p < .05. Large effect size (r = −0.82) for channel comparison.*

QTA Quality Performance by Service Delivery Channel

Despite significantly higher incident rates at centre-based facilities, no statistically significant differences were observed in composite QTA final scores between channels (p = .448). This pattern held consistently across all eight quality domains. Clinical governance scores did not differ significantly by channel (p = .677), nor did product quality (p = .657), client-centred care (p = .275), total services section score (p = .890), medical PAC (p = .469), implant insertion (p = .988), or IUD insertion (p = .273). Table 3 presents quality scores by domain and channel.

Table 3. QTA Domain-Specific Performance Scores by Service Delivery Channel (N = 108)

QTA Domain	Centre M (SD)	Outreach M (SD)	U	p
QTA Final Score	92.1 (4.8)	92.5 (4.3)	1,276.5	.448
Clinical Governance	91.3 (5.1)	91.8 (4.7)	1,301.0	.677

Product Quality	93.2 (4.2)	92.9 (4.5)	1,290.0	.657
Client-Centred Care	90.8 (5.9)	91.9 (5.2)	1,188.0	.275
Total Services Section Score	92.4 (4.6)	92.7 (4.1)	1,256.0	.890
Medical PAC Score	91.9 (5.3)	92.3 (4.9)	1,241.0	.469
Implant Insertion Score	92.6 (4.4)	92.6 (4.3)	—	.988
IUD Insertion Score	91.4 (5.7)	92.1 (5.1)	—	.273

Note: *M = mean; SD = standard deviation; U = Mann-Whitney U statistic. No domain showed a statistically significant difference by channel.*

Integrated Interpretation

The findings across the three analytical components are internally consistent and interpretively important. Centre-based facilities generated significantly higher incident rates than outreach services, yet their assessed quality performance was statistically indistinguishable from outreach teams across every quality domain measured. This divergence is inconsistent with a quality deficit explanation, which would predict higher incident rates alongside lower quality scores. The observed pattern is instead consistent with a service scope and case complexity explanation: centre-based facilities provide surgical PAC, manage clinical complications and referrals from outreach settings, and care for a client population with systematically higher clinical risk profiles, generating structurally higher incident counts under equivalent quality conditions [18].

This interpretation is further supported by the safety flag analysis. If centre-based facilities were providing lower-quality care, one would expect higher rates of safety flag identification at those facilities. No such pattern was observed. Safety flags were distributed without significant difference between modalities, and safety domain scores were equivalent between assessment types. The absence of any quality signal accompanying the elevated incident rates at centres reinforces the conclusion that the incident rate differential is a structural caseload phenomenon rather than a quality performance deficit [19].

Discussion

This study provides integrated evidence that incident rate differences between centre-based and outreach FP/PAC service delivery channels in Sierra Leone reflect structural differences in service scope and case complexity rather than quality deficits. Centre-based facilities generated significantly higher incident rates than outreach teams across all four years examined yet showed statistically equivalent quality assessment performance across all eight quality domains. This pattern — divergent incident rates, equivalent quality scores — has important implications for how safety data are monitored and interpreted in reproductive health programmes in LMICs [12].

The core finding aligns with evidence from health systems research showing that case-mix complexity is a primary determinant of adverse event rates in clinical settings, independent of quality of care [4, 5]. In reproductive health, the distinction between facility and community service delivery creates predictable structural differences in the acuity and complexity of client populations each channel serves. Community-based outreach services are typically designed to reach lower-risk clients and to refer clinically complex cases to higher-level facilities [14]. The higher incident rates observed at centres—particularly for clinical incidents, which were 14 to 28 times higher per 1,000 CYP at centres than at outreach sites—are consistent with this structural model and corroborate findings from comparable sub-Saharan African reproductive health programmes [7, 20].

The finding that safety flags did not differ between remote and in-person assessment modalities adds an important complementary dimension. If supervisory modality had influenced safety detection — for example, if remote assessors were systematically less likely to identify safety concerns because they could not observe physical environments directly — this would undermine the validity of remote assessment for safety monitoring. The absence of any modality effect on safety flags, safety domain scores, or percentage of high-risk services observed confirms that remote quality assessment captures safety-relevant information with fidelity comparable to in-person assessment [8, 9]. This supports the use of remote assessment as a legitimate safety monitoring mechanism in LMIC FP/PAC programmes, which is particularly important as remote and hybrid supervisory models become more widely adopted globally [21].

The integrated analytical approach employed in this study addresses a methodological gap in reproductive health programme monitoring. Most published quality monitoring studies report safety indicators separately, leaving programme managers without guidance on how to reconcile divergent patterns [10]. The risk of misinterpretation is not trivial: a programme manager reviewing incident data without quality scores might conclude that centre-based facilities require intensive corrective action when they are in fact performing well under structurally demanding conditions [16]. The integrated framework demonstrated here provides a more analytically sound basis for safety-informed programme management and is consistent with calls for comprehensive quality monitoring frameworks in LMICs [15, 22].

These findings also have implications for the construction of channel-sensitive safety benchmarks in LMIC reproductive health monitoring systems. If centres and outreach teams are held to the same incident rate benchmarks, centres will systematically appear to underperform not because they provide lower-quality care, but because they manage a more clinically complex population [11]. Channel-specific benchmarks that account for differences in service scope, clinical risk profile, and referral burden would provide a more equitable and defensible basis for performance monitoring. This is consistent with broader evidence that standardised performance benchmarks without case-mix adjustment can systematically penalise facilities managing higher-acuity populations [4, 23].

Strengths and Limitations

This study benefits from a longitudinal four-year dataset that allows incident rates to be examined for consistency across time and by channel, and from the simultaneous analysis of safety flags, incident rates, and quality scores within the same dataset—a methodological strength comparatively rare in reproductive health monitoring literature [10]. Coverage of all 23 service delivery points across 14 districts provides geographic representativeness within the programme context.

Several limitations should be acknowledged. The study relies on routinely collected programme data, which may contain reporting inconsistencies. Incident rates are facility-level aggregates and do not enable case-level analysis of specific clinical or procedural factors driving individual incidents. The interpretation of higher centre-level incident rates as a case complexity effect is plausible and internally consistent with the quality data but cannot be formally tested without individual patient-level clinical records documenting case acuity, referral status, and procedure type [24]. The study is conducted in a single programme context in Sierra Leone; whether similar patterns hold in other West African or LMIC FP/PAC programmes remains to be tested. Future research should incorporate case-level clinical data and formally decompose the structural and quality-related components of channel-level incident rate variation [25].

Conclusion

Centre-based FP/PAC facilities in Sierra Leone showed significantly higher incident rates than community-based outreach services over the four-year study period yet demonstrated equivalent quality assessment performance across all eight quality domains measured. This pattern indicates that the incident rate differential reflects structural differences in service scope and case complexity rather than quality deficits. Safety flags did not differ between remote and in-person assessment modalities, confirming that supervisory modality does not influence safety detection and supporting the validity of remote quality assessment as a safety monitoring tool.

For programme managers and monitoring system designers, these findings underscore the importance of interpreting safety indicators in an integrated framework that considers quality assessment performance alongside incident rates and accounts for channel-specific differences in clinical scope and patient complexity. Developing channel-sensitive safety benchmarks would reduce the risk of misclassifying complex, high-performing facilities as poor performers on the basis of elevated incident counts. For the broader literature on reproductive health quality monitoring, this study demonstrates the analytical value of integrated safety frameworks that treat incident data and quality assessment findings as complementary rather than independent sources of evidence.

Conflict of Interest

The authors declare that they have no conflict of interest.

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Ethical Approval

Ethical approval was granted by the Sierra Leone Ethics and Scientific Review Committee (SLESRC), Ministry of Health and Sanitation, Government of Sierra Leone (Reference No: 008/09/2022, extended to 20 July 2023). This study used de-identified aggregated secondary programme data; no individually identifiable participant data were used or reported.

Author Contributions

- **Onunkwor, F.I.:** Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing – Original Draft.
- **Paul, A.O.:** Supervision, Writing – Review and Editing.
- **Aguolu, R.:** Formal Analysis, Writing – Review and Editing.

All authors approved the final manuscript and take responsibility for its content.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to the de-identified secondary programme data arrangement with the implementing organisation.

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Macro-Level Health Financing Trends and Household Financial Catastrophe in Nigeria: A Multi-Method Analysis of Institutional Reforms, 2000-2023

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Abstract *Safety monitoring in family planning (FP) and post-abortion care (PAC) services in low- and middle-income countries (LMICs) relies on safety flags and incident rates, yet these indicators are rarely interpreted together. This creates a risk that incident rate differences between service delivery channels may be misread as quality deficits when they reflect differences in service scope and case complexity. This study examined safety flags, incident rates, and quality assessment performance in an integrated framework across centre-based facilities and outreach teams in a Sierra Leone FP/PAC programme. A longitudinal observational analysis used 108 Quality Technical Assessment (QTA) records from 23 paired service delivery points across 14 districts (2019–2022). Safety flags and safety domain scores were compared between remote and in-person assessment modalities using chi-square and Mann-Whitney U tests. Clinical and product incident rates per 1,000 couple-years of protection (CYP) were compared between channels. Domain-specific QTA scores were compared across eight quality domains. Safety flags did not differ significantly between modalities ($p = .740$). Centre-based facilities showed significantly higher incident rates than outreach services ($U = 0.00$, $Z = -2.309$, $p = .021$, $r = -0.82$). Despite this, no significant channel differences were observed in composite QTA final scores ($p = .448$) or in any of the eight quality domains. The divergence between higher incident rates at centres and equivalent quality scores indicates the difference reflects structural differences in service scope and case complexity rather than quality deficits. These findings support integrated safety frameworks in reproductive health programme monitoring.*

Keywords *Incident Rates, Integrated Analysis, Post-Abortion Care, Quality Assessment, Safety Flags, Sierra Leone.*

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Introduction

Nigeria, Africa's most populous country with over 220 million people as of 2023, bears a disproportionately high burden of both communicable and non-communicable diseases [1, 2]. The country is among the eight nations that accounted for two-thirds of global tuberculosis cases [3] and continues to experience some of the highest rates of HIV and malaria in sub-Saharan Africa. Despite this disease burden, the health system remains chronically under-resourced and structurally fragmented, a paradox that has attracted sustained attention from policymakers and global health organizations.

Health care in Nigeria is funded through a mix of government taxes, out-of-pocket payments, social and community health insurance, private funding, donor support, and government support [4-6]. Although responsibility is shared among federal, state, and local governments, this setup has led to poor coordination, an unfair distribution, and families still having to pay out of pocket [7]. As a result, in 2017, Nigeria's out-of-pocket health spending accounted for more than 75 percent of total health expenditure, placing it among the highest globally [8].

Universal Health Coverage (UHC) refers to ensuring that all individuals and communities receive the health services they need without suffering financial hardship [9, 10]. To reach UHC, health financing systems must be sufficient, fair, and protective; these are standards that Nigeria's current system does not meet. The share of households facing catastrophic health costs rose from 16.4% in 2009/2010 to 48% in 2015/2016 [11]. Almost 40% of Nigerians live in poverty [12], and high out-of-pocket payments continue to impoverish families [13]. High OOP expenditure (resulting from low public health expenditure) contributes to the inaccessibility of health services and to inequitable and inefficient health financing [5].

Since 1999, Nigeria has made several major changes to its health financing policies, including five key policies that explicitly commit to specific levels of health care financing and should have affected health spending. These are the previous National Health Insurance Scheme (NHIS) law of 1999, now replaced by the National Health Insurance Authority (NHIA) Act 2022; the National Health Act (NHA) 2014, which encompasses the Basic Health Care Provision Fund (BHCPF); the National Health Policy (NHP); the 2016 National Health Financing Policy and Strategy (NHFPS); and the 2018 – 2022 National Strategic Health Development Plan II (NSHDP II). In this study, we merged these into four periods: the period from 2000 to 2005, covering the NHIS and the Abuja Declaration commitment in 2001, which stipulated that 15% of GDP be allocated to health; the period from 2006 to 2013, covering the post-implementation of NHIS, which started in 2005; the third period, from 2014 to 2019, covering the National Health Act (2014), which enshrines Nigeria's commitment to universal health coverage (UHC) and provides the legal framework for the operation of the health system in Nigeria, and the COVID-19 pandemic; and the fourth period, from 2000 to 2023, covering the most recent, the National Health Insurance Authority (NHIA) Act of May 2022, which, for the first time, made health insurance contributions mandatory, and the post-COVID-19 era [5, 6]. This study examines whether these laws have actually improved financial protection for households.

Existing Solution

Nigeria's future path can still change. Thomas-McLean et al. cited Costa Rica, Ghana, Rwanda, Sri Lanka, and Thailand as successful Universal Health Coverage (UHC) systems, crediting their success to shared risk pools, smart buying of services, strong primary care, and responsible governance. In contrast, Nigeria is grouped with Chad and India as a low

performer and does not exhibit these features to the same extent [14]. Importantly, the World Health Organization's 78th World Health Assembly resolution on health financing in 2025 supports this study's recommendation. The resolution calls on countries to pool government funds, including mandatory insurance, to lower out-of-pocket costs when people receive care [15]. Evidence from this study, other research, and global experience points to one conclusion: health financing must change, and government leadership is key.

Purpose and Objectives

This study examines trends in Nigeria's health financing from 2000 to 2023. The analysis follows these specific objectives:

1. To describe and quantify the key components and trends in Nigeria's health financing from 2000 to 2023 using GHED data.
2. To assess the burden of OOP health expenditure relative to international benchmarks across the full study period and four policy sub-periods.
3. To examine macroeconomic and health system correlates of OOP expenditure using correlation and bivariate regression analysis.
4. To test whether institutional reform transitions produced statistically significant changes in financing indicators using Wilcoxon signed-rank tests and effect size analysis.

Study Rationale and Novelty

Previous global studies, such as Micah et al., offer broad cross-national data on health spending trends but lack the Nigeria-specific detail necessary for effective policymaking [16]. This study addresses this gap by providing a multi-indicator, single-country longitudinal analysis using the most recent GHED release in December 2025 [8], encompassing ten financing indicators across four institutionally defined eras. Unlike studies limited to one or two outcome measures, this research reports on a comprehensive set of indicators relating to financial protection and evaluates the impact of each legislative reform transition. Additionally, the correlation analysis extends beyond income as the sole measure of vulnerability, instead examining structural financing composition as the primary determinant of household OOP burden. This approach more precisely identifies actionable policy levers for Nigerian decision-makers.

Materials and Methods

Data Source

This study uses secondary data from the WHO Global Health Expenditure Database (GHED), December 2025 release [8]. The GHED provides comparable health expenditure data for 195 countries from 2000 onward, underpinned by the System of Health Accounts 2011 methodology developed jointly by WHO, OECD, and Eurostat [8]. The main study period is 2000 to 2023, covering 24 annual observations for Nigeria, divided into four policy sub-periods aligned with key institutional milestones (Table 1).

Table 1. Analytical Sub-Periods and Policy Rationale

Policy Era	Years	Policy Rationale
Post-Abuja Declaration	2000–2005	Abuja Declaration (April 2001) commits Nigeria to a 15% health budget target. NHIS Act (1999) was enacted but non-operational throughout this period.
NHIS Voluntary Operations (Pre-reform)	2006–2013	NHIS formal operations commence (2005); voluntary enrolment remains below 5%; structural decline in

		GGHE-D; 2008 global financial crisis; GDP rebasing (2014).
Post-National Health Act (Post-NHIA)	2014–2019	National Health Act signed October 2014; BHCPF established; operationalization commences 2018–2019; NHIS voluntary framework continues.
COVID-19 Pandemic and NHIA Act	2020–2023	COVID-19 fiscal disruption (2020–2022); NHIA Act signed May 2022, introducing mandatory contributory insurance; 2023 is the first full year under the new framework.

Indicator Selection

Ten GHED indicators were selected based on their theoretical roles as predictors of household financial catastrophe or measures of OOP burden (Table 2). Out-of-pocket expenditure (OOPS) and out-of-pocket health expenditure (OOPHE) are used interchangeably throughout the study. In the correlation and regression analyses, oops_che is the primary outcome, and gghed_che is the primary predictor; all 10 indicators are examined simultaneously in the heatmap analysis.

Table 2. Primary GHED Indicators Used in the Analysis

Indicator	Variable Name	Code	Primary Analytic Role
OOP expenditure as a share of CHE	Out-of-pocket (OOPS) as % of Current Health Expenditure (CHE)	oops_che	Primary dependent variable/outcome
OOP per capita (constant 2021 USD)	Out-of-Pocket Expenditure (OOPS) per Capita in US$	oop_pc_usd	Secondary outcome: absolute per-person burden
Current health expenditure(CHE) as % of GDP	Current Health Expenditure (CHE) as % of Gross Domestic Product (GDP)	che_gdp	System scale control; secondary outcome (crowding-out)
GGHE-D as a share of CHE	Domestic General Government Health Expenditure (GGHE-D) as % Current Health Expenditure (CHE)	gghed_che	Primary independent variable: government financing share
GGHE-D as a share of GDP	Domestic General Government Health Expenditure (GGHE-D) as % Gross Domestic Product (GDP)	gghed_gdp	Secondary predictor: fiscal effort
GGHE-D per capita (PPP, constant 2021 USD)	Domestic General Government Health Expenditure (GGHE-D) per Capita in US$	gghed_ppp_pc	Secondary predictor: fiscal capacity
Social health insurance as a share of CHE	Social Health Insurance (SHI) as % of Current Health Expenditure (CHE)	shi_che	Secondary predictor: risk-pooling depth

Private domestic prepayment as a share of CHE	Domestic Private Health Expenditure (PVT-D) as % Current Health Expenditure (CHE)	pvtd_che	Secondary predictor: voluntary insurance contribution
External health financing as a share of CHE	External Health Expenditure (EXT) as % of Current Health Expenditure (CHE)	ext_che	Secondary predictor: donor dependency
CHE per capita (constant 2021 USD)	Current Health Expenditure (CHE) per Capita in US$	che_pc_usd	Control variable: total system scale

Note: *oops_che is the primary dependent variable; gghed_che is the primary predictor. gghed_gdp, gghed_ppp_pc, shi_che, pvtd_che, and ext_che are secondary predictors. che_gdp and che_pc_usd are system-scale controls.*

Data Preparation

Raw GHED data were downloaded in CSV and XLSX formats and processed using Python. Data preparation followed structured steps. First, the data were extracted by selecting Nigeria and the relevant available annual GHED indicator values for 2000 to 2023. Both reported and modeled values were retained, with modeled observations clearly flagged. Secondly, we assess the completeness of each indicator for the study period, ensuring that all variables have no missing data. The third stage involves monetary standardization, in which all per capita monetary values were converted to constant 2021 international dollars using Gross Domestic Product (GDP) deflators and Purchasing Power Parity (PPP) factors from the IMF World Economic Outlook [17]. The conversion formula is given as:

$$Value_{constant,\ 2021} = Value_{current} \times \frac{GDP\_Deflator_{2021}}{GDP\_Deflator_{current\ year}} \quad (1)$$

Descriptive summaries were also computed, and time-series analyses, along with other statistical methods, were employed in the study. For the trend analysis, annual values for each primary GHED indicator were plotted, with vertical lines marking the four policy-relevant eras (Table 1). LOESS (Locally Estimated Scatterplot Smoothing) regressions were then overlaid to reveal underlying directional trends without forcing a linear shape on the data [20]. Annualized percentage changes were also computed for each indicator and each sub-period (Table 1) using a log-linear regression framework. For any variable Y over a period t_1 to t_2, the annualized growth rate (g) is derived from the regression of $\ln(Y_t)$ on t, where

$$In(Y_t) = a + \beta t + \epsilon_t \quad (2)$$

We then compute the growth rate g as:

$$g = (e^{\beta} - 1) \times 100\ \% \quad (3)$$

Furthermore, we assessed the correlation and bivariate association using Pearson (linear) and Spearman (rank) correlation coefficients. The results were displayed using panel figures.

In the study, an autoregressive distributed lag (ARDL) model was used to identify macro-level GHED indicators that most likely predict the trajectory of OOPHE as a share of CHE in Nigeria. This method is particularly suitable because it handles small-sample time series with potentially non-stationary variables of mixed integration orders [18]. The general equation for the ARDL model is given as:

$$OOPHE_t = \alpha_0 + \sum_{i=0}^{p} \beta_i OOPHE_{t-1} + \sum_{j=0}^{q1} \gamma_j GGHE_{t-j} + \sum_{k=0}^{q2} \delta_k Z_{t-k} + \epsilon_t \quad (4)$$

Where $OOPHE_t$ is the OOPHE share of CHE in year t, $GGHE_t$ is GGHE-D as a share of CHE, and Z_t is a composite vector summarizing SHI, private domestic prepayment, and external financing shares. The lag orders p, q1, and q2 were chosen by grid search over (p, q1, q2) ∈ {0, 1, 2} with AIC minimization, which conserves degrees of freedom in the 24 samples.

To examine the effects of different legislative health financing milestones and macroeconomic shocks, a comparative assessment was conducted across the four analytical sub-periods. This was achieved by estimating mean values and confidence intervals, conducting Wilcoxon signed-rank tests, and calculating effect sizes for the samples using Cohen's d. Cohen's d is computed as the difference of means divided by the pooled standard deviation. Effect sizes are interpreted with the standard thresholds (negligible $d < 0.2$, small $0.2 \leq d < 0.5$, medium $0.5 \leq d < 0.8$, large $d \geq 0.8$).

All analyses are implemented in Python and were executed in a Google Colab environment. Core libraries, scipy.stats (Wilcoxon, t-tests, bootstrap statistics), seaborn, and matplotlib. Intermediate datasets, tables, and figures are saved to a structured output folder.

While the study aims to answer the predefined questions, it is constrained by the aggregate indicator level. This is because the GHED indicators are national totals and cannot capture sub-national variation across Nigeria's 36 states and the FCT. Macro-level findings should be read alongside available household survey evidence from the National General Household Survey [11]. Also, the results are presented as longitudinal associations; therefore, causality is constrained by the observational time-series design and the limited set of instruments, which precludes causal inference. Legislative milestones are treated as quasi-experimental events, but concurrent macroeconomic confounding factors cannot be fully accounted for. The 2023 modeled estimate also has limitations for this study. The 2023 GHED data rely on WHO-modeled estimates due to the usual two- to three-year national health accounts compilation lag. Sensitivity analyses excluding 2023 are reported alongside the primary results to show how much that single observation drives the findings. Finally, we also report the limitations of this study since we used the catastrophic-expenditure proxy. Direct CHE incidence data from household surveys are available for Nigeria only for 2010/2011 and 2015/2016. GHED OOPHE indicators are therefore used as a macro-level proxy for catastrophic-expenditure risk, in line with standard practice [19].

Limitations

Covers both the 2023 modeled-estimate issue and the deeper problem that GHED OOP figures are macro-level proxies rather than household-level CHE incidence measures. Future research should focus on annual or biennial household panel surveys as the only way to track whether the NHIA Act actually reduces catastrophic household expenditure.

GHED indicators are national totals and cannot capture differences across Nigeria's 36 states and the Federal Capital Territory; results should be considered alongside household survey data of 2010/2011 and 2015/2016. The results show associations over time; the study's design and limited tools do not allow for proving cause and effect. Legislative milestones are treated like natural experiments, but economic factors may still affect results. The 2023 GHED data are WHO estimates waiting for the usual two-to-three-year update; tests excluding 2023 data are included. Direct data on catastrophic health spending from household surveys are available only for 2010/2011 and 2015/2016; GHED out-of-pocket indicators are used as broad substitutes, following standard practice [19].

Results

Descriptive Statistics and Benchmark Comparison

Figure 1 describes the percentage of longitudinal annual bar graphs of Nigeria's health financial indicators from 2000 to 2023. The CHEs are dominated by out-of-pocket health expenses (oops_che). This financial indicator starts at 60.1% in 2000, rises to a maximum percentage in 2017 (77.4%), and slightly drops by 7% (71.9%) in 2023, though

2022 was 75.7%. On the other hand, domestic government general health spending as a share of CHE (gghed_che) shows a weak, decreasing trend, from 26.9% in 2001 to 14.3% in 2023. The other indicators, such as external health financing (ext_che) and social health insurance (shi_che), remain below 10% across all 24 years of the data. In addition, comparing national wealth (che_gdp) and health expenditures shows fluctuations, with little or no increase, within a narrow band that remains below the recommended 5% level throughout the time series.

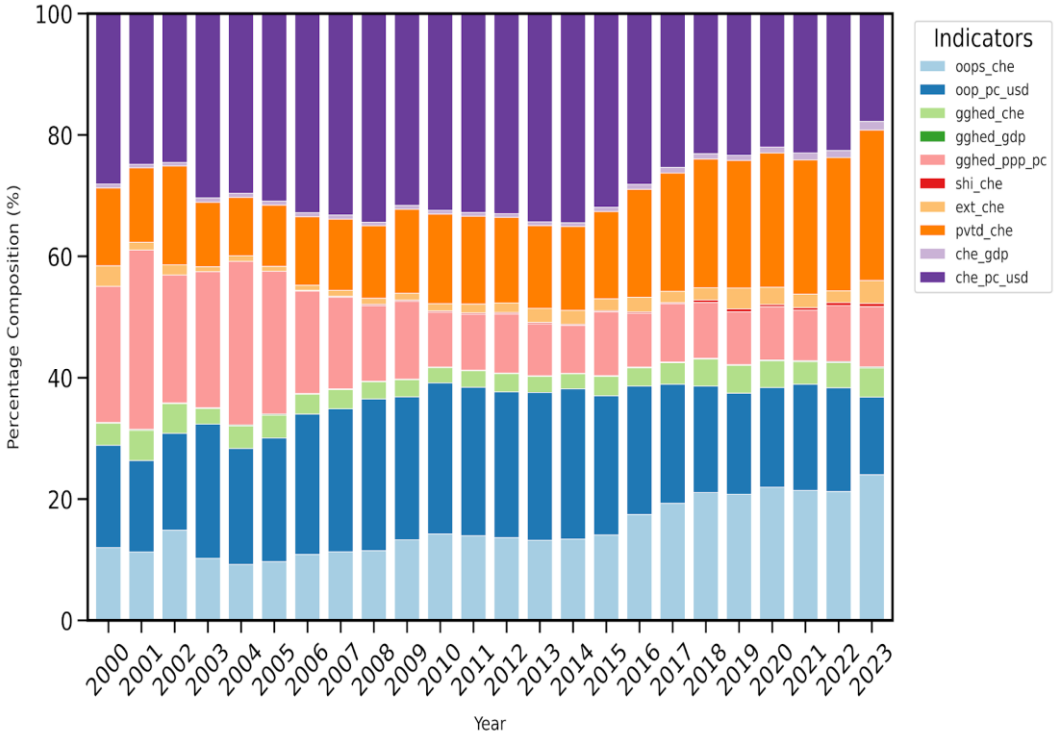


Figure 1. Longitudinal Annual Percentage Composition of Nigeria's Key Health Financing Indicators from 2000 to 2023

Table 3. Descriptive Statistics and WHO Benchmark or Global Target

Indicator	WHO/Global Target	Mean	SD	Variance	Min	Median	Max
che_gdp	≥5–6% GDP	3.7	0.6	0.3	2.5	3.6	5.1
che_pc_usd	≥USD 86	148.9	54.4	2957.1	53.3	169.3	218.4
gghed_che	≥50–60%	17.3	4.1	17.2	13.0	16.0	26.9
gghed_gdp	≥5%	0.6	0.2	0.0	0.4	0.6	1.2
gghed_ppp_pc	≥USD 86	74.4	49.6	2459.6	29.7	50.7	188.9
shi_che	≥20–30% CHE	0.9	0.6	0.3	0.0	1.1	1.7
ext_che	≤5%	8.4	2.9	8.3	5.4	7.5	17.0
pvtd_che	5–15% complementary	74.3	4.0	16.0	64.7	74.9	80.1
oops_che	≤15–20%	71.5	4.8	23.4	60.2	72.3	77.4
oop_pc_usd	Below gghed_ppp_pc	105.9	38.3	1467.2	38.3	122.9	158.9

Note: *Nigeria's indicators do not meet WHO benchmarks for all primary financial protection measures. Critically, oop_pc_usd (mean USD 105.9) exceeds gghed_ppp_pc (mean USD 74.4), representing a structural financing inversion in which households individually outspend the government on healthcare.*

Table 3 presents full descriptive statistics for all ten indicators across 2000–2023, benchmarked against WHO targets.

Table 3 compares the econometric assessment of national health financing indicators with established WHO target thresholds, means, deviations, and system variances. The results indicate that Nigeria fails to meet WHO benchmarks. This is evident in public health spending averaging only 0.6% of GDP (gghed_gdp), well below the recommended ≥5% threshold. This creates a catastrophic reliance on domestic private pathways, with the mean out-of-pocket expenditure (oops_che) at about 71.5% of total health expenditure. These figures exceed the safe range of ≤ 15–20% by more than threefold. Thus, the average per capita oop_pc_usd reaches $105.90, structurally reversing the target by overtaking public purchasing power spending (gghed_ppp_pc) at $74.40. Although the nominal current health expenditure per capita (che_pc_usd) meets global baselines at $148.90, we find that national health funding (che_gdp) is stagnant at 3.7%. In addition, the absence of a social health insurance strategy (shi_che = 0.9%) and over-reliance on external aid (ext_che) exceeding the 8.4% threshold put the system at high risk.

LOESS Trend Analysis

To understand shifts in household expenditures, fiscal planning, and the scale of the health system, we use LOESS in Figure 2 to extract the nonlinear signal across three panels while avoiding ambiguity over the study period (2000-2023). The results indicate that the household out-of-pocket burden (oops_che) persists and remains dominant, peaking at ~77.4% in 2017, then gradually declining via LOESS to ~71% by 2023. The gghed_che shows strong interannual variation, peaking in 2001 (26.9%) and 2004 and 2005 (over 25%), with a downward trend from 2005 to approximately 14.3% (2023), meaning that general government domestic spending crashed by almost 50%. In the same vein, the social health insurance (shi_che) and other risk-pooling schemes remain statistically penalized.

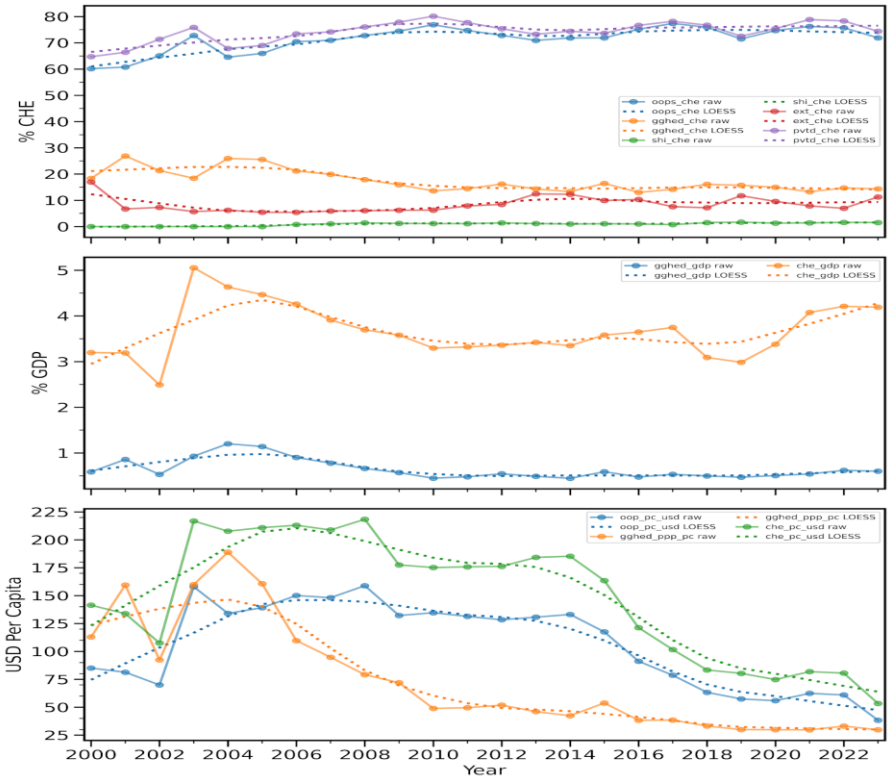


Figure 2. LOESS-Smoothed Trend Analysis Across Three Panels

Figure 2. Longitudinal time series and LOESS-smoothed trends of health financing indicators from 2000 to 2023. Indicators are compared between raw and LOESS-smoothed values, with the latter superimposed, for indicators expressed as a share of current health expenses (top), as a ratio of GDP (middle), and in constant per capita USD (bottom).

For the stagnant fiscal efforts demonstrated in the center panel (Figure 2), health expenditure relative to che_gdp falls below the 5% level, indicating a shortfall in structural enhancement within the macroeconomic footprint. The last panel in Figure 2 shows that real health spending per capita (che_pc_usd) peaks in 2014 at a constant 2021 USD level of ~ $102(raw without conversion) before declining. This signals a decoupling of systemic scale from expanding household financial demands.

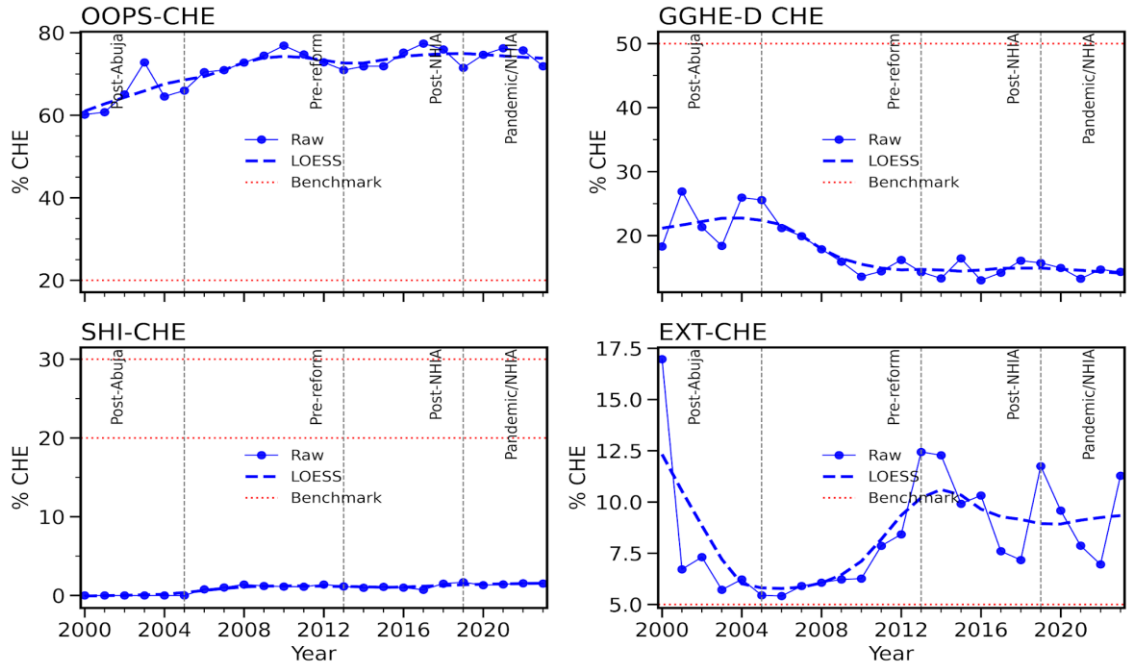


Figure 3. Comparative Trajectories and LOESS-Smoothed Trends of Key Health Financing Indicators Against International Benchmarks Across Policy Eras (2000-2023)

In Figure 3, we present the LOESS analysis of the tracks for health financing indicators relative to international benchmarks. The oops_che LOESS shows a wide gap relative to the 20% benchmark, while the trajectory remains consistently between 60% and ~80% throughout the study period. Conversely, the gghed_che shows a decreasing trend since 2001, when it was approximately 22%, and has stabilized below the 50% benchmark. After the small 2006 inflection in shi_che, the trend remains negligible, staying below 10% and near the lower end of the 20% benchmark. However, the only indicator that consistently remains above the 5% benchmark is the gghed_che, which peaks during the post-NHIA era. These results show that Nigeria's health financing is structurally and statistically deficient. The more than 50% disparity between international standards and protocols and actual household spending indicates a severe financial catastrophe.

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Sub-Period Mean Values and Annualized Changes

Table 4. Mean Indicator Values Across the Four Analytical Sub-Periods

Indicator	Post-Abuja	Pre-Reform	Post-NHIA	Pandemic/NHIA
oops_che	64.9	73.0	74.0	74.6
che_gdp	3.8	3.6	3.4	4.0
oop_pc_usd	111.3	139.3	90.2	54.4
gghed_che	22.7	16.7	14.8	14.3
shi_che	0.0	1.2	1.2	1.5
pvtd_che	69.2	76.0	75.4	76.8
ext_che	8.1	7.3	9.8	8.9

From Table 4, we find that oops_che increases from 64.9% to 74.6% across the four policy eras analyzed. In contrast, the government's contribution declines from 22.7% to 14.3%, as shown by the gghed_che indicator. This shift is accompanied by a reduction in the absolute value of oop_pc_usd from $139.3 to $54.4 in the current era. Although there is a slight increase from 0% to 1.5% in the social health insurance (shi_che), the system remains highly dependent on private voluntary expenditure (pvtd_che). The pvtd_che grew from 69.2% to 76.8%, while the overall footprint of the health sector (che_gdp) remains below 4.0%, except in 2021, with 4.1%, and in 2022 and 2023, with 4.2%.

Figure 4. Annual percentage growth rates of key health financing indicators across policy sub-periods (2000 - 2023). This horizontal bar chart quantifies the pace of change (with 95% confidence intervals) for indicators of household burden (e.g., oops_che), fiscal effort (e.g., gghed_che), and system architecture (e.g., shi_che) across four distinct legislative and economic eras: Post-Abuja (gray), Pre-reform (blue), Post-NHA (red), and the Pandemic/NHIA (green) period.

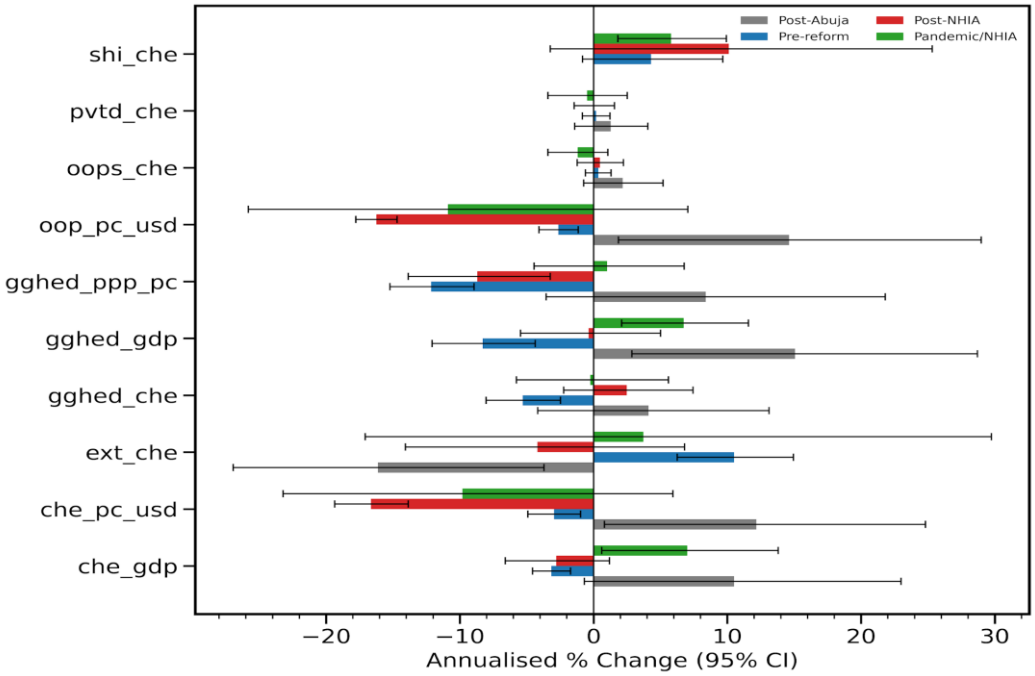


Figure 4. Annualized Log-Linear Growth Rates Per Indicator Across Policy Sub-Periods

Annualized log-linear growth rates by indicator and sub-period are shown in Figure 4 as a bar chart, grouped by indicator and policy period. The post-NHA window shows modest improvements in some indicators, largely reversed during the pandemic window. Specifically, pandemic/NHIA-era experiences include an upward surge in shi_che growth to ~30%, making it the highest in the localized risk-pooling structure, in contrast to the sharp contraction in the gghed_che post-Abuja era (-12%). The household financial burden appears statistically stagnant, with the oops_che indicating a 0% annual growth rate across all four policy eras, despite episodic shifts in funding sources. This suggests that legislative milestones have not yet significantly reduced relative out-of-pocket costs. A continuous stagnation in financial protection is reflected in a -15% decline in real per capita health spending (che_pc_usd). While these outcomes continue to decline as resources available per individual decrease, the use of formal insurance methods is increasing. The analysis, therefore, separates system formalization from fiscal scale, as insurance development has yet to attain the pace necessary to offset a declining per-capita resource base and ongoing household reliance on out-of-pocket expenses.

Institutional Reform Transitions: Wilcoxon Tests and Effect Sizes

Table 5 presents results from paired Wilcoxon signed-rank tests and Cohen's d effect sizes for the three sub-period transitions. These results directly address the study's fourth objective: whether institutional reform milestones produced statistically significant shifts in financing outcomes.

The results from the Paired Wilcoxon signed-rank tests and Cohen's d effect sizes analysis (Table 5) show that the transition from the Post-Abuja to the Pre-reform era is statistically significant across the series, among other structural shifts. This transition period shows a large (L) effect size, with increases in several components, such as the initial emergence of social insurance (shi_che: -7.57L; from 0.00 to 1.15), oops_che (-2.39L; from 64.88 to 73.00), and pvtd_che (-2.15L; from 69.20 to 76.00). In the Pre-reform vs. Post-NHIA transition periods, our results show a statistically significant and large (L) reduction in per-capita household costs (oop_pc_usd), which fell from 139.31 to 90.21 and 2.31L. Also, external funding (ext_che) expands significantly (-1.13L), from 7.32 to 9.84, within the same transition periods between the Pre-reform and Post-NHIA eras. Despite the large effect size in the Pandemic/NHIA era for che_gdp (rising to 3.96) and the increase in insurance in these recent shifts (though this is partly modeled), the outcome is insignificant at $p < 0.05$.

https://doi.org/10.21522/TIJPH.2013.14.03.Art023

Table 5. Paired Wilcoxon Signed-Rank Tests and Cohen`s d Effect Sizes Across Policy Era Transition (2000-2023)

Mean (Lower_CI, Upper_CI)					**Cohen_d Effect_size,Wilcoxon_stat^Sig (p_val < 0.05 *)**		
Indicators	**Post-Abuja**	**Pre-Reform**	**Post-NHIA**	**Pandemic/NHIA**	**Comparison 1**	**Comparison 2**	**Comparison 3**
oops_che	64.88 (61.24, 68.52)	73.00 (71.44, 74.56)	73.96 (71.94, 75.98)	74.64 (72.74, 76.54)	−2.39 L, 0*	−0.41 S, 7	−0.29 S, 4
che_gdp	3.84 (3.03, 4.65)	3.61 (3.37, 3.84)	3.40 (3.15, 3.65)	3.96 (3.58, 4.35)	0.33 S, 7	0.63 M, 2	−1.64 L, 0
oop_pc_usd	111.25 (81.81, 140.68)	139.31 (131.42, 147.19)	90.21 (66.15, 114.26)	54.40 (43.54, 65.25)	−1.11 L, 5	2.31 L, 0*	1.45 L, 0
gghed_che	22.74 (19.62, 25.86)	16.68 (14.77, 18.59)	14.81 (13.62, 15.99)	14.32 (13.59, 15.05)	1.85 L, 2	0.81 L, 4	0.38 S, 4
shi_che	0.00 (0.00, 0.00)	1.15 (1.01, 1.29)	1.16 (0.88, 1.45)	1.45 (1.34, 1.57)	−7.57 L, 0*	−0.05 N, 9	−0.99 L, 0
pvtd_che	69.20 (66.01, 72.38)	76.00 (74.31, 77.69)	75.36 (73.62, 77.09)	76.76 (74.62, 78.90)	−2.15 L, 0*	0.28 S, 8	−0.64 M, 3
ext_che	8.06 (4.53, 11.59)	7.32 (5.72, 8.92)	9.84 (8.16, 11.52)	8.92 (7.04, 10.80)	0.22 S, 8	−1.13 L, 0*	0.45 S, 4

Note: *Effect Size (Cohen's d): N = Negligible, S = Small, M = Medium, L = Large. Sig (*): Denotes statistical significance at the p < 0.05 level based on the Wilcoxon signed-rank test. Comparison 1 = Post-Abuja (2000 - 2005) vs Pre-reform (2006 - 2013); Comparison 2 = Pre-reform (2006 - 2013) vs Post-NHIA (2014 - 2019); Comparison 3 = Post-NHIA (2014 - 2019) vs Pandemic/NHIA (2020 - 2023).*

The transition from the Post-Abuja to the Pre-reform era (Comparison 1) is statistically significant across multiple indicators and shows the largest structural shifts of any era transition. The emergence of social health insurance (shi_che) from zero represents the most dramatic structural change recorded across the full study period (−7.57L, $p < 0.05$), though its absolute scale, from 0.00% to 1.15%, remained financially negligible. OOP share rose sharply (−2.39L, $p < 0.05$; from 64.88% to 73.00%), as did private voluntary expenditure (−2.15L, $p < 0.05$; from 69.20% to 76.00%), indicating that the commencement of NHIS operations catalyzed increased private sector activity without reducing the household OOP burden.

The Pre-reform to Post-NHIA transition (Comparison 2) shows a statistically significant and large reduction in absolute per-capita household costs (oop_pc_usd: 2.31L, $p < 0.05$; from USD 139.31 to USD 90.21). However, as noted above, this decline reflects macroeconomic contraction and currency depreciation rather than improved financial protection, since oops_che, the oops share of total health spending, remained essentially unchanged (from 73.00% to 73.96%). External financing expanded significantly during this transition (−1.13L, $p < 0.05$; from 7.32% to 9.84%), reflecting increased donor activity.

The Post-NHIA to Pandemic/NHIA transition (Comparison 3): the period that includes the landmark 2022 NHIA Act mandating contributory insurance does not reach statistical significance at $p < 0.05$ for any indicator. Despite large effect sizes for che_gdp (−1.64L) and nominal growth in shi_che (−0.99L), the instability of the Pandemic/NHIA period and the recency of the NHIA Act (first operational year 2023, partially modeled) mean the reform's effects are not yet statistically detectable. This is an important null finding: the most recent and most ambitious institutional reform has not yet produced measurable household financial protection.

Correlation Analysis

The correlation analysis examines all ten GHED indicators simultaneously without imposing directional structure. Figure 5 presents the multi-panel Pearson correlation heatmap.

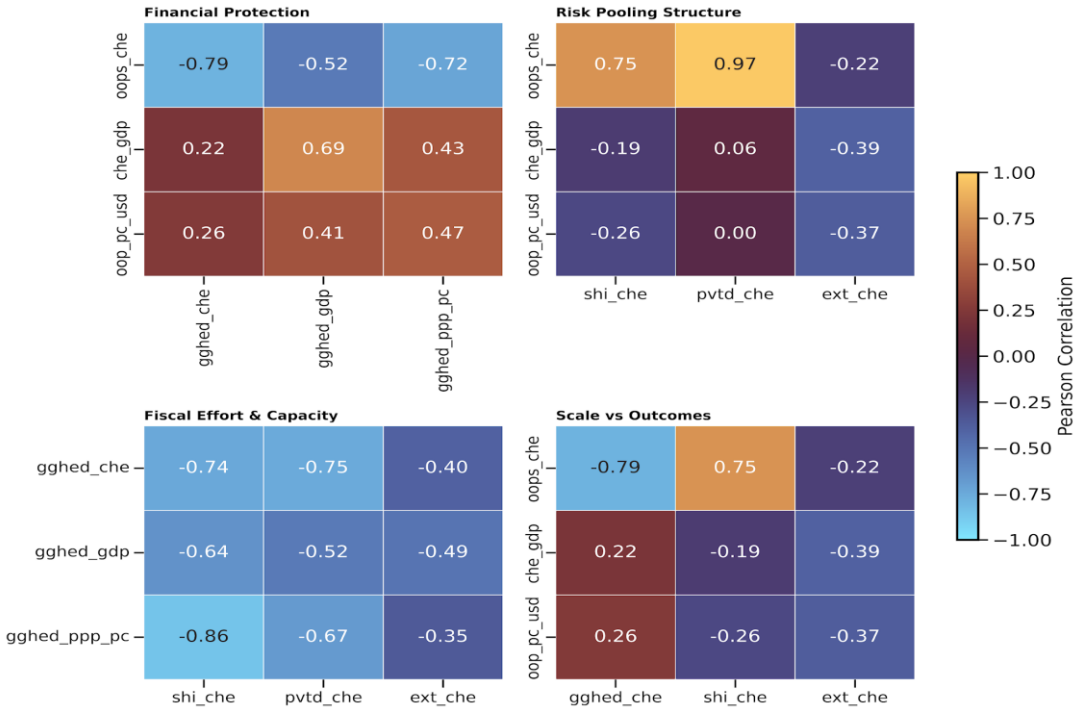


Figure 5. Multi-Pearson Correlation Heatmap of Nigeria`s Health Financing Indicators

Four key patterns emerge. In the financial protection panel, a strong inverse relationship is observed between government financing share and household burden: gghed_che correlates negatively with both oop_pc_usd (−0.79) and oops_che (−0.72). In the fiscal effort and capacity panel, gghed_gdp shows strong inverse correlations with gghed_che (−0.74) and gghed_ppp_pc (−0.86), indicating that higher GDP-relative fiscal effort has not translated into higher government financing shares of CHE, a pattern consistent with documented budget fragmentation and off-budget health spending in Nigeria. In the risk-pooling structure panel, pvtd_che is the strongest correlate of oops_che (r = +0.97), while the counter-effects of ext_che (−0.19) and shi_che (−0.22) are marginal correlations, confirming that donor financing and social insurance are far too small to meaningfully offset private voluntary spending. In the scale-versus-outcomes panel, while gghed_che correlates negatively with oops_che (−0.79), shi_che correlates positively with oops_che (r = +0.75), suggesting that aggregate health system growth in Nigeria has not been accompanied by a commensurate shift in protective financing.

Bivariate Regression: Government Financing Share and Household OOP Burden

Figure 6 presents the bivariate Pearson and Spearman correlation scatter plot between gghed_che (government health financing share of CHE) and oops_che (household OOP share of CHE) across the 24-year study period.

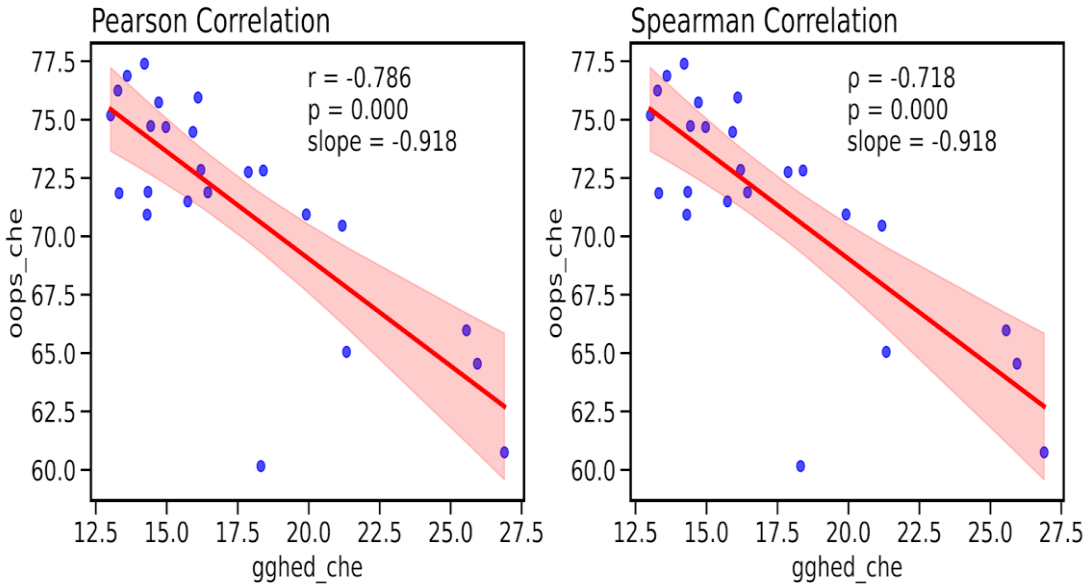


Figure 6. Bivariate Pearson and Spearman Correlation Between gghed_che and oops_che, Nigeria 2000–2023

The analysis confirms a significant negative relationship between government health investment and household OOP burden (Pearson r = −0.786, Spearman ρ = −0.718, p < 0.001 for both). The OLS regression slope (β = −0.918, 95% CI: [−1.19, −0.65]) indicates that for every one percentage-point increase in the government's share of current health expenditure, the household OOP share declines by approximately 0.92 percentage points. This relationship is robust to both Pearson and Spearman measures, suggesting it is not substantially influenced by outliers or non-linearity. This finding provides quantitative evidence in the study that increasing the government's financing role is associated with reduced household financial burden and that the structural decline in gghed_che documented across the study period directly contributed to the rise in oops_che.

Discussion

Persistent Household Financial Catastrophe

The main finding of this study is that Nigeria's out-of-pocket share of current health expenditure has never fallen below 60% across 24 years. It has been above 70% and has shown no statistically significant downward response to any of the four institutional reforms examined. The scale is striking: a mean of 71.5%, more than triple the WHO ceiling of 15–20%. Its structural persistence stands out. Even at its minimum recorded value of 60.2%, the household OOP burden remains three times the international threshold needed for effective financial protection. This means domestic spending on health, which is key to achieving universal health coverage, shows no clear trend of increased government priority for health as reported by the WHO [**Error! Reference source not found.**, **Error! Reference source not found.**, 21].

This ongoing problem reflects a growing imbalance in how healthcare expenditures are paid for. Government health spending dropped from 22.7% after the Abuja Declaration to 14.3% by 2020–2023, while household out-of-pocket spending rose from 64.9% to 74.6% in the same time. A simple statistical analysis clearly shows this link: the Pearson correlation is −0.786 ($p < 0.001$), and the regression slope of −0.918 between government and household spending indicates that each 1% drop in government spending is associated with a similar increase in household spending. These findings align with those of Frimpong et al. [22]., who also found similar links in their analysis. The current numbers (−0.79, −0.22) confirm this strong relationship in Nigeria. Other studies worldwide show that more government or social insurance spending lowers out-of-pocket costs. In Nigeria, there is a need to further explore the underlying factors causing this opposite trend.

Another important issue comes from the correlation analysis. Total health spending as a share of GDP (che_gdp) is strongly linked to out-of-pocket spending ($r = +0.75$). This surprising result points to a key policy problem. Even though Nigeria's health system has grown alongside the economy, this link does not imply that one causes the other. Instead, it shows that growth is mostly due to private, voluntary, and direct household payments, not government or shared insurance funding. Growing the health system without changing its funding worsens the financial hardship households face when seeking healthcare. Private domestic prepayment (pvtd_che) and out-of-pocket spending are almost perfectly linked ($r = 0.97$), showing they both reflect the same basic problem: almost no risk sharing in Nigeria's health system.

What Institutional Reforms Have, and Have Not Achieved

After over 25 years of changes to the law, households are still not well protected. The Wilcoxon analysis shows three main points. After the National Health Insurance Scheme (NHIS) began in the pre-reform period (2006–2013), the largest change was the first appearance of social health insurance (−7.57L, $p < 0.05$), but this increase was small, rising from 0.00% to 1.15% of current health spending. Instead of lowering household costs, this time saw increases in both out-of-pocket and private voluntary spending (−2.39L and −2.15L, $p < 0.05$). This suggests that the NHIS encouraged more private-sector funding but did not reduce households' direct payments. Private spending went up alongside household spending, not instead of it.

The National Health Act of 2014 is often referred to as a major reform. The apparent improvement from before to after the NHIA period, as shown by a significant drop in per-person out-of-pocket spending (2.31L, $p < 0.05$; from USD 139.31 to USD 90.21), is largely misleading. The main measure, the out-

of-pocket share of health spending, changed by less than one percentage point and was not statistically significant. The drop in dollar spending occurred at the same time as an economic slowdown and currency losses after the 2014 oil price crash, not because households were better financially protected. This finding aligns with the WHO African region report that in 2020, only five countries achieved, while the remaining countries, including Nigeria, spent less than US$ 249 per capita, with health expenditures ranging from US$ 16.4 to US$ 236.6, highlighting significant disparities across the region [23].

The 2022 NHIA Act represents the most ambitious reform examined in this study, as it introduces contributory insurance for the first time. However, the Wilcoxon analysis shows no significant changes at the start of 2022. This is expected, as the reform is new and still being implemented, and the 2023 GHED data are partly estimated. Still, the lack of immediate change is important. It establishes a clear baseline before the reform and shows that passing a mandatory insurance law alone does not guarantee financial protection. The main challenge now is to put it into practice well: getting the informal sector (about 80% of Nigeria's workers) to join, creating a suitable benefits package, regulating health maintenance organizations (HMOs), and, most importantly, raising government health spending from the current 4.2% to the Abuja Declaration goal of 15%, which Nigeria promised in 2001 but has not reached.

The financing challenges between 2020 and 2023. First, the government's share of health spending declined to its lowest level in 24 years, at 14.3%. Second, total health spending as a proportion of GDP remained below the World Health Organization's recommended minimum of 5%. Third, real per-person health spending decreased to levels last observed around 2000. The NHIA Act of 2022 was enacted during a period of economic difficulty, with the health system already weakened by currency devaluation, the impact of COVID-19, and prolonged resource constraints. Although this context does not diminish the significance of the reform, it clarifies the lack of clear improvements in protective indicators, as shown by the LOESS analysis [24-27].

Conclusion

In conclusion, the findings show that Nigeria's health financing system has been deteriorating over the past decade. Over 24 years and four reform periods, the government's share of health spending has dropped by half, while household out-of-pocket spending has increased by nearly 10 percentage points. Social health insurance now accounts for only 1.5% of current health spending, and all key measures remain far below international standards for financial protection. Right now, Nigerian households spend more on health care than the government does, which runs counter to achieving Universal Health Coverage.

The 2022 NHIA Act is the main reform studied here, but its effects are not yet clear in the available data. This study provides a starting point for measuring its future impact. Passing the law alone is not enough. For mandatory insurance to truly protect households financially, Nigeria must do three things to achieve UHC/lower OOPs: provide steady funding to reach the Abuja Declaration's goal of 15% government health spending, require all workers to contribute, and strictly regulate benefits and the health maintenance organization (HMO) market to make sure insurance offers real protection when care is needed.

The main strength of this study is its detailed, Nigeria-specific analysis of the latest GHED data published in December 2025, covering four reform periods and using four methods. This gives a more up-to-date and strong evidence base for Nigerian health financing reform than earlier studies. Every year, millions of households are pushed into poverty by medical costs, showing how urgent reform is.

The data clearly point to the needed changes. The key question is whether there is enough political will now to make these reforms happen.

Conflict of Interest

The authors declare no conflict of interest.

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Ethical Approval

We used secondary open-source data from the World Health Organization website, available at https://apps.who.int/nha/database/. Ethical approval was not obtained because, since November 12, 2016, WHO publications have been made available under the CC Attribution-Non Commercial-ShareAlike 3.0 IGO license. This license allows any non-commercial use without the need to obtain permission from WHO. Adaptations and translations are also permitted, as long as the adapted work is published under the same or a similar license (https://www.who.int/about/policies/publishing/open-access). Also, no direct human participants were involved, minimizing ethical concerns.

Data Availability

The data set analyzed in this study was generated and published by the World Health Organization and is available for download at https://apps.who.int/nha/database/. The Global Health Expenditure Database (GHED) provides comparable data on health expenditure for 195 countries, including Nigeria and territories, since 2000, with open access to the public. The secondary data analyzed in this study is available at an open source.

Author Contributions

The following authors were responsible for different areas of the study, as shown below:

- **Maria Ada Ochigbo:** Conceptualization, design, data extraction, first draft, review, and responding to feedback.
- **Nnodimele Onuigbo:** Overall supervision, mentorship, and guidance.
- **Tomvieeibe Cephas Dombo:** Data analysis using Python statistical, mathematical, or computational techniques to interpret data, review, and proofreading of the final test.

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Socio-Cultural Factors Associated with Teenage Pregnancy among Adolescent Girls in Jewi Refugee Camp, Gambella Region, Ethiopia

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Abstract *Teenage pregnancy remains a pressing public health issue with profound health, social, and economic consequences for adolescent girls, their families, and communities. It is associated with many socio-cultural factors that influence the occurrence of teenage pregnancy and sexual and reproductive health risk behaviors. This study assessed the prevalence of teenage pregnancy and socio-cultural factors among adolescent girls in Jewi Refugee Camp, Gambella Region. A community-based cross-sectional study was conducted from February 1 to March 30, 2026, employing a systematic sampling technique among female adolescents aged 13 to 19 years. Data were collected using a structured, pretested questionnaire with Kobo Collect software and analyzed in SPSS version 25. Pregnancy was confirmed using urine Human Chorionic Gonadotropin (HCG) test kits. A modified Poisson regression model was applied, and statistical significance was declared at $p < 0.05$. All 383 female adolescents participated in this study, yielding a response rate of 100%. The prevalence of teenage pregnancy was 33.2%. The mean age at first pregnancy was 15.46 years. Factors significantly associated with teenage pregnancy were age group (APR=1.354, 95% CI: 1.073 – 1.708), family planning use (APR = 2.755; 95% CI: 1.669 – 4.546), transactional sex (APR = 0.328; 95% CI: 0.206 – 0.523), parent-adolescent communication (APR=0.24, 95% CI: 0.114 – 0.51), and family pressure for early marriage (APR = 1.560; 95% CI: 1.144 – 2.128). The prevalence of teenage pregnancy was high. Comprehensive intervention is needed to strengthen access to family planning services, discourage child marriage, and address socio-cultural norms. Future qualitative research is needed to validate these findings.*

Keywords *Adolescent Pregnancy, Jewi Refuge, Socio-Cultural Factors, Teenage Pregnancy.*

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Introduction

Teenage pregnancy remains a significant global public health challenge with profound implications for health, education, and socio-economic development [1]. It is a significant contributor to maternal and child morbidity and mortality, and perpetuates cycles of poor health, school dropout, limited economic opportunities, and intergenerational poverty [2]. Globally, complications of adolescent pregnancy and childbirth are the leading causes of death among girls aged 15–19 years. An estimated 99% of these deaths occur in LMICs, where adolescent mothers are more prone to eclampsia, puerperal endometritis, and systemic infections compared to women aged 20–24 years [3].

An estimated 21 million girls aged 15–19 years and 2 million girls under the age of 15 years become pregnant annually in developing regions. Each year, approximately 16 million births occur among adolescents aged 15 to 19 years, while an additional 2.5 million births occur among girls younger than 16 years. Approximately half of these pregnancies are unintended, and 55% of unintended pregnancies ended in unsafe abortions [4]. Despite recent declines in adolescent fertility rates, teenage pregnancy continues to pose a significant global challenge with severe health and economic consequences [5].

The burden of teenage pregnancy is particularly high in Sub-Saharan Africa (SSA), where poverty, social exclusion, gender-based violence (SGBV), and early marriage remain widespread. [6]. In many communities, socio-cultural norms, family expectations, poverty, lack of sexual education, and limited access to reproductive health services contribute significantly to the high prevalence of adolescent pregnancy [7]. Evidence suggests that maternal health outcomes are strongly influenced by socio-economic status, educational attainment, age at conception, and number of pregnancies [8]. Adolescent pregnancies are often unintended, whether mistimed (occurring earlier than desired) or unwanted (pregnancy occurring when no children were desired), and are associated with unsafe abortion, obstetric complications, and poor maternal and neonatal outcomes [9]. Healthy reproduction or the safest period for pregnancy and childbirth is generally considered to be between the ages of 20 and 30 years. Pregnancies occurring before or after this age range are associated with a significantly higher risk of maternal and neonatal complications [9].

Early marriage is a significant driver of teenage pregnancy. In low- and middle-income countries, more than 30% of girls marry before the age of 18, and 14% marry before 15 years [10]. Rising rates of teenage pregnancy are a major contributor to maternal and child mortality in Africa, including Ethiopia [11].

Several studies conducted in SSA have identified multiple determinants of adolescent pregnancy, including poverty, peer influence, low educational attainment, child marriage, family instability, lack of parental supervision, and poor parent-adolescent communication on SRH [7]. The region (SSA) continues to report the highest adolescent fertility rates globally. Countries such as Nigeria, Mali, Angola, Mozambique, Guinea, Chad, Malawi, and Cote d'Ivoire have persistently high rates of teenage childbearing. Furthermore, a study conducted in Palabek refugee camp in northern Uganda reported a teenage pregnancy prevalence of 41.2% among adolescent girls [12]. According to the United Nations Population Fund (UNFPA), approximately one in four girls in Sub-Saharan Africa gives birth before the age of 18 years [13].

Globally, evidence suggests that in some settings, more than one-third of girls report experiencing coerced sexual debut, highlighting the significant role of gender-based violence in adolescent reproductive health outcomes [10]. Refugee settings present a particular challenge since adolescent girls face risks of gender-based violence, sexual

abuse, and restricted access to SRH services, leading to higher rates of unplanned pregnancy compared to the non-refugee population [14].

In Ethiopia, the prevalence of teenage pregnancy varies considerably across regions and population groups [11]. Previous studies have reported teenage pregnancy prevalence rates ranging from 28.6% to over 30%, with community-based studies documenting similar findings for both unintended pregnancy and adolescent childbearing [15-17]. Socio-cultural and religious practices continue to influence reproductive health behaviors and maternal health outcomes [6]. Consequently, public health interventions aimed at reducing teenage pregnancy must address cultural norms surrounding early marriage and childbearing while actively engaging community leaders, religious institutions, parents, and adolescents [10].

The Gambella region hosts the largest South Sudanese refugee population in the country. Adolescents constitute a substantial proportion of this population and face numerous socio-cultural, economic, and structural vulnerabilities that increase their risk of teenage pregnancy. A study conducted in Kule refugee camp reported that more than one-third of adolescent girls had experienced teenage pregnancy [18]. Despite the high burden of teenage pregnancy in refugee settings, there is limited evidence regarding the socio-cultural factors influencing adolescent pregnancy among refugee girls in the Gambella region, Ethiopia. Previous studies conducted in Ethiopia refugee camps have focused on the prevalence and general determinants of teenage pregnancy. However, none have specifically assessed the socio-cultural factors using a mixed-methods approach that incorporates both survey and biological confirmation of pregnancy status in the Gambella region. Addressing these gaps is essential for developing context-specific interventions and policies aimed at reducing teenage pregnancy and improving adolescent reproductive health outcomes in the refugee populations.

Methods and Materials

Study Setting and Design

A community-based cross-sectional study was conducted from February 1 to March 30, 2026, to assess the prevalence of teenage pregnancy and identify the socio-cultural factors influencing it. This quantitative research focused on adolescent girls aged 13 to 19 years residing in the Jewi Refugee Camp located in the Gambella region of Southwest Ethiopia. Jewi Refugee Camp is located 18 kilometers east of Gambella Town and 748 kilometers from Ethiopia's capital city, Addis Ababa. Jewi Refugee Camp has a population of 69,778 according to a UNHCR report [19].

Study Area and Period

This study was conducted from February 1 to March 30, 2026, in Jewi Refugee Camp in the Gambella region. Jewi Refugee Camp is one of the seven refugee camps in Gambella and has a population of 69,778 with 13,956 households, according to a UNHCR report [19]. It is located 748 kilometers West of Ethiopia's capital, Addis Ababa, and 18 kilometers East of Gambella town.

Gambella town is the capital city of Gambella Region, located around 766 kilometers southwest of Ethiopia's capital, Addis Ababa. Gambella Region borders South Sudan to the west, Oromia Region to the northeast, and the South West Ethiopia Peoples' Region (SWEPR) to the southeast. It covers an area of approximately 29,783 square kilometers and has a population of around 525,000, according to the report of UNICEF Ethiopia [20].

Study Population

The study population included all adolescent girls aged 13 to 19 years who had lived in the study sites for at least one year. The study specifically focused on female

teenagers aged 13 to 19 years from the selected households who participated in this research.

Inclusion and Exclusion Criteria

Adolescent girls aged 13–19 years residing within the Jewi refugee camps for at least one year and who signed a written consent form to participate in this study while adolescent girls aged 13–19 years who were sick during the data collection and who had a mental illness or who refused to participate in the study as well as those who did not reside in Jewi refugee camps for one year were excluded in the study.

Sample Size Determination and Techniques

The required sample size was determined using the single population proportion formula based on the Cochran formula by considering z as the normal standard deviation set at 1.96, with a confidence interval (CI) level of 95%, d = margin of error assumed to be 5%, p = 34.6%, the prevalence of teenage pregnancy according to the previous study conducted in Kule refugee camp [18], and a 10% non-response rate.

Based on the above formula and substituting values, the sample size was 348 and adding a 10% non-response rate of 348. Therefore, the final sample size will be 383.

Sampling Techniques and Procedure

The study selected Jewi Refugee Camp using the lottery technique. The study included all four zones in the camp. The number of households in each zone was assigned using a proportional allocation based on the total sample size for Jewi Refugee Camp. The study identified participants from the selected households using a systematic sampling technique. For households with more than one teenage girl, a lottery sampling technique was applied to select one teenage girl for the interview and testing for pregnancy that is not physically observed. Households without a teenage girl were skipped to find those with an adolescent girl as indicated in (Figure 1) below.

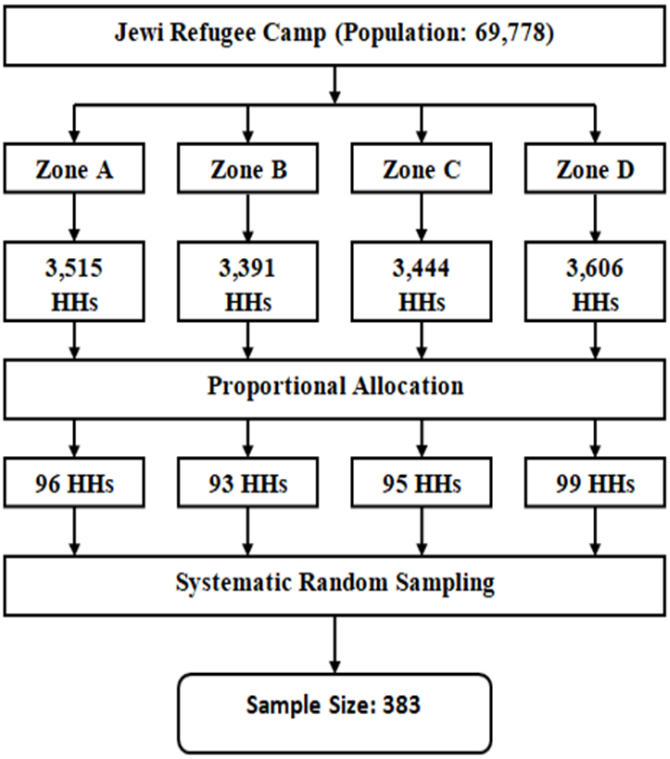


Figure 1. Sampling Technique Used for the Selection of the Study Population in Jewi Refugee Camp, Gambella Region, Southwest Ethiopia, 2026

Study Variables

Dependent Variable

Teenage pregnancy (TP): Teenage pregnancy (Yes/No) will be assessed in teenage girls aged 13–19 years who had ever been pregnant ending in live birth, abortion, stillbirth, or pregnant during the time of the data collection.

Independent Variables

Socio-Demographic Characteristics: include age, educational level, school attendance, and living arrangement.

Individual Behavioral Factors Characteristics: Contraceptive knowledge and use, access to sexual and RH services, age at first sexual intercourse, and substance use; and Sexual-based violence variable: Rape, Coercion, and Sexual assault (intimate-partner violence).

Family & Community Characteristics: includes Parent–adolescent communication, family pressure for marriage (Age at first marriage), household income, polygamous families, Socio-cultural factors: Early marriage, religious beliefs, gender norms.

Operational Definition

Teenage Pregnancy: is a pregnancy in girls within the ages of 13–19, or it is when a female becomes pregnant before the age of 20.

Early Sexual Intercourse/Debut: is defined as having had first sexual intercourse at or before age 15 years.

Early Marriage Pressure: is a marriage that takes place under the age of 18 years due to pressure from family or community.

Zone in Refugee Camp: It is an administrative unit within the refugee camp that divides it into several sections or zones, such as Zone A, B, C, and D, for administrative purposes.

Felt Pressure or Forced to Sexual Intercourse: is a situation where someone is being pushed towards intimacy without their consent, or any sexual activity that occurs without consent.

Data Collection Instruments and Quality Control

Data collection was conducted by trained data collectors using a structured questionnaire following a pre-testing phase. The questionnaire was adapted from the WHO [21] and developed with modifications from different literature. It was initially prepared in English, then translated into Nuer, and subsequently translated back into English to ensure consistency. A peer-to-peer data collection approach was adopted to remove gender- and age-related social barriers and to create mutual trust between the interviewees and interviewers. Data were collected by four female Nurses (Diploma holders) using the KoboCollect Android software and intensive supervision was done throughout the data collection by one public health professional (with a degree).

Pregnancy in adolescent girls was determined using urine human chorionic gonadotropin (HCG) test kits. Each study participant was asked before collecting a urine sample if she was pregnant or if the pregnancy was visible to the data collectors at the time of data collection. Urine samples were collected from all study participants who had never been pregnant previously, except for those whose pregnancies were visible and confirmed.

Data Quality Control

Data were collected by four female nurses and one field supervisor. The data collectors and supervisor underwent three days of training focused on interviewing techniques, the study's objectives, informed consent, and ensuring confidentiality. The procedures for data collection and the use of data collection tools were also clarified. Fieldwork and ethical issue manuals were utilized during training and provided to data collectors and the supervisor as reference materials for actual

data collection. The supervisor checked the completeness, accuracy, and clarity of the collected data daily. The questionnaire was pretested on 5% of the sample size in refugee camps other than Jewi Refugee Camp to validate and estimate the time for data collection.

Data Processing and Analysis

The data collected by Kobo Collect (version 2024.1.3) were exported to the Statistical Package for Social Science (SPSS) version 25 for data cleaning, transformation, and analysis. Descriptive statistics, such as mean, frequencies, and Standard deviations, were used to summarize study variables, with categorical data presented in tables.

Bi-variable modified Poisson regression was done to identify the potential predictors of teenage pregnancy. Variables with P-values less than 0.25, including relevant factors and confounders, were included in multivariable modified Poisson regression models to identify independent predictors. Modified Poisson regression models or Poisson regression with robust standard errors were preferred over log-binomial regression for validating binary outcome results (p-values and confidence intervals). Adjusted risk ratios (ARRs) with 95% confidence intervals (CIs) were reported with statistical significance set at p-value < 0.05 and 95% CIs excluding 1. Model fitness was evaluated using deviance statistics or Pearson's chi-square goodness-of-fit test. Multicollinearity was assessed using the variance inflation factor (VIF).

Results of the Study

Socio-Demographic Characteristics

A total of 383 female adolescents participated in this study, yielding a response rate of 100%. The participants were aged between 13 and 19 years, with a mean age of 17.08 years (17.08 ± 1.79). Nearly half of the respondents, 193 (50.4%), were aged 18 to 19, indicating they were in late adolescence. All the socio-demographic characteristics of the respondents are summarized in (Table 1) below.

The majority of the respondents, 298 (77.8%), were attending school at the time of the study, of whom 235 (61.4%) were enrolled in primary education. Among the respondents, 85 individuals (22.2%) dropped out of school. The leading reasons were early marriage (61, 72%), followed by unplanned pregnancy (12, 14%) and financial constraints (12, 14%). Regarding parental educational status, 207(54.2%) of fathers had attained secondary or university level, whereas the majority of mothers, 347 (90.6%), had no formal education.

Of the respondents surveyed, two-thirds (252 or 65.8%) had never been married, while 131 (34.2%) reported being married between the ages of 13 and 18. The mean age at first marriage among married adolescents was 16.40 years (16.40 ± 0.98), indicating a high prevalence of early marriage. All participants identified as Christian, with Protestant being the largest denomination at 153 participants (39.9%), closely followed by Seventh-day Adventist with 149 participants (38.9%).

Regarding household characteristics, more than half of the respondents (205; 53.5%) lived in households comprising ten or more family members. Additionally, 173 (45.2%) belonged to polygamous and extended family households. More than half of the households (214; 55.9%) reported a monthly income of less than 3,500 ETB. Humanitarian assistance was the primary source of household income for the respondents as indicated in Table 1.

Individual and Family Characteristics on Sexual and Reproductive Health

The study found that more than half, 217 (56.7%), of the respondents had ever engaged in sexual intercourse, and 116 (30.3) initiated sex at an early age (early sexual debut) between the ages of 13 and 15 years, with a mean age at first sexual intercourse of 15.5

years. Individual characteristics on sexual and reproductive health services have been summarized in Table 2 below.

Most respondents, 326 (85.1%), reported knowing sexual and reproductive health (SRH) services, and their primary sources of sexual and reproductive health information were health workers (156; 47.9%), followed by peers and media (87; 26.7) and school teachers (66; 20.2%). Despite the relatively high level of awareness, only 139 (36.3%) respondents reported ever using a family planning method. Among those who had used contraceptives, the methods mostly used were condoms (130; 33.9%) and oral contraceptive pills (111; 29.0%). The leading reasons for non-use of contraceptives were religious beliefs (132; 34.5%) and lack of adequate knowledge about contraceptive methods (88; 23%) **(**Table2). The majority of family planning users, 113 (29.5%), obtained contraceptive methods from health centers and health posts. However, the frequency of contraceptive utilization was generally low, with most of the respondents reporting that they used family planning methods only rarely or sometimes.

Among the respondents, 173 (45.2%) belonged to polygamous and extended family households. Additionally, 205 individuals (53.5%) reported living in a household with ten or more members. Around 276 (72.1%) were raised by both biological parents, while 74 (19.3%) reported that they had a family history of teenage pregnancy. The family characteristics on sexual and reproductive health services are summarized in Table 3.

Hundred and fifty-four (40.2%) reported that they had communicated with their parents about sexual and reproductive health-related issues. The majority, 229 (59.8%), had not discussed sexual and reproductive health related matters with their parents.

Table 1. Socio-Demographic Characteristics of the Respondents in Jewi Refugee Camp, Gambella Region, Southwest Ethiopia, 2026

Variables	Number	Percent
Age in years		
13–17 years	190	49.6%
18–19 years	193	50.4%
Marital status		
Never married	252	65.8%
Ever married	131	34.2%
School attendance		
Currently in school	298	77.8%
Drop-out from school	85	22.2%
Reason for school drop-out (N=85)		
Early marriage	61	72%
Unplanned pregnancy	12	14%
Financial constraints	12	14%
Educational level of the respondent		
Informal and primary level	235	61.4%
Secondary level	148	38.6%
Educational status of the father		
Informal to primary educational level	176	46%
Secondary to college/university educational level	207	54%
Educational status of the mother		
Informal educational level	347	90.6%

Primary educational level and above	36	9.4%
Educational status of the spouse (N= 131)		
Informal to secondary education level	59	45%
College and university educational level	72	55%
Religion		
Protestant	153	39.9%
Seven Day Adventist	149	38.9%
Catholic	81	21%
Occupational status of the father		
Employed or small business	150	39.2%
farmer	133	34.7%
Unemployed	100	26.1%
Occupational status of the mother		
Employed or small business	41	10.7%
Farmer	188	49.1%
Unemployed	154	40.2%
Household per capita		
< 350 birrs	186	48.6%
> 350 birrs	197	51.4%
Primary sources of household income		
Employed and Small business	16	4.2%
Humanitarian assistant	367	95.8%

Table 2. Individual Level Characteristics on Sexual and Reproductive Health of the Adolescent Girls in Jewi Refugee Camp, Gambella Region, Southwest Ethiopia, 2026

Variables	**Number**	**Percent**
Age at first sexual intercourse (217)		
13–15 years	116	53.5%
16–18 years	101	46.5%
Age at first marriage (N = 131)		
14–15 years	24	18%
16–17 years	90	69%
18–19 years	17	13%
Age at first pregnancy (N = 127)		
13–15 years	12	9.4%
16–17 years	98	77.2%
18–19 years	17	13.4%
Had ever been pregnant		
Yes	127	33.2%
No	256	66.8%
Had sexual intercourse in exchange for money & gifts (N = 217)		
Yes	90	41.5%
No	127	58.5%
Had information about sexual and RH services and family planning		
Yes	326	85.1%

No	57	14.9%
Source of information about sexual and RH services and family planning (N = 326)		
Health workers	156	47.9%
Peer and social media	87	26.7%
School teachers	66	20.2%
Parents or guardians	17	5.2%
Had ever used family planning or contraceptive methods		
Yes	139	36.3%
No	244	63.7%
Place family planning or contraceptive methods obtained		
Hospital/Health center or Health post	113	29.5%
Private clinic or pharmacy	26	18.7%
Type of family planning methods used		
Condom	130	33.9%
Oral contraceptive pills (OCPs)	111	29%
Depo-Provera (Injectable	84	22.7%
Emergency contraceptive pills	11	3.4%
Calendar or rhythm	9	2.3%
Reasons for non-contraceptive use (N = 244)		
Cultural norm or religious	132	54.1%
Lack of knowledge	88	36.1%
Fear of side effect	14	5.7%
Partner refusal	10	4.1%

Note: *RH = Reproductive health*

Table 3. Family Characteristics on Sexual and Reproductive Health of Adolescent Girls in Jewi Refugee Camp, Gambella Region, Southwest Ethiopia, 2026

Variables	**Number**	**Percent**
Type of family in the household		
Nuclear family	182	47.5%
Polygamous and extended family	173	45.2%
Single-parent & child-headed household family	28	7.3%
Type of parent who raised or lived with the girl		
Both parent	270	72.1%
Single parent	83	21.7%
Guardian/ relative or peer	24	6.2%
Family size		
< 10 members	178	46.5%
> 10 members	205	53.5%
Family history (mother/ sister) of teenage pregnancy		
Yes	74	19.3%
No	309	80.7%
Discussed with parents about sexual and reproductive health related issues		
Yes	154	40.2%

No	229	59.8%
Frequency of discussion about Sexual and RH related issues (N = 154)		
Often to very often	22	14.3%
Sometime	93	60.4%
Rarely	39	25.3%
Persons usually talk to girls about Sexual and RH-related issues (N = 154)		
Parents and siblings	73	47.4%
Health workers/ teachers or friends	81	52.6%
Girls' feelings about discussing sexual and RH issues with parents (N = 154)		
Comfortable to very comfortable	58	37.7%
Uncomfortable to very uncomfortable	96	62.3%
Reasons for not discussing sexual and RH issues with parents (N = 229)		
Community considered as taboo and shameful	186	81.2%
Parents felt uncomfortable	19	8.3%
Fear of encouraging promiscuity	15	6.6%
Lack of parents' knowledge on sexual & RH	9	3.9%
Parents supervised and monitored girls' movement and activities after school		
Yes	192	50.1%
No	191	49.9%
Family members pressured the girl to marry		
Yes	191	49.9%
No	192	50.1%
Reasons for family members to pressure the girls for early marriage		
Bride price or dowry	194	50.7%
Fear of premarital pregnancy	104	27.2%
Cultural or traditional expectation	43	11.2%
To strengthen family relationship or tie	42	10.9%

Note: *RH= Reproductive Health*

Prevalence of Teenage Pregnancy

The overall prevalence of teenage pregnancy among the respondents was 127 (33.2%). The mean age at first pregnancy was 15.46 years, and from the pregnant adolescents, 27 (21.3%) reported becoming pregnant before the age of 18 years. The study showed that 217 (56.7%) of the respondents were sexually active and 90 (41.5%) had experienced transactional sex. The prevalence of teenage pregnancy was higher among the age group of 13–17 years, with 3.65 times more likely to experience teenage pregnancy compared to those aged 18–19 years (PR= 3.645**;** 95% CI: 2.506–5.305, p <0.001). The prevalence of teenage pregnancy in Jewi refugee camp is shown in (Figure 2) below.

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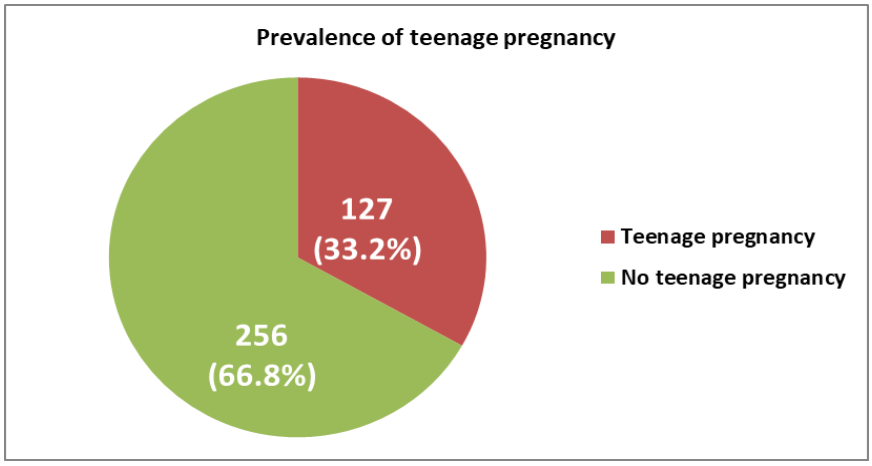


Figure 2. Distribution of Adolescent Girls Pregnancy Status among Adolescent Girls in Jewi Refugee Camp, Gambella Region, Southwest Ethiopia, 2026

Socio-Demographic Factors

Associated Teenage Pregnancy

Table 4 presents the bi-variable analysis of socio-demographic characteristics associated with teenage pregnancy among the adolescent girls in Jewi refugee camp. Age was significantly associated with teenage pregnancy. Adolescents aged 13–17 years were 3.65 times more likely to experience teenage pregnancy compared to those aged 18–19 years (PR = 3.65; 95% CI: 2.506–5.305, $p < 0.001$). Fathers' occupation also showed a significant association with teenage pregnancy. Adolescents whose fathers were farmers and unemployed had 1.33 and 1.41 times more likelihood of teenage pregnancy (PR= 1.33; 95% CI: 0.896–1.983, $p = 0.05$), and (PR = 1.42; 95% CI: 0.95–2.11) than adolescents whose fathers had employment.

In addition, years lived in the refugee camp showed a borderline association with teenage pregnancy, with adolescents residing in the camp for more than 10 years having a higher prevalence of teenage pregnancy than those who had lived in the camp for less than 10 years (PR = 1.55; 95% CI: 0.98–2.45). School attendance status showed a significant association. Those attending school had a 62.7% lower prevalence of teenage pregnancy than school dropouts (PR = 0.37; 95% CI: 0.29–0.48, $p < 0.001$). Household per capita income was significantly associated with teenage pregnancy.

Educational attainment was another significant factor. Adolescents with informal and primary education had a lower prevalence of teenage pregnancy compared to those at secondary education (PR = 0.60; 95% CI: 0.43–0.94, $p < 0.001$). Similarly, respondents whose fathers had attained informal and primary educational levels were less likely to report teenage pregnancy than those whose fathers had secondary and university educational level (PR = 0.55; 95% CI: 0.41–0.74, $p < 0.001$).

Regarding occupation, students had a significantly lower prevalence of teenage pregnancy than employed respondents (PR = 0.41; 95% CI: 0.31–0.54, $p < 0.001$), whereas no statistically significant difference was observed among employed respondents and other occupational groups. Marital status demonstrated a strong association with teenage pregnancy. Married adolescents living with their partners had a significantly different prevalence of teenage pregnancy compared to those who had never married (PR = 0.26; 95% CI: 0.19–0.35, $p < 0.001$) according to Table 4.

Table 4. Socio-Demographic Characteristics of the Respondents that Influenced Teenage Pregnancy in Jewi Refugee Camp, Gambella Region, Southwest Ethiopia, 2026

Variables	Teenage Pregnancy		PR (95% CI)
	Yes (%)	No (%)	
Age group			
13–17 years	27 (14.2)	163 (85.8)	3.65 (2.51 −5.31)**
18–19 years	100 (51.8)	93 (48.2)	1
School attendance status			
Attending school currently	72 (24.2)	226 (75.8)	1
Drop-out from school	55 (64.7)	30 (35.3)	0.37 (0.29 −0.48)**
Highest educational level completed			
Informal and primary school	92 (39.1)	143 (60.9)	0.60 ((0.43−0.94)**
Secondary school level	35 (23.6)	113 (76.4)	1
Educational level of the father			
Informal to primary level	77 (43.8)	99 (56.3)	0.55 (0.41−0.47)**
Secondary to university level	50 (34.2)	157 (75.8)	1
Educational level of the mother			
Informal educational level	115 (33.1)	232 (66.9)	1.01 (0.62−1.63)
Primary educational level	12 (33.3)	24 (66.7)	1
Marital status			
Never married	85 (64.9)	46 (36.1)	1
Ever married	42 (16.7)	210 (83.3)	0.26 (0.19−0.35)**
Occupational status of the respondent			
Employed	11 (37.9)	8 (42.1)	1
Unemployed	39 (61.9)	24 (38.1)	0.41 (0.31−0.54)**
Students	77 (25.6)	224 (74.4)	0.94(0,31 −0.54)
Occupational status of the father			
Employed	52 (34.7)	98 (65.3)	1
Farmer	49 (36.8)	84 (63.2)	1.33 (0.90−1.98)*
Unemployed	26 (28.0)	74 (74.0)	1.42 (0.95−2.11)*
Household monthly income in ETB			
> 3500 birrs	49 (29.0)	120 (71.0)	1
< 3500 birrs	78 (36.4)	136 (63.6)	0.80 (0.59−1.07)*
Household average monthly income or per capita income in Ethiopian birr (ETB)			
> 350 birrs	55 (27.9)	142 (72.1)	1
< 350 birrs	72 (38.7)	114 (61.3)	0.72 (0.54−0.96)**
Years lived in refugee camp			
> 10 years	111 (35.5)	202 (64.5)	1.55 (0.98−2.25)*
< 10 years	16 (22.9)	54 (77.6)	1

Note: *ETB = Ethiopian birr*

Individual and Family Level Factors Associated with Teenage Pregnancy

Table 5 below presents the results of the bivariate Poisson regression analysis examining the association between sexual and reproductive health (SRH), family-related factors, and teenage pregnancy. Variables with a p-value < 0.05 were considered statistically significant.

Teenagers who had never heard about sexual and reproductive health (SRH) services were 2.34 times more likely to experience teenage pregnancy compared to those who had heard about sexual and reproductive health services or family planning (PR = 2.34; 95% CI: 1.262–4.339, p < 0.001). Similarly, adolescent girls who had never heard about family planning methods had a higher prevalence of teenage pregnancy (PR = 2.34; 95% CI: 1.262–4.339, p < 0.001).

Adolescents who receive sexual and reproductive health (SRH) information from their parents or school teachers experience a 1.35 times higher rate of teenage pregnancy compared to those who obtain information from health workers. The prevalence ratio is 1.346, with a 95% confidence interval of 0.945 to 1.917 (p < 0.001). Although this association is significant, it is considered marginal. For girls who obtained information from peers, friends, and media, there was no significant association with teenage pregnancy (PR = 0.834; 95% CI: 0.521–1.334). Use of family planning methods was strongly associated with teenage pregnancy. Adolescents who had never used family planning methods or contraceptive methods were 6.44 times more likely to report teenage pregnancy than those who had ever used contraceptive methods (PR = 6.44; 95% CI: 3.497–11.867, p < 0.001) (Table 5).

Sexual risk behaviors (had sexual intercourse in exchange for money, gift, or support) showed a different prevalence of teenage pregnancy (PR = 0.102; 95% CI: 0.064–0.164, p < 0.001). Those adolescents who had sexual intercourse in exchange for money had an 89.8% lower prevalence of teenage pregnancy compared with those who had never experienced sexual intercourse in exchange for money, gifts, or support.

Family characteristics were also important determinants. Adolescents from polygamous or single-parent families had a higher prevalence of teenage pregnancy compared with those from nuclear or extended families (PR = 1.59; 95% CI: 0.771–3.280, p < 0.25), although the association was not statistically significant. Family pressure for early marriage was one of the strongest predictors identified in the analysis. Adolescents who reported pressure from their families to marry early were nearly seven times more likely to experience teenage pregnancy than those who had never experienced pressure from their parents to marry early (PR = 6.974; 95% CI: 4.297–11.319, p < 0.001).

Parent-adolescent communication emerged as a strong protective factor. Adolescents who discussed SRH-related issues with their parents had a substantially lower prevalence of teenage pregnancy compared to those who did not (PR = 0.074; 95% CI: 0.033–0.163, p < 0.001). Family history of teenage pregnancy was also associated with teenage pregnancy in reverse. Adolescents whose mothers or sisters had experienced teenage pregnancy had a lower prevalence of teenage pregnancy (PR = 0.408; 95% CI: 0.316 – 0.526, p < 0.001).

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Table 5. Individual and Family Level Factors Associated with Teenage Pregnancy in Jewi Refugee Camps, Gambella Region, Southwest Ethiopia, 2026.

Variables	Teenage Pregnancy	
	Yes (%)	No (%)
Ever heard about family planning and sexual and RH services		
Yes	118 (36.3)	207 (63.7)
No	9 (15.5)	49 (84.5)
Primary source of information on sexual and reproductive health (RH) services		
Health workers	68 (43.3)	89 (56.7)
Parents or school teachers	22 (26.5)	60 (73.2)
Peers/friends or social media	28 (32.2)	59 (67.8)
Ever used family planning or contraceptive methods		
Yes	10 (7.4)	126 (92.6)
No	117 (47.4)	130 (52.6)
Had sexual intercourse in exchange for money/gift/support		
Yes	111 (89.5)	13 (10.5)
No	16 (9.1)	159 (90.9)
Type of family		
Nuclear & extended family	121 (34.1)	234 (65.9)
Polygamous & single parent	6 (21.4)	22 (78.6)
Type of parent who raised (living with) the girl		
Both biological parents	87 (31.5)	189 (68.5)
Single biological parent	27 (32.5)	56 (67.5)
Guardian or relative	13 (54.2)	11 (45.6)
Discussed with parents about sexual and reproductive health issues		
Yes	6 (3.9)	148 (96.1)
No	121 (52.8)	108 (47.2)
Family pressured the girl for early marriage.		
Yes	111 (58.1)	80 (41.9)
No	16 (8.3)	176 (91.7)
Family history(mother/ sister) of teenage pregnancy		
Yes	47 (63.5)	27 (36.5)
No	80 (25.9)	229 (74.1)

Socio-Cultural Factors Influencing Teenage Pregnancy

Table 6 presents the results of the modified Poisson Regression analysis model conducted to explore independent socio-cultural factors associated with teenage pregnancy after controlling for potential confounders. Variables with a p-value < 0.25 in the bi-variable analysis were included in the final model, and statistical significance was defined as a p-value less than 0.05.

After adjustments, age group, ever use of family planning methods, transactional sex, parent –adolescent communication on sexual and reproductive health (SRH) related issues, and family pressure for early marriage remained significantly associated with teenage pregnancy.

Adolescent girls in the age group of 13–17 years were 1.35 times more likely to experience teenage pregnancy than those in the age group of 18–19 years (APR = 1.354,

95% CI: 1.073–1.708, p = 0.011). Girls who had never used family planning methods were 2.76 times more likely to report teenage pregnancy than those who had used family planning methods (APR = 2.755; 95% CI: 1.669–4.546, p < 0.001). This suggests that contraceptive use plays an important role in preventing unintended teenage pregnancy.

Transactional sex was also significantly associated with teenage pregnancy. Adolescent girls who had engaged in sexual intercourse in exchange for money, gifts, or support were 67.2% less likely to experience teenage pregnancy or had a lower prevalence of teenage pregnancy compared to those who had not engaged in transactional sex (APR = 0.328; 95% CI: 0.206–0.523, p < 0.001). Similarly, parent-adolescent communication on sexual and reproductive health-related issues was significantly associated with teenage pregnancy. Adolescents who had not discussed sexual and reproductive health-related issues with their parents had a 76% lower prevalence of teenage pregnancy compared with those who had communication on sexual and reproductive health-related issues with their parents or guardians (APR = 0.24, 95% CI: 0.114–0.51, P < 0.001). Family pressure for early marriage was another significant protector. Girls who reported being pressured by their families to marry early were 1.56 times more likely to experience teenage pregnancy than their counterparts (APR = 1.560; 95% CI: 1.144–2.128, p < 0.001).

In summary, the final modified Poisson regression model identified older adolescent age (18–19 years), ever use of family planning methods, coercive sexual experiences, transactional sex, lack of parent-adolescent communication on SRH issues, and family pressure for early marriage as independent predictors of teenage pregnancy among adolescent girls in Jewi refugee camps.

Table 6. Multivariable Modified Poisson Regression Model of Socio-Cultural Factors of Teenage Pregnancy in Jewi Refugee Camp of Gambella, Southwest Ethiopia, 2026

Variables	Teenage Pregnancy		PR (95% CI)	APR (95% CI)
	Yes (%)	No (%)		
Age group				
13–17 years	27 (14.2)	163 (85.8)	3.645(2.51−5.31)**	1.35(1.07−1.71)*
18–19 years	100 (51.8)	93 (48.2)	1	1
School attendance status				
Attending school currently	72 (24.2)	226 (75.8)	1	1
Drop-out from school	55 (64.7)	30 (35.3)	0.37 (0.29−0.48)**	0.98 (0.78−1.24)
Educational status of the respondent				
Informal &primary school	92 (39.1)	143 (60.9)	0.60 ((0.43−0.94)**	0.96 (0.77−1.19)
Secondary school level	35 (23.6)	113 (76.4)	1	1
Educational status of the Father				
Informal to primary level	77 (43.8)	99 (56.3)	0.55 (0.41−0.47)**	0.85 (0.69−1.05)
Secondary to university level	50 (24.2)	157 (75.8)	1	1
Marital status of the respondent				
Never married	85 (64.9)	46 (36.1)	1	1
Ever married	42 (16.7)	210 (83.3)	0.26 (0.19−0.35)**	0.89 (0.70−1.13)
Occupation status of the father				
Employed	52 (34.7)	26 (28.0)	1	1
Farmer	49 (36.8)	84 (63.2)	1.33 (0.90−1.98)*	1.12 (0.87−1.44)

Unemployed	26 (28.0)	84 (63.2)	1.42 (0.95−2.11)*	0.85 (0.67−1.07)
Household average monthly income or per capita income in Ethiopian birr				
> 350 birrs	55 (27.9)	142 (72.1)	1	1
≤ 350 birrs	72 (38.7)	114 (61.3)	0.72 (0.54−0.96)**	0.95 (0.80−1.13)
Ever heard about family planning methods				
Yes	118 (36.3)	207 (63.7)	1	1
No	9 (15.5)	49 (84.5)	2.34(1.26−4.34)**	1.03 (0.82−1.28)
Ever used family planning methods				
Yes	10 (7.4)	126 (92.6)	1	1
No	117 (47.4)	130 (52.6)	6.44 (3.497−11.87)**	2.76 (1.67−4.55)**
Had sexual intercourse in exchange for money, gift or support				
Yes	111 (89.5)	13 (10.5)	0.10 (0.06−0.16)**	0.33 (0.21−0.52)**
No	16 (9,1)	159 (90.9)	1	1
Felt pressured or forced to have sexual intercourse				
Yes	15 (48.4)	16 (51.6)	0.66 (0.44−0.98)**	1.22 (1.01−1.48)
No	112 (31.8)	240 (68.2)	1	1
Discussed sexual and RH related issues with parents				
Yes	6 (3.9)	148 (96.1	1	1
No	121 (52.8)	108 (47.2)	0.07 (0.03−0.16)**	0.24 (0.11−0.51)**
Family pressured girls for early marriage.				
Yes	111 (58.1)	80 (41.9)	6.97 (4.30−11.32)**	1.56 (1.14−2.13)**
No	16 (8.3)	176 (91.7)	1	1
Family history(mother/ sister) of teenage pregnancy				
Yes	47 (63.5)	27 (36.5)	0.41 (0.32−0.33)**	0.90 (0.75−1.08)
No	80 (25.9)	229 (74.1)	1	1
Type of family				
Nuclear &extended family	121 (34.1)	6 (21.4)	1	1
Polygamous &single parent	234 (65.9)	22 (78.6)	1.59 (0.77−3.28)*	0.83 (0.52−1.33)
Parents raised (living together with) the girl				
Both biological parents	87 (31.5)	189 (68.5)	1	1
Single biological parent	27 (32.5)	56 (67.5)	0.58 (0.39−0.87)**	0.88 (0.66−1.17)
Guardian or relative	13 (54.2)	11 (45.8)	0.60 (0.37−0.97)**	0.86 (0.63−1.16)

*Notes: * p-value < 0.25, **p-value < 0.05,*

Abbreviation: PR prevalence rate; APR adjusted prevalence rate

Discussion

This study aimed to assess the prevalence and socio-cultural factors associated with teenage pregnancy in Jewi refugee camp. It identified some socio-cultural determinants of teenage pregnancy after controlling for potential confounding factors. Specifically, age group, use of family planning methods, transactional sex, and parent-adolescent communication on sexual and reproductive health (SRH) related issues, and family pressure for early marriage remained significantly associated with teenage pregnancy.

The overall prevalence of teenage pregnancy in this study was 33.2%, which is higher than the studies conducted in Rwanda (10.7%, Sub-Saharan Africa 24.9% and a systematic pool review by AJOG Global Reports at a Glance with 17.9% [22, 23]. This might be due to the high prevalence of early

marriage and early sexual initiation in this refugee camp. However, the current finding is lower than those from studies conducted in Somalia, and Zambia, which reported rates of 35.9%, 47.2%, and 48%, respectively [24, 25]. The difference may be justified by variations in socio-demographic characteristics among participants. The findings of this study align with those from studies conducted in Ethiopia [15-17].

The findings of this study showed that adolescents aged 13–17 years were 35.4% more likely to experience teenage pregnancy compared with those aged 18–19 years. Although teenage pregnancy is generally expected to increase with age due to longer exposure to sexual activity, the current findings might reflect the unique socio-cultural context and the humanitarian circumstances of the refugee settings, where younger adolescents are disproportionately exposed to early marriage, early sexual initiation, limited autonomy, and sexual coercion. The younger girls might have limited experience with safe sexual practices and the influence of pornography through watching romantic movies. Similar findings were reported in Ethiopia and among the displaced population and humanitarian settings, where younger girls were particularly vulnerable to harmful traditional practices and gender inequalities [15, 26].

The study further revealed that adolescent girls who had never used family planning methods were nearly three times more likely to report teenage pregnancy than those who had ever used contraceptive methods. These findings are consistent with previous studies conducted in Zambia and other sub-Saharan African countries, which demonstrated that inadequate access to contraceptive information and services remains a major contributor to unintended adolescent pregnancies [27-29] and also consistent with studies conducted on refugee adolescents, which identified barriers to family planning utilization, including stigma, misconceptions about contraceptive side effects, lack of privacy, and inadequate youth-friendly services [30] Therefore, improving access to adolescent-friendly SRH services and increasing contraceptive uptake could substantially reduce the burden of teenage pregnancy in refugee camps.

Similarly, parent-adolescent communication on sexual and reproductive health-related issues demonstrates an inverse association with teenage pregnancy. Adolescents who did not discuss sexual and reproductive health-related issues with their parents had a 76% lower prevalence of teenage pregnancy. This study is contrary to the established evidence, which generally indicates that open communication between parents and adolescents promotes informed decision-making and safe sexual behavior. A possible explanation might be the reverse causality inherent in a cross-sectional study, where discussions about sexual and reproductive health occur after adolescents become pregnant or engage in sexual activity. In many communities, conversations surrounding sexuality are often initiated in response to perceived risk behavior rather than protective measures. The other possible explanation might be the knowledge gaps concerning Sexual and reproductive health and socio-cultural beliefs about early marriage, as parents might discuss early marriage. Similar findings have been reported that societies do not encourage an open discussion about sex, as parents do not feel comfortable [5, 31].

Unexpectedly, adolescents who reported engaging in transactional sex had a significantly lower prevalence of teenage pregnancy (67%) than those who did not engage in transactional sex. These findings contradict the existing literature and some studies conducted in Rwanda, Ghana, South Africa, and Sub-Saharan Africa, which identified transactional sex as a risk factor for adolescent pregnancy [14, 32, 33]. One of the possible explanations is that girls who are

involved in transactional sex might be more likely to use condoms or other contraceptive methods to avoid unintended pregnancy due to fear of social consequences. A similar report in a cross-sectional study observed a protective association [34]. Additional qualitative investigations are necessary to understand this relationship.

Family pressure for early marriage was another significant determinant of teenage pregnancy. Adolescent girls who had experienced pressure from their families to marry early were approximately 1.6 times more likely to become pregnant than those who had not experienced pressure from their families. This finding is consistent with the evidence indicating that child marriage remains a major contributing factor for adolescent pregnancy, and early marriage leads to early childbearing in low-resource and humanitarian settings [35-37]. In the refugee camps, where economic hardship and cultural norms may perpetuate early marriage practices, interventions aimed at delaying marriage and promoting girls' education are essential.

Conclusions

Overall, the findings underscore the complex interplay of socio-cultural and sexual and reproductive health factors influencing teenage pregnancy among refugee adolescents. This highlights the need for comprehensive interventions that strengthen access to family planning services, discourage child marriage, promote girls' empowerment, and address socio-cultural norms that predispose adolescent girls to early pregnancy. Given the unexpected findings regarding transactional sex and parent-adolescent communication, future longitudinal and qualitative studies are recommended to establish causal pathways and provide deeper contextual understanding.

Disclosure

The authors declare no conflicts of interest in this work.

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Ethical Approval

Ethical approval and clearance were obtained from the Gambella Regional Health Bureau (RHB) in January 2026. An official letter of permission and collaboration was written and submitted to Jewi Refugee Camp during the data collection period. Before data collection, participants were informed about the study's purpose and their right to decline participation. Confidentiality was maintained by keeping all information strictly confidential and ensuring that data would only be used for the study's purpose. Additionally, both written and verbal consent were obtained from participants and their parents or guardians before data collection, confirming their willingness to participate.

Authors' Contribution

The corresponding author contributed to the study's conception, design, data acquisition, analysis, interpretation, manuscript drafting, and revision for important intellectual content. The corresponding author also submitted the manuscript to the journal and accepts full responsibility for the integrity and accuracy of the work. The co-authors' contributions included scientific guidance, critical review of the manuscript for intellectual content, and final approval of the version to be published,

and they agree to submit the manuscript to the journal.

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Assessment of the Operational Coordination of Surveillance and Response to Noncommunicable Diseases in the Butembo Branch of the North Kivu Provincial Health Division, DRC

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Abstract *Coordinated surveillance and response are essential for transforming data on noncommunicable diseases (NCDs) into evidence-based prevention and care interventions. This study assessed the level of such coordination in the health districts under the jurisdiction of the Butembo provincial health division in the Democratic Republic of the Congo. This quantitative, descriptive, cross-sectional, evaluative study used a comprehensive approach across all 17 health districts under the Butembo provincial health division. Data were collected using a framework combining a structured questionnaire, observation rubrics, a document review, and the extraction of indicators from the District Health Information Software 2 (DHIS2). Standardised scores were classified as low (<50%), moderate (50–74%), or high (≥75%). The average overall coordination score was 33.76 ± 5.90%, and all districts scored at a low level. The mean score was 45.93% ± 7.16% for surveillance coordination, 34.74% ± 3.85% for organizational capacity and 17.86% ± 11.35% for response coordination. Indicators extracted from DHIS2 had the highest score (86.76%), while coordination of risk factor surveillance was nearly nonexistent (3.43%). The existing system was primarily oriented towards data collection and transmission, with limited translation of surveillance data into concrete prevention and care interventions. Strengthening the surveillance system and integrating NCDs into health and humanitarian emergency preparedness and response plans are essential.*

Keywords *Coordination, DHIS2, Non Communicable Diseases, North Kivu, Response, Surveillance.*

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Introduction

Noncommunicable diseases (NCDs) are currently one of the major global public health challenges. According to the World Health Organization [1] in 2021, NCDs were responsible for approximately 43 million deaths worldwide, including at least 18 million premature deaths, that is, deaths occurring before the age of 70 years. This mortality is primarily attributable to four major groups of conditions: cardiovascular diseases, cancers, diabetes, and chronic respiratory diseases. These diseases are strongly associated with four major risk factors: tobacco use, physical inactivity, harmful use of alcohol, and unhealthy diets. The situation is particularly alarming in low- and middle-income countries (LMICs), which account for approximately 73% of NCD-related deaths and 82% of premature deaths, at a time when these countries are undergoing demographic, nutritional, and epidemiological transitions [2-5].

In the WHO African Region, NCDs occur within the context of a dual health burden, characterized by the coexistence of chronic diseases, communicable diseases, public health emergencies, and humanitarian crises. The WHO Regional Office for Africa [6, 7] reports that NCDs account for an increasingly large share of total mortality in the region. This trend is exacerbated by shortages of essential medicines, screening and diagnostic technologies, trained human resources, and mechanisms for long-term follow-up of patients with chronic conditions. This situation in many resource-limited countries reflects the inadequate preparedness of health systems to meet the growing needs associated with NCDs [8, 9].

In the Democratic Republic of the Congo (DRC), the lack of reliable nationwide data is among the challenges related to NCDs; this limits our understanding of the scale of the problem, even as the country is undergoing a demographic transition amid a difficult socioeconomic and security context. Consequently, controlling NCDs while carrying out activities to combat communicable diseases remains a difficult task [10, 11]. However, the WHO's *"Health at a Glance"* report published in 2021 highlights that the estimated number of deaths reported by the DRC was 857,667, of which 35% were associated with NCDs [12].

In North Kivu, the extent of NCDs remains insufficiently documented. However, routine data from DHIS2 for the period 2019–2023 indicate a significant clinical burden associated primarily with hypertension, diabetes, heart failure, bronchial asthma, and strokes [13]. In the Nyiragongo health district in North Kivu, for example, the prevalence of hypertension among adults was 36.1%, while only 2.4% of people with hypertension were receiving treatment [14].

While the response to NCDs implies transforming surveillance data into concrete actions in terms of prevention, screening, diagnosis, treatment, referral, long-term follow-up, and continuity of care, many frontline services remain inadequately prepared to manage NCDs, particularly at the primary care level [15]. These weaknesses relate in particular to trained human resources, diagnostic tests, clinical guidelines, essential medicines, equipment, and mechanisms for improving the quality of care. These gaps are particularly evident at the peripheral level of the health system, which is nonetheless the gateway to prevention, screening, management, and community-based follow-up for chronic diseases [8, 16-18]. Coordinating surveillance and the response to NCDs in fragile settings becomes even more critical. Continuity of care for patients with chronic conditions is severely disrupted, due in particular to service disruptions and organizational barriers to access [19]. From this perspective, integrating NCDs into preparedness and response approaches for all health risks appears

necessary [20]. In North Kivu, this issue is particularly acute due to insecurity, population displacement, the disruption of services, and repeated health emergencies, all of which can affect the quality of surveillance, supervision, and the organization of an appropriate response[12, 21-23].

Most available studies in LMICs focus on health-facility readiness, particularly the availability of trained staff, guidelines, diagnostic technologies, medicines, and models of primary care [8, 15-18]. However, less attention has been paid to how district-level coordination links routine surveillance data to prevention, care, referral, and continuity interventions, especially in fragile and humanitarian settings [19, 20].

Since coordination mechanisms between the District Management Office (DMO), health facilities, routine data, and response interventions have been little explored particularly within the Butembo provincial health division branch this study aims to assess the level of coordination in surveillance and response to noncommunicable diseases (NCDs) to identify the system's strengths and weaknesses, as well as organizational shortcomings that may limit the use of data and the implementation of an appropriate NCD response in the context of North Kivu Province. This evidence gap is particularly important in North Kivu, where recurrent insecurity and service disruptions may weaken both routine surveillance and the translation of data into sustained NCD action [21-23].

Materials and Methods

Study Design

The study was conducted using a quantitative, descriptive, cross-sectional, and evaluative approach at the central offices of the health districts under the Butembo PHD branch. It aimed to assess the level of coordination of surveillance and response to NCDs based on measurable indicators. Using DHIS2, reporting indicators were documented retrospectively for the period from January to December 2025, while other data related to routine activities reflected the situation observed at the time of the survey.

Study Setting

The study was conducted at the Butembo provincial health division branch, North Kivu Province, in the Democratic Republic of the Congo; this branch comprises 17 health districts, each coordinated by a district management office (DMO), which serves as the operational level for coordinating health activities, including the coordination of surveillance and response to noncommunicable diseases. Thus, the DMO, not individual health facilities was the unit used to assess district-level operational coordination.

Study Population

The study focused on a population comprising the 17 health districts under the jurisdiction of the Butembo provincial health division branch, selected using an exhaustive approach. The units of observation for this study were the DMOs, the structures responsible for planning, coordinating, monitoring, supervising, and managing health facilities at the health district level. In practice, information was obtained from a member of the district management team (district management officer, supervising nurse, data manager); this information was supplemented by a document review and direct observation.

Sampling

Due to the limited size of the population, the 17 health districts under the jurisdiction of the Butembo provincial health division branch were selected exhaustively as study units through their district management offices; this provided a comprehensive assessment of the capacity to coordinate surveillance and response to NCDs across the entire branch.

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Data Collection Techniques and Tools

Data collection was conducted exclusively by the principal investigator between June and July 2026 using a data collection form programmed in KoboToolbox. This form combined a structured questionnaire, direct observation, a document review, and data extraction from DHIS2. Certain statements were verified against the DMO's records, reports, operational plans, meeting minutes, and other archives. Three components were evaluated. First, surveillance, which covered risk factors, organization and management, morbidity, mortality, complications, the information system, the quality of reporting, and data use. The response component**,** for its part, focused on prevention, governance, diagnosis, medications, emergencies, referrals, business continuity, and community participation. Finally, organizational capacities included human, logistical, and financial resources, partnerships, and monitoring.

Items were scored on a scale of 1 to 3: 1 for an element that was absent or not implemented; 2 for an element that was partially present, irregular, or insufficiently documented; and 3 for an element that was available, structured, and documented. Reporting indicators namely completeness, timeliness, quality of data entry, and feedback were retrospectively extracted from DHIS2 for January through December 2025. For these indicators, a score of 1 corresponds to a percentage < 80%; a score of 2 corresponds to a percentage between 80 and 89%; and a score of 3 corresponds to a percentage ≥ 90%.

The scoring grid was developed based on the WHO PEN [24] , the SARA approach [25], and the WHO STEPS framework [26]. It was reviewed by three independent experts two researchers in NCDs and one expert in epidemiological surveillance and then pretested in early June 2026 in the Nyangezi health district in South Kivu.

Data Analysis

The data were analysed using IBM SPSS Statistics software**,** version 22, and were subjected to descriptive analysis, including frequencies, percentages, means, medians, and standard deviations (SD). The internal consistency of the assessment grid was evaluated using Cronbach's alpha [27]. To assess the performance level in each domain studied, the various scores assigned to the indicators were converted into percentages. In the absence of normative thresholds, operational thresholds were defined to facilitate the interpretation of the scores obtained in each domain. Since each item was rated on a scale from 1 to 3, the scores were converted to a percentage of the maximum possible (POMP), according to the POMP method proposed by Cohen et al. and recently applied by Schwappach et al. [28, 29] using the following formula:

$$Standardised\ score = \frac{score\ achieved - lowest\ possible\ score}{Highest\ possible\ score - Lowest\ possible\ score} \times 100$$

Through this transformation, the scores were scaled to a range of 0 to 100%, without altering the initial rating scale of 1 to 3 [28]. Thus, for practical purposes, a score below 50% was classified as low; a score between 50% and 74% was classified as moderate; and a score of 75% or higher was classified as high. Using the scores obtained for all items, the overall score was calculated as the sum of the scores obtained relative to the total range of theoretically possible scores, then scaled to a range of 0 to 100. These cut-offs were operational rather than normative; scores therefore indicate relative attainment of the assessed coordination criteria, not clinical performance standards.

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Ethical Considerations

Ethical approval was obtained from the Ethics Committee of Lukanga Adventist University (CER/UNILUK/CER-FRIDI-UNILUK/2026/0028). In addition to this approval, an authorization to collect data was issued by the Head of the North Kivu provincial health division under number 251/178/DPS-NK/BN/2026. Participation in the study was formalized by the signing of an informed consent form that specified the study's objectives, the right to refuse to answer certain questions, and the guarantee of anonymity and confidentiality of the information collected. However, this anonymization did not apply to the identification of health districts as units of data analysis.

Results

General Characteristics of the Studied Health Districts

The health districts (HD) under the Butembo Provincial Health Division, Butembo branch are predominantly rural, with 13 out of 17 HD or 76.5% being rural; three HD or 17.6% are urban; and only one district or 5.9% is urban-rural. Ten health districts, or 58.8%, have average accessibility, while three districts, or 17.6%, are considered difficult to access; four health districts, or 23.5%, are relatively easy to access. Support from technical and financial partners for NCDs remains limited; thirteen out of 17 health districts (76.5%) received no specific support for NCD surveillance and response activities, while four others (23.5%) reported only occasional support. No health districts reported regular, structured support specifically dedicated to NCDs (Table 1).

Table 1. General Characteristics of the Health Districts

	Sample Size (n = 17)	**Percentage**
Type of Health District		
Rural	13	76.5
Urban	3	17.6
Urban-rural	1	5.9
Geographic Accessibility		
Difficult	3	17.6
Average	10	58.8
Easy	4	23.5
Partner Support for NCDs		
No support	13	76.5
Occasional support	4	23.5
Regular support	0	0.0

Internal Consistency of the Instrument

For the instrument as a whole, internal consistency was high, with a Cronbach's alpha of 0.905; this value indicates that the items collectively contributed to a consistent measurement of the level of operational coordination despite the small number of observation units and the multidimensional nature of the scale. The surveillance dimension showed good internal consistency ($\alpha = 0.811$), while the response dimension had excellent internal consistency ($\alpha = 0.918$). In contrast, the alpha for organizational capacities was low ($\alpha = 0.485$); this result can be explained by the multidimensional nature of this component,

which encompasses human resources, logistics, funding, partnerships, supervision, and continuous improvement.

Overall Level of Operational Coordination of Surveillance and Response

The overall level of operational coordination of monitoring and response is presented in Table 2. The analysis focused on three complementary components: NCD surveillance, the operational response to these diseases, and the organizational capacities required for their coordination. Overall, the results indicate that the system established for NCD surveillance and response remains underperforming. The average overall score for operational coordination was 33.76% ± 5.90, with a median of 34.04%. The observed values ranged from 26.60% to 49.47%, highlighting a relatively moderate dispersion but, more importantly, the fact that not a single health district reached the 50% threshold corresponding to the average level. Thus, all 17 health districts were generally classified in the low coordination level category.

Surveillance nevertheless remained the relatively most developed dimension, with an average score of 45.93% ± 7.16. It outperformed organizational capacities, which averaged 34.74% ± 3.85. The response to NCDs appeared to be the component with the greatest shortcomings, at only 17.86% ± 11.35. The gap of nearly 28 points between surveillance and response indicates that mechanisms for collecting and transmitting information are more firmly established than concrete interventions for the prevention, diagnosis, management, and follow-up of NCDs at the Butembo provincial health division branch. Accordingly, the higher surveillance score should not be interpreted as strong NCD surveillance overall, because it was largely driven by routine DHIS2 reporting while risk-factor surveillance remained extremely weak.

Table 2. Overall Operational Coordination

Dimension	Mean ± SD (%)	Median (%)	Min–Max (%)
Surveillance of NCDs	45.93 ± 7.16	45.59	30.88–61.76
NCD response	17.86 ± 11.35	19.64	3.57–46.43
Organizational capacity	34.74 ± 3.85	35.94	28.12–40.62
Overall coordination	33.76 ± 5.90	34.04	26.60–49.47

Results by Assessed Domains

Table 3 presents the different results by assessed area. A high degree of heterogeneity in performance emerges upon detailed examination of the various domains. Reporting indicators extracted from the DHIS2 platform showed the highest score, at 86.76% ± 26.69, corresponding to an overall high level. The areas of reporting, data quality, analysis, and improvement, meanwhile, achieved an average score of 57.45% ± 11.27. However, the other components of surveillance remained weak. Institutional organization and management scored 46.57% ± 5.94, while tools, resources, and information systems scored 42.86% ± 7.99. Surveillance of morbidity, complications, and mortality scored 36.93% ± 5.87. The main weakness concerned the surveillance of NCD risk factors, for which the average score was only 3.43% ± 4.23.

Areas related to the response were particularly inadequate, indicating a low level of coordination or support from the DMOs regarding staff training, equipment, funding, and supervision. The DMOs' involvement in governance, prevention, and response coordination scored 10.29% ± 12.68. DMO support regarding the availability of tests and

diagnostic technologies reached 16.54% ± 14.14, while coordination of continuity of care, referral, community engagement, and patient support stood at 13.87% ± 10.56. Coordination regarding medications, supplies, emergencies, and ongoing care showed a slightly higher, though still low, score of 29.83% ± 16.02. Organizational capacities revealed poor coordination; the area of human resources and their competencies scored 24.63% ± 7.15, and logistical and financial resources and partnerships scored 26.96% ± 7.53. Supervision, support for health facilities, and continuous improvement reached 34.71% ± 11.25.

Table 3. Performance of Operational Coordination Components

Component	Coordination Areas Evaluated	Mean ± SD (%)	Average Score Classification
Surveillance	Reporting indicators extracted from DHIS2	86.76 ± 26.69	High
Surveillance	Reporting, Quality, Analysis, and Improvement	57.45 ± 11.27	Medium
Surveillance	Institutional Organization and Management	46.57 ± 5.94	Low
Surveillance	Tools, Resources, and Information Systems	42.86 ± 7.99	Low
Surveillance	Surveillance of morbidity, complications, and mortality	36.93 ± 5.87	Low
Organizational capacities	Supervision, support for health facilities, and continuous improvement	34.71 ± 11.25	Low
Response	Medications, supplies, emergencies, and ongoing care	29.83 ± 16.02	Low
Organizational capacities	Logistical and financial resources and partnerships	26.96 ± 7.53	Low
Organizational capacity	Human resources and skills	24.63 ± 7.15	Low
Response	Tests and diagnostic technologies	16.54 ± 14.14	Low
Response	Continuity, referral, community, and support	13.87 ± 10.56	Low
Response	Governance, prevention, and response coordination	10.29 ± 12.68	Low
Surveillance	Surveillance of risk factors	3.43 ± 4.23	Low

Variations in the Level of Coordination among Health Districts

The operational coordination scores by health district are presented in Table 4. Although all districts were classified as “low,” their scores revealed distinct profiles. Beni ranked first with an overall score of 49.47%, close to the threshold for the average level. This district also had the highest score for surveillance (61.76%) and the highest response score (46.43%), even though its organizational capacity remained low (39.06%). Maseraka ranked second with 39.89%, followed by Mabalako (39.36%), Vuhovi (37.77%), and Kyondo (37.23%). These districts generally combined relatively more developed

surveillance with a response that was still insufficient.

An intermediate group consisted of the Alimbongo, Kayna, and Oicha health districts, each scoring 34.57%, followed by Mutwanga (34.04%) and Musienene (32.45%). Kamango had an overall score of 31.38%. The lowest scores were observed in Lubero and Manguredjipa (29.79% each), Katwa (28.72%), Kalunguta (27.13%), as well as in Biena and Butembo (26.60% each). However, the same overall score could mask different situations. Lubero achieved 50.00% for surveillance but only 5.36% for response. Biena had the highest organizational capacity of all districts (40.62%), while its surveillance score was only 30.88%. Butembo recorded the lowest response score, at 3.57%.

Table 4. Operational Coordination Scores by Health District

Rank	Health District	Surveillance (%)	Response (%)	Organizational Capacity (%)	Overall Score (%)	Level
1	Beni	61.76	46.43	39.06	49.47	Low
2	Maseraka	55.88	23.21	37.50	39.89	Low
3	Mabalako	51.47	25.00	39.06	39.36	Low
4	Vuhovi	52.94	26.79	31.25	37.77	Low
5	Kyondo	45.59	26.79	37.50	37.23	Low
6	Alimbongo	44.12	21.43	35.94	34.57	Low
6	Kayna	47.06	19.64	34.38	34.57	Low
6	Oicha	42.65	23.21	35.94	34.57	Low
9	Mutwanga	45.59	17.86	35.94	34.04	Low
10	Musienene	42.65	19.64	32.81	32.45	Low
11	Kamango	45.59	5.36	39.06	31.38	Low
12	Lubero	50.00	5.36	29.69	29.79	Low
12	Manguredjipa	36.76	21.43	29.69	29.79	Low
14	Katwa	44.12	5.36	32.81	28.72	Low
15	Kalunguta	42.65	7.14	28.12	27.13	Low
16	Biena	30.88	5.36	40.62	26.60	Low
17	Butembo	41.18	3.57	31.25	26.60	Low

Discussion

Operational coordination was low overall (33.76%), with surveillance performing better than organizational capacity and response. This pattern suggests the system is stronger in routine data reporting than in converting information into coordinated NCD prevention and care.

The low overall level observed is corroborated by the results of several studies conducted in low- and middle-income countries characterized by a lack of preparedness in primary care systems to manage NCDs. A systematic review conducted by Kabir et al.[15] highlighted frequent shortages of trained personnel, clinical guidelines, equipment, diagnostic tests, and essential medications in primary care facilities. Similar findings were observed in several South Asian countries, despite the rapidly increasing burden of NCDs, although these findings related more to health facility assessment than to DMO coordination [8]. A distinctive feature of the African context remains the fact that limited resources are primarily directed toward acute communicable diseases and humanitarian emergencies [9, 30].

Surveillance was the relatively most developed area, primarily due to the

performance driven by indicators extracted from DHIS2 namely, completeness, timeliness, data entry quality, and feedback with an average score of 86.76. However, this performance should be interpreted with caution; it appears to be a result of the routine reporting system and the achievements of SNIS/DHIS2 in the area of reporting, unrelated to the strengthening of specific surveillance for NCDs. Indeed, good reporting indicators can coexist with insufficient surveillance of risk factors, complications, longitudinal follow-up, and the effective use of data for decision-making; this can thus mask the shortcomings specific to NCD surveillance, particularly in a system more concerned with the administrative transmission of data to higher levels than with its local use [26, 31]. The mere availability of DHIS2 does not guarantee effective surveillance. Analytical skills, along with organizational support and a culture conducive to using data for decision-making, are all elements that must be leveraged to ensure the effectiveness of DHIS2 [32].

The main weakness in surveillance coordination remains the inadequate surveillance of risk factors, with an average score of 3.43% and a median of zero; in other words, at the operational level, interventions targeting tobacco use, harmful alcohol use, physical inactivity, and unhealthy diets were barely integrated into the routine activities of health districts. Attention is primarily focused on diagnosed diseases and services provided, thereby limiting health officials' knowledge of risk factors in a context where no STEPwise survey has ever been conducted in North Kivu Province [33].

Coordination of NCD response activities was particularly weak. The areas of governance, prevention, and coordination scored an average of 10.29%, while activities supporting the availability of diagnostic tests and technologies reached 16.54%. Support for continuity of care, referral, community engagement, and patient support scored 13.87%. These results are consistent with evaluations that have shown low availability of essential NCD control services in several primary care systems, which struggle to translate the data they generate into concrete screening, diagnostic, treatment, and follow-up services [16, 17]. Inadequate monitoring of tests, technologies, medications, and supplies is likely to lead to diagnostic delays, treatment interruptions, and an increase in complications. These observations confirm the importance of an integrated package that combines essential medicines, basic technologies, clinical protocols, and trained personnel, in accordance with WHO PEN guidelines [24].

In the specific context of North Kivu, which is suffering the negative effects of insecurity, population displacement, and service disruptions, the lack of support from the DMOs for the continuity of chronic care remains a concern for NCDs that require prolonged follow-up. Integrating the NCD dimension into preparedness and response plans for humanitarian crises could reduce medication shortages and disruptions in care pathways [19, 20].

The organizational capacities of health districts to address NCDs were also weak, particularly in terms of human resources and skills which scored an average of 24.63% as well as logistical and financial resources and partnerships, which scored 26.96%. Indeed, the lack of regular support from a partner in nearly all health districts could contribute to the shortcomings observed in their organizational capacities [34]. However, the organizational capacity dimension showed low internal consistency ($\alpha = 0.485$), which may reflect conceptual heterogeneity among the components grouped within this dimension. Its aggregate score was therefore interpreted with caution.

Finally, all health districts showed a low overall level, but their profiles varied from one district to another. Beni had the highest score, at 49.47%, while Biena and Butembo had the

lowest scores, at 26.60%. Some districts had relatively better surveillance but a very weak response, such as Lubero, whose scores were 50.00% and 5.36%, respectively. These variations indicate that improvement measures should be tailored to the profile of each health district.

However, the descriptive nature of the study and the small number of units do not allow for the identification of the factors responsible for these differences. Further qualitative and analytical studies are therefore needed to explore the role of accessibility, partner support, team competencies, and the security context.

Conclusion

Operational coordination of NCD surveillance and response was low across all 17 health districts (33.76%), with response (17.86%) and organizational capacity (34.74%) lagging behind surveillance (45.93%).

The apparent surveillance advantage was largely driven by DHIS2 reporting, whereas risk-factor surveillance and translation of data into prevention and care remained weak.

Limitations of the Study

The main limitations were the cross-sectional design, the small number of units (17 districts), partial reliance on respondent-reported information, and the use of operational rather than validated normative score thresholds. These factors limit causal inference and broader generalization.

Recommendations

Priority actions should directly address the weakest domains: integrate routine surveillance of NCD risk factors, strengthen district support for prevention, diagnosis, referral and continuity of care, and improve human-resource and logistical capacity. Given the strong DHIS2 reporting score, emphasis should shift from data transmission alone toward local analysis and use of data for action.

Conflict of Interest

The authors declare that they have no conflicts of interest.

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Ethical Approval

Ethical approval for this study was granted by the Ethics Committee of the Adventist University of Lukanga (No. CER/UNILUK/CER-FRIDI-UNILUK/2026/0028). All participants provided informed consent before participating in the study.

Authors' Contributions

The lead author designed the study, developed the tools, collected the data, analyzed the data, and drafted the manuscript. The co-authors contributed to the scientific oversight, critical review, and final validation of the manuscript.

Data Availability

The data supporting the findings of this study are not publicly available to protect respondent confidentiality. An anonymized dataset may be obtained from the corresponding author upon reasonable request, subject to applicable ethical requirements.

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Erosion behind the Volume: A Retrospective Longitudinal Analysis of the Resilience of Maternal Newborn and Child Health Services Following USAID exit in Nigeria

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Abstract *Nigeria's maternal, newborn, and child health (MNCH) services depend heavily on external donor funding, particularly from the United States Agency for International Development (USAID). Following December 2023 closure of USAID's flagship MNCH project in Bauchi State, and the global suspension in 2025, this study evaluates the impact on sustainability of MNCH services in a high-burden setting. Using a retrospective longitudinal design, the study analysed routine administrative data from 454 health facilities over a 48-month period (January 2022 - December 2025). Nine indicators were assessed using Wilcoxon signed-rank test and Interrupted Time Series analysis to examine performance during and after USAID implementation. The results showed that while absolute volumes on antenatal visits and facility deliveries continued to rise, critical coverage indicators, specifically Penta3 and fully immunized child (FIC) rates, recorded declines ($p < 0.05$). Multi-variable mixed-effects regression identified participation in the Basic Health Care Provision Fund (BHCPF) as the most consistent independent protective factor for resilience ($p < 0.001$), followed by location within Maternal Neonatal Mortality Reduction Innovation Initiative (MAMII) priority locations. Private and secondary health facilities demonstrated greater vulnerability to funding shocks. These findings suggest that tracking volume alone can mask the active erosion of quality of care after donor exit. The study concludes that MNCH sustainability is a direct consequence of domestic planning. Policy makers must prioritize stabilizers like the BHCPF and incorporate trend-based monitoring to safeguard gains post donor funding.*

Keywords *Basic Health Care Provision Fund (BHCPF), Donor Transition, Maternal Newborn and Child Health (MNCH), Nigeria, Sustainability, USAID.*

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Introduction

For a long time, maternal, newborn, and child health (MNCH) services in low- and middle-income countries (LMICs) have remained critically dependent on external donor funding to sustain their operational continuity [1, 2]. This dependency is quite pronounced in Nigeria. The United States Agency for International Development (USAID) was the most significant external funder of Nigeria's health sector. In 2024 alone, Nigeria received $876 million in development aid from USAID, the fifth largest donation in Africa. USAID's 2025 budget had earmarked 89.27% of its $602.95 million to health-related programmes in Nigeria [3], underscoring heavy reliance on external support in the health sector. Often, this dependence results in a critical vulnerability. When donor funds are halted or suspended, health systems could face immediate and potentially severe disruptions across multiple functional domains [4, 5]. The effects of donor exit are well-documented in global health literature and can have dire consequences for life-saving interventions that are not well rooted in host country domestic institutional support [6, 7]. Such exit become a shock and potentially have negative and far-reaching impact on the quality and coverage of health services especially when domestic health institutions are weak, such as is the case in many Northern Nigeria States.

Bauchi state is one of the six states in North East Nigeria which has been plagued by poor health outcomes, rising poverty and insecurity. For over two decades, USAID has funded various high impact integrated service delivery and health systems strengthening projects in Bauchi state including programs on strengthening primary health care service delivery, health workforce management, social behaviour change, logistics and supply chains management, and health finance/governance projects. However, recent shifts in global donor funding priorities have led to withdrawal of USAID supported programs [8]. The decreased resourcing due to this action potentially threatens the continuity of critical health services at health facility levels and ultimately negatively impact overall health outcomes of the populations they serve.

USAID's flagship MNCH project in Bauchi state officially closed in December 2023 after about six years of implementing MNCH services across the state. Many analysts have expressed concern that domestic resources will unlikely fully absorb the shortfall, most especially in Nigerian states already operating under severe financial constraints [9].

Modelling studies have evaluated the impact of USAID defunding on mortality, projecting that up to 14 million all-age deaths and 4.5 million deaths in under five children could result from the cut in USAID funding [10]. Despite growing concern about the consequences of the 2025 USAID programme closures, empirical evidence on the facility-level impacts of this withdrawal on Maternal Newborn and Child Health (MNCH) service delivery remains strikingly limited leaving a gap in context-specific, facility-level insights capable of informing corrective actions at grassroots level.

Bauchi State, Northeast Nigeria, is a setting already burdened by some of Nigeria's highest maternal and child mortality rates and poor MNCH indices [11], driven by weak health systems, high levels of poverty, low female education and socio-cultural barriers [11, 12], as well as characterized by deep dependence on donor funds to run health systems [13]. Health service utilization is usually affected by demand-side and supply-side factors such as availability of services, cost, quality and access to health facilities [14].

This study assessed whether the progress made in the utilization and quality of MNCH services during USAID have been sustained, flatlined or eroded after USAID's closure through a sustainability analysis of key MNCH indicators reported from health facilities

previously funded by USAID in Bauchi State Nigeria.

Context and Policy Implications

Health is on the concurrent legislative list in Nigeria, meaning that both the Federal and State governments can legislate on health issues. The Federal Ministry of Health and Social Welfare (FMoHSW) provides policy guidelines, domestication and implementation largely occur at the sub-national level. Both Federal and State governments have rolled out a number of initiatives to improve health outcomes and achieve universal health coverage (UHC), most notably the National Health Act (NHAct) of 2014. This laid the foundation for establishing the Basic Health Care Provision Fund (BHCPF), launched in 2019 [15]. Under the BHCPF, at least one Primary Health Centre (PHC) per geographic ward is identified and upgraded (infrastructure, staffing, commodities, basic equipment) to provide the national basic minimum package of health services, and in addition, routinely financed every quarter through direct financing from a statutory deduction of 1% of the national consolidated revenue fund supplemented by contributions from international donors, the private sector, and other sources. Bauchi State has 212 BHCPF PHCs. FMoHSW also unveiled the Maternal and Neonatal Mortality Reduction Innovation Initiative (MAMII) in 2024 [16]. This is designed to concentrate efforts on reducing maternal mortality in 172 high-priority LGAs that contribute over 55% of Nigeria's maternal deaths through innovative, data-driven and community-centered approaches. Eleven of these 172 high priority LGAs are in Bauchi State. At State level, Bauchi has been part of a multi-partite Memorandum of Understanding with development partners and private philanthropic organizations leading to setting up a Basket Fund in 2015 [17]. The aim was to establish a sustainable financing mechanism where the state government and development partners jointly funded priority primary healthcare (PHC) interventions while progressively increasing state ownership.

While there is a robust body of evidence showing the positive impact of donor-funded programs on MNCH service delivery in low- and middle-income countries [18, 19], very little evidence exists on the effects of donor withdrawal on health services. The existing body of evidence on the effects of donor transition is largely based on HIV/AIDS program transition in East Africa, with limited evidence on MNCH programs [20, 21] and none at the level of health facilities in Nigeria. The evidence is based on national or subnational aggregate data, qualitative case studies, or modelling, leaving a critical gap in empirical, facility-level comparative evidence on how donor exit impacts the volume, quality and continuity of MNCH service delivery.

The insights generated from this study have immediate practical implications for a range of stakeholders at various levels of the health system. For the State Government of Bauchi, information on the types of MNCH services and facilities most susceptible to donor withdrawal will allow the State Ministry of Health and Social Welfare (SMOHSW) and State Primary Health Care Development Board (SPHCB) to inform state resource allocation priorities, identify potential emergency mitigation interventions, and build transition planning capacity in anticipation of future aid exits. For the Federal Government of Nigeria, the study will provide evidence to guide the implementation of the NHAct and the rollout of the BHCPF in a context-specific manner, and help build a nationally applicable donor transition policy framework - an existing gap in the literature [22]. A 2021 qualitative case study in Nigeria confirmed a lack of systems to absorb the cost of donor programs and ensure service delivery continuity [9]. This study will provide the empirical evidence from the health facilities themselves to inform and guide policy actions for service continuity. For development

partners, including the United Nations Children Fund (UNICEF), the World Health Organization (WHO), the World Bank, Bill and Melinda Gates Foundation (BMGF) and bilateral donors that may consider returning to northeastern Nigeria, the study will pinpoint the health system building blocks most significantly impacted by USAID's exit, and the service delivery bottlenecks which need the most urgent bridging. This knowledge will be essential in any future strategy for health investment in this setting - to be focused, cost-effective, and based on a documented need.

This study becomes a natural experiment in the wake of the 2025 US Government Executive Order which is both critical and timely. In January 2025, the United States Government issued an Executive Order (EO 14169) that immediately suspended and closed USAID operations worldwide [23], bringing to an abrupt halt over 20 years of uninterrupted USAID funding to Bauchi State's health sector. Modelling research has forecast devastating impacts of this withdrawal globally [10]. The findings of this study will be directly relevant to state and national policymakers and development partners responding to the post-USAID health system environment, and will establish Nigeria as an empirical case study to inform the global health community responding to the 2025 US government foreign aid exit.

Materials and Methods

The study is a retrospective quasi-experimental, health facility longitudinal analysis using routine administrative data with a segmented pre (January 2022 – December 2023) versus post (January 2024 – December 2025) comparison stratified by health facility characteristics. The unit of analysis is health facility-month (n= 454 health facilities by 48 months), aggregated to health facility pre and post summaries. The study is a paired analysis in which each health facilities aggregate summary after USAID funding serves as its own control.

Bauchi State is one of the six States in Northeast Nigeria. It is the fifth largest State in terms of geographic landmass (approximately 49,259 km^2) and population, with an estimated population of 8.3 million people [24]. The state has 20 Local Government Areas (LGAs), 323 political wards, and six emirate councils. The LGAs are also divided into three geopolitical senatorial zones (North, Central and South). The State is ethnically and religiously diverse, with Islam and Christianity as the most widespread religions; Hausa, Jarawa, and Fulfulde as the most common languages; and more than 60 native languages. Livelihood of majority of the populace is mainly subsistence farming [25]. Over two decades, USAID's funding in Bauchi shifted from vertical interventions to integrated health systems strengthening. Major programs like Targeted States High Impact Project (TSHIP) and the Integrated Health Project (IHP) prioritized maternal health, financial risk protection, and workforce development. The strategy evolved from purchasing inputs to building sustainable domestic systems. The IHP was USAID's final flagship project focused on MNCH and health systems strengthening covering 476 health facilities across the entire state and was implemented between 2019 and 2023. Review of the sustainability of IHP's MNCH work is the basis of this study.

This study assessed nine key MNCH indicators across three domains.

Maternal Health: Monthly antenatal first visits (ANC 1), monthly deliveries in the health facility, monthly deliveries taken by skilled birth attendants (SBA), and percentage of deliveries taken by SBA (% SBA).

Neonatal Health: Monthly postnatal care visits for mothers within 3 days, monthly postnatal care visits for newborn within 3 days, babies with 4% chlorhexidine gel applied at birth for cord care.

Child Health: Monthly third dose of pentavalent vaccines given (Penta3), monthly fully immunized child under one year (FIC).

The study data were obtained from monthly routine administrative data from all 474 USAID-supported health facilities in Bauchi State, downloaded from the National Health Management Information System-District Health Information Software2 (NHMIS-DHIS2) over a four-year period (i.e., 48 time periods), and exported to Microsoft Excel for preliminary cleaning. Thereafter the data was loaded and imported to Python version 3.12.13 [26] utilizing the cloud-based Google Collaboratory environment [27] for further data cleaning and analysis. The USAID-IHP Master Facility List (MFL) was used to identify and categorize the health facilities by level of care (primary, secondary and tertiary), ownership (public versus private), senatorial zones (north, central and south), presence of government direct health facility financing through the BHCPF and location (urban versus rural). Additional information on MAMII LGAs was obtained from the Bauchi State Ministry of Health and Social Welfare, and included to identify whether each health facility was located within MAMII areas (yes or no).

Analysis involved data cleaning procedures to identify missing/incomplete data and outliers. Using the indicator for health facility deliveries as a proxy, 19 health facilities were identified to have >80% missing data and these were dropped. Additionally, data from the only tertiary health facility in the MFL was dropped as the number was statistically insignificant for reasonable analysis. The final analysis was based on 454 health facilities. There were 178,088 complete datapoints out of the expected 196,128 datapoints, implying the overall completeness of the dataset used for the final analyses was 90.76%. The indicator for total health facility deliveries had the highest data completion of 96.01%, while postnatal visits for newborns had the lowest level of completion at 66.29%. Out of 178,008 data points, 3,810 (2.14%) were identified as outliers using z-scores >3 method. The identified outliers were examined manually and where they were determined as truly impossible values, these were replaced using mean imputation. A data validation issue was observed in 0.37% of the data, where the number of deliveries by SBA exceeded the total deliveries reported in a month (i.e.,>100% for %SBA). A ceiling of 100% was applied to these datapoints by correcting their numerator and denominators. Shapiro-Wilk test was then used to test for normality of all the variables. The data for all the indicators was not normally distributed. Wilcoxon signed-rank test was used to compare statistically significant median absolute difference (MAD) in performance during USAID (January 2022 to December 2023) compared to after USAID (January 2024 to December 2025) for all the indicators. Mann Whitney U-test was used to compare the magnitude of change between binary facility characteristics (BHCPF status, ownership, urban/rural location, location in MAMII LGA and level of care) to identify any differences in the pattern of changes. While Kruskal Wallis test with Bonferroni-corrected pairwise post-hoc analysis was used to assess difference in subgroups with more than two categories (senatorial zone). Statistical significance for all tests were evaluated relative to an alpha level of 0.05 [28].

A complimentary interrupted-time series (ITS) analysis was conducted using Generalized Estimating Equations (GEE) with a Poisson distribution for count indicators and a Gaussian distribution with an identity link for percentage-based indicators, fitted to facility-level monthly panel data, with 48 monthly time points per facility. This was used to compare segmented regression trends before and after USAID exit, with interruption/transition point set at December 2023. The ITS models used an independence working correlation structure with cluster-robust standard errors to account for within-health facility correlation. Benjamini-Hochberg correction was then applied to account for multiple comparisons across indicators. Furthermore, because the

actual interruption point (December 2023) coincides with known seasonal dips in NHMIS data due to end-of-year holidays and health workers leave, a placebo falsification test was conducted to compare the level of change immediately after interruption with a historical unexposed point in December 2022 [29-31].

To further understand whether identified health facility characteristics are truly independent in influencing the change in MCH indicators or if they capture overlapping variance, a mixed-effect regression analysis with facility random effects for each MCH indicator was built using the median difference calculated for each facility as the dependent variable and the categorical protective factors as independent variables [32].

Results

Of the 454 health facilities, 184 (40.53%) were located in the South, 140 (30.84%) in the North and 130 (28.63%) in the central senatorial zone of the State. Four hundred and thirty-one (94.93%) were primary, 428 (94.27%) were public health facilities, 392 (86.34%) were located in rural areas, 201 (44.27%) were implementing the BHCPF and 222 (48.90%) were within MAMII designated LGAs. The detailed distribution of the health facilities in this study is shown in Table 1.

Table1. Distribution of Health Facilities by Characteristics (N = 454)

Category of Health Facility	Count (n)	Percentage (%)
Level of Care		
Primary	431	94.93
Secondary	23	5.07
BHCPF Implementation		
No	253	55.73
Yes	201	44.27
Health facility is in MAMII LGA		
No	232	51.1
Yes	222	48.9
Ownership		
Public	428	94.27
Private	26	5.73
Location		
Rural	392	86.34
Urban	62	13.66
Senatorial Zone		
Central	130	28.63
North	140	30.84
South	184	40.53

By counts of service utilization volume, the maternal indicators recorded significant increases after USAID closure with slope changes of +0.66% per month for ANC1, +0.54% per month for total deliveries and +0.48% per month for deliveries taken by SBA (Table 2). However, two coverage/quality indicators showed significant declines after USAID closure with negative slope changes of −2.24% per month for Penta3 and −1.49% per month for FIC, all $p < 0.05$. Postnatal visits for mother and newborn within 3 days and cord care for newborns showed declining trends but these were not statistically significant.

Percentage of deliveries by SBA showed no change (both medians at 100.0) despite a highly significant p-value ($p < 0.0001$) due to the ceiling effect applied to this indicator obscuring the true direction of change at the median. Therefore, a count of frequencies in the medians before versus after was computed. Only one health facility (0.22%) recorded an increase, 29 (6.49%) recorded a decrease, and 417 (93.29%) facilities recorded no change in median facility-level coverage; signifying a net declining trend ($p < 0.0001$).

Table 2. Median (IQR) Coverage and Median Difference (95% CI) per Indicator, During vs. Post USAID Period

Indicator	Median During USAID (IQR)	Median After USAID (IQR)	Median Difference (95% CI)
Antenatal first visit	49.00 (30.00–81.00)	53.00 (33.00–88.00)	2.5 (1–3.5)
Health facility deliveries	25.00 (16.00–40.00)	31.00 (20.00–46.00)	2.5 (2–4)
Deliveries taken by SBA	25.00 (17.00–40.00)	30.00 (20.00–46.00)	2.5 (2–3)
Percentage of deliveries taken by SBA	100.00 (100.00–100.00)	100.00 (100.00–100.00)	0 (0–0)
Penta 3 doses given	28.00 (19.00–41.00)	28.00 (20.00–40.00)	0.5 (−0.5–1)
Fully Immunized <1 years	21.00 (13.00–32.00)	26.00 (18.00–37.00)	5.5 (4–6.5)
Postnatal visit within 3 days (Mothers)	29.00 (18.00–48.00)	36.00 (22.00–57.00)	4 (3–4.5)
Postnatal visit within 3 days (Newborn)	29.00 (18.00–48.00)	36.00 (22.00–57.00)	3.5 (2.5–4.5)
Newborn received cord care with 4% chlorhexidine gel	27.00 (19.00–42.00)	35.00 (23.00–50.00)	3 (2.5–4)

IQR = Inter quartile range, CI = Confidence Interval

Level of Care

There were significant differences in the magnitude of change after USAID by health facility level of care for six of nine indicators ($p<0.05$), except for postnatal visits for mothers, FIC and Penta3 doses given. Post-hoc comparison using Bonferroni correction indicated that these differences were specifically attributed to significantly better performance among primary level facilities compared to secondary.

Senatorial Zone

There was significant difference by zone in eight of the nine indicators, except antenatal first visits ($p < 0.05$). The Bonferroni post-hoc comparison showed that facilities within the North and Central senatorial zones were significantly better sustained than those in the South for total deliveries, deliveries by SBA and postnatal visits ($p < 0.05$). However, the Central zone showed better sustainability for Penta 3 than the North and South ($p = 0.0011$);

while the North and South were significantly different from each other.

BHCPF, Ownership and MAMII

Health facilities implementing the BHCPF showed significantly better sustained performance in seven of the nine indicators ($p < 0.001$). For example, BHCPF facilities recorded a median difference of +8 compared to +4 in non-BHCPF health facilities for FIC ($p = 0.001$). Health facilities within MAMII designated LGAs showed significant increment in five of the nine indicators ($p < 0.05$) and public health facilities in four of the nine ($p < 0.001$). Privately owned health facilities showed an absolute significant decline in the postnatal care visits for newborns ($p = 0.0054$) and postnatal care visits for mothers ($p = 0.0044$).

Mixed-Effect Regression Analysis

Multivariable mixed-effects regression models were fitted to identify facility characteristics independently associated with changes in MNCH service utilization following USAID closure as shown in Table 3. Facility-specific random intercepts were included to account for clustering of repeated observations within health facilities. Diagnostic assessment indicated no evidence of problematic multicollinearity among the explanatory variables, with variance inflation factors ranging from 1.01 to 1.46.

Across the study outcomes, participation in the BHCPF was the characteristic most consistently associated with improvements in service utilization. After adjustment for ownership, level of care, senatorial zone and facility-level random effects, BHCPF-supported facilities recorded significantly greater increases in first antenatal care attendance ($\beta = 4.41$, $p = 0.016$), facility deliveries ($\beta = 2.87$, $p = 0.003$), deliveries conducted by SBA ($\beta = 2.94$, $p = 0.003$), % SBA ($\beta = 4.03$, $p = 0.024$), FIC ($\beta = 2.54$, $p = 0.006$), postnatal care visits for mothers within three days of delivery ($\beta = 4.03$, $p = 0.005$), postnatal care visits for newborns ($\beta = 3.97$, $p = 0.005$), and cord care services ($\beta = 2.01$, $p = 0.037$). No statistically significant association was observed between BHCPF participation and Penta 3 vaccination ($\beta = 1.12$, $p = 0.188$).

Facility ownership was not associated with changes in most indicators after adjustment for other facility characteristics. The only exception was the proportion of deliveries attended by skilled birth attendants, for which ownership remained a significant predictor ($p < 0.001$).

Facility level demonstrated independent associations with several service indicators. Primary healthcare facilities showed significantly greater improvements in facility deliveries, deliveries attended by skilled birth attendants, fully immunized children, postnatal care for mothers, postnatal care for newborns, and cord care than facilities providing higher levels of care. However, facility level did not differ significantly for first antenatal care attendance, Penta 3 vaccination, or the proportion of deliveries attended by skilled birth attendants.

Geographical differences persisted for selected outcomes but were less pronounced after accounting for facility-level variation. Senatorial zone remained significantly associated with changes in immunization-related indicators, particularly Penta 3 vaccination and the proportion of fully immunized children, while associations with maternal health indicators were less consistent across the models.

The estimated random-effects variance indicated substantial heterogeneity in performance between health facilities across all models. Random-effect standard deviations ranged from 6.05 to 13.13, suggesting that a considerable proportion of the variation in service utilization remained attributable to facility-specific characteristics not captured by the measured explanatory variables.

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Table 3. Multi-Variable Mixed-Effects Regression Analysis of Health Facility Characteristics Associated with Changes in Maternal and Child Health Service Utilization

Indicator	Model R^2	Adjusted R^2	F Statistic	Model p-value	BHCPF β (p-value)	Public Ownership β (p-value)	Primary Level β (p-value)	North Zone β (p-value)	South Zone β (p-value)
Antenatal first visit	0.024	0.013	2.18	0.056	4.41 (0.016)	–2.31 (0.612)	6.25 (0.142)	–2.40 (0.294)	–1.86 (0.393)
Health facility deliveries	0.074	0.063	6.99	<0.001	2.87 (0.003)	1.63 (0.476)	5.99 (0.008)	0.50 (0.678)	–2.92 (0.011)
Deliveries taken by SBA	0.093	0.083	9	<0.001	2.94 (0.003)	2.40 (0.313)	8.34 (<0.001)	0.19 (0.874)	–3.31 (0.005)
Percentage of deliveries taken by SBA	0.104	0.094	10.26	<0.001	4.03 (0.025)	23.20 (<0.001)	7.04 (0.090)	–0.53 (0.811)	–3.37 (0.111)
Penta 3 doses given	0.038	0.027	3.41	0.005	1.12 (0.189)	2.53 (0.341)	–2.27 (0.238)	–3.39 (0.002)	–3.18 (0.002)
Fully Immunized <1 years	0.043	0.032	3.88	0.002	2.54 (0.007)	4.30 (0.140)	–3.27 (0.121)	–2.69 (0.021)	–2.76 (0.013)
Postnatal visit within 3 days (Mothers)	0.062	0.051	5.8	<0.001	4.03 (0.005)	4.27 (0.239)	7.21 (0.029)	–0.25 (0.887)	–4.22 (0.013)
Postnatal visit within 3 days (Newborn)	0.072	0.061	6.75	<0.001	3.97 (0.005)	3.98 (0.270)	8.67 (0.009)	–0.11 (0.950)	–4.63 (0.006)
Newborn received cord care with 4% chlorhexidine gel	0.067	0.053	4.8	<0.001	2.01 (0.085)	4.11 (0.489)	7.04 (0.005)	0.77 (0.574)	–3.13 (0.024)

Discussion

The results provide a critical empirical evaluation of health system resilience in Bauchi State following the termination of USAID funding. By distinguishing between "level effects" (raw coverage) and "trend effects" (the trajectory of growth), this study shows that while some health gains appear sustained, the quality and coverage of essential services are actively eroding without donor support. The results confirm that the impact of the USAID closure is indicator-specific rather than uniform. While "headline" indicators like the raw counts of ANC1 and health facility delivery volumes showed continued growth, coverage-based indicators such as the proportion of skilled birth attendance, Penta3, and fully immunized children (FIC) underwent significant post-transition slope reversals. This aligns with some studies which highlight that rising absolute numbers of clinic visits or vaccine doses administered can give the illusion of system success, masking sub-national drop-offs in actual coverage and service delivery quality [33]. From a methodological standpoint, naive pre/post comparison would have falsely signalled sustenance, whereas incorporating trend-based and mixed-effects regression analysis unearths the genuine system performance post USAID.

The data identifies the BHCPF as the single most consistent protective factor, significant across seven of nine indicators. This underscores the premise that access to sustained domestic financing is a primary regulator of health system performance following a shock. However, a number of studies have evaluated the effectiveness of the fund, reporting mixed performance [15, 34]. Bauchi along with other states (Sokoto, Lagos, Kaduna, Kano and Plateau) have particularly been noted for proactive implementation, excelling in supportive supervision and efficient funds disbursement [34], while some other states like Borno, Yobe, Kogi, Zamfara and Nasarawa [34, 35] have not recorded significant improvement to services with the BHCPF. Across all evaluated regions, even high-performing states grappled with suboptimal implementation in at least one thematic area; suggesting that the BHCPF is yet to reach its full potential. A recent technical analysis from the 2022 Comprehensive National PHC Assessment, which collected facility-level information from 3,531 BHCPF facilities nationwide, showed that BHCPF facilities operate at a very low mean technical efficiency (11%) [36]. The analysis specifically focused on assessing their technical efficiency in converting inputs, such as clinical staff and inpatient beds, into health outputs like immunizations and deliveries. This suggests that while the BHCPF currently functions as a vital stabilizer to prevent system collapse, it is not yet an optimizer of health outcomes.

Furthermore, the resilience of health facilities located in MAMII-designated LGAs provides some of the first facility-level outcome evidence for this recent federal initiative, confirming its role in buffering high-burden areas against service collapse.

In addition, the vulnerability of private facilities, which showed an absolute decline in postnatal care in this study, confirms structurally recurring fragility in public-private health arrangements documented in both Nigeria and Ethiopia. This reinforces the consensus that private-sector actors require deliberate integration into state-led financing rather than an assumption of passive resilience.

This study’s findings are remarkably consistent with existing literature while offering sharper, more localized insights. The observed pattern, where service volume is maintained but quality indicators erode parallels findings from Ghana’s Maternal and Child Health and Nutrition Improvement Project, suggesting that intra-country heterogeneity in donor-transition resilience is a recurring feature in West African health systems [37].

While these results provide a robust baseline, several questions remain that necessitate further investigation:

1. The Central senatorial zone Outlier: An important finding in this study was that the Central senatorial zone significantly outperformed both the North and South in Penta3 sustainability. Qualitative deep-dives are needed to explore the specific positive outlier mechanisms, such as superior cold-chain logistics, outreach strategies, or supervisory factors, that protected immunization gains in this zone so they can be replicated elsewhere.
2. Drivers of Technical Inefficiency: Given the suboptimal efficiency of BHCPF-funded facilities [36], future research should move beyond whether the fund protects services to why efficiency remains so low. Investigating the impact of catchment area population dynamics and subnational health allocations on service productivity is essential to ensure that increased domestic investment does not result in a waste of scarce resources.

Conclusion

In conclusion, this study validates the critical role of domestic financing and facility-tier integration as a primary determinant of health system resilience. The results show that while the system has not collapsed, it is losing ground on the most critical quality-of-care indicators. For policymakers in Nigeria and beyond, the message is clear: sustainability is not an accident of project design, but a direct consequence of the domestic service-delivery architecture existing at the moment of donor exit. This study also stands as a methodological pointer: a naive pre/post comparison would have signalled reassuring improvement, while trend-based analysis reveals genuine erosion. This is directly relevant to an active global crisis. Relying on simple coverage-level indicators, as many national HMIS dashboards and routine donor-transition monitoring frameworks still do, would risk missing a genuine deceleration in service quality while headline numbers continue climbing due to population growth or residual momentum. With private facilities providing a substantial share of care across LMIC settings generally, this study's finding that private facilities absorbed the funding shock measurably worse than public facilities is a specific, actionable warning for the broader global health financing architecture currently being redesigned to ensure that mechanisms need explicit private-sector financing and supervisory tracks, not an implicit assumption that public-sector-oriented domestic financing reforms will carry private providers along by default.

Conflict of Interest

The author declares no competing interests.

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Ethical Approval

The data used for the study was routinely collected health service data extracted from the National Health Management Information System District Health Information Software 2 (NHMIS-DHIS2). The dataset was based solely on aggregated summaries and did not include any patient-level records that can be traced to individuals. There was no direct interaction with human subjects in the course of this study and no risk was posed to individual privacy or confidentiality. Ethical review and approval was sought and obtained from the Bauchi State

Health Research Committee, with approval number NHREC/TR/BAU-HREC/28/8/2023.

Author Contribution

JAU was fully responsible for conceptualization, collection, analysis and drafting the manuscript.

Data Availability

The datasets generated and analysed for this study are available from the corresponding author upon reasonable request.

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Poliomyelitis Eradication in Burkina Faso: Progress in Epidemiological Surveillance of Acute Flaccid Paralysis (AFP) and Environmental Surveillance from 2020 to 2024

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Abstract *Surveillance for acute flaccid paralysis (AFP) and environmental surveillance is one of the pillars of the polio eradication strategy, particularly in contexts marked by insecurity and the circulation of vaccine-derived polioviruses type 2 (cVDPV2). Through a descriptive and retrospective cross-sectional study, we evaluated the performance of the surveillance system in Burkina Faso between 2020 and 2024, using data from AFP monitoring, active research and environmental monitoring. The indicators were analysed annually and by health district and compared to the standards of the Global Polio Eradication Initiative. A total of 6,243 AFP cases were reviewed; 70.6% were children under five years of age and 58% were boys. Seventy-four cVDPV2 were detected, mainly in 2020. The national rate of non-polio AFP remained above the expected threshold (more than 3 cases per 100,000 children < 15 years), while stool collection adequacy remained generally satisfactory (above 80%). However, several deficiencies remain, including active surveillance visits, contact sample collection, environmental monitoring, and timely delivery of samples to the laboratory. Overall, the system is satisfactory, but its effectiveness would improve in hard-to-reach areas to strengthen early detection and outbreak response.*

Keywords *Acute Flaccid Paralysis, Burkina Faso, cVDPV2, Environmental Monitoring, Poliomyelitis, Sensitivity, Speed.*

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Introduction

Despite significant progress since the launch of the Global Polio Eradication Initiative (GPEI), polio remains a persistent threat to international public health [1]. In 1988, the disease still affected about 350,000 children in more than 125 countries, before coordinated vaccination and surveillance efforts led to a reduction of more than 99% in global incidence [2, 3]. Since 2016, only wild poliovirus type 1 has continued to circulate endemicly, mainly in Pakistan and Afghanistan, but the emergence of vaccine-derived polioviruses, particularly type 2, has profoundly renewed the challenges of surveillance and response [4] and this since the withdrawal of trivalent and monovalent oral polio vaccine type 2 (Switch) from routine immunization in 2016.

The certification of the WHO African Region as free of wild poliovirus in August 2020 was a historic step forward [5]. However, this certification does not eliminate the risk of poliomyelitis. Outbreaks of cVDPV2, driven by immune gaps, wars and insecurity, population movements and fragile health systems, continue to affect several African countries. The global surveillance network has detected outbreaks of variant polioviruses in 47 countries, with 319 cases of variants reported by the end of 2024 [6].

In this fight for polio eradication, AFP surveillance has a central function. It aims to detect any case compatible with acute flaccid paralysis in children under 15 years of age, or any suspected case of poliomyelitis regardless of age, and then to confirm the etiology virologically by taking stool samples [7]. This surveillance is complemented by environmental surveillance, which identifies the silent circulation of polioviruses in wastewater, even in the absence of clinical cases. The combination of these two approaches increases the sensitivity of the system, shortens the detection time and guides the vaccination decision [8]. The quality of surveillance depends as much on active detection as on rigorous adherence to standards for sample collection, preservation, transport and analysis [3].

Burkina Faso is located in a regional area exposed to the circulation of variant polioviruses, due to its proximity to several countries that have experienced cVDPV2 outbreaks, including Mali, Niger, Benin and Togo [6]. The low vaccination coverage recorded in some health districts and the inaccessibility of certain parts of the country due to security challenges are all internal weaknesses. Although Burkina Faso was certified free of the autochthonous circulation of wild poliovirus in 2015, it recorded, between 2020 and 2024, seventy-four (74) polioviruses variant type 2, two of which were from environmental monitoring. All thirteen administrative regions reported at least one cVDPV2 during the period [9], reflecting the territorial scale of the risk and the need for highly sensitive surveillance.

The situation in Burkina Faso is also operationally unique. Most cVDPV2 cases were detected in 2020, amid a significant increase in surveillance following the notification of an Indigenous index case linked to transboundary exposure. Technical and operational support, including the recruitment of epidemiological consultants, GPEI coordination and capacity-building of field workers, contributed to increased case reporting [9]. However, the apparent decline in detections after 2021 coincides with the exacerbation of security challenges in several regions [10]. This raises questions about the system's capacity to maintain consistent, sensitive surveillance in hard-to-access health districts.

This article proposes a structured scientific analysis of the performance of PFA monitoring and environmental monitoring in Burkina Faso over the period 2020-2024. He is particularly interested in two dimensions: sensitivity, understood as the ability of the system to detect suspected cases and produce quality samples; and timeliness, defined as the ability to report,

investigate, route samples and obtain results within the timeframes recommended by WHO and GPEI.

Method

Study Setting

The study was conducted in Burkina Faso, a West African country organized, in terms of health, into thirteen (13) regions and seventy (70) health districts. The health district is the operational unit of the health system and the basic level for reporting, investigation, sample collection, supervision and analysis of surveillance indicators. AFP surveillance data are generated by health facilities and community actors, consolidated at the district and regional levels, and then centralized at the national level by the relevant structures of the Ministry of Health, with technical support from WHO through the GPEI [9].

Environmental surveillance of poliomyelitis, which has been in place in the country since 2016, has gradually expanded. It initially had four sites, before being reorganised following external assessments. In 2021, the network was expanded to six functional sites, mainly in Ouagadougou and Bobo-Dioulasso. In 2024, after a new external evaluation, the number of functional sites reached ten (10), including six (06) in Ouagadougou and four (04) in Bobo-Dioulasso [9]. Wastewater samples are sent to a reference laboratory in the Global network (Institut Pasteur de Dakar), while stool samples from AFP cases are sent to the polio reference laboratory in Abidjan (Institut Pasteur de Côte d'Ivoire).

Study Design

This is a descriptive and retrospective cross-sectional study of poliomyelitis surveillance data in Burkina Faso from 2020 to 2024. The retrospective nature of the data is due to the use of secondary data already collected as part of routine surveillance and programmatic response activities. The cross-cutting nature stems from the analysis of the indicators over a defined period, without direct intervention with the participants. Finally, the descriptive approach aims to document national and sub-national trends in key indicators and then compare them to the GPEI performance standards.

The study does not seek to establish a formal causal relationship between response interventions and indicator trends. Rather, it aims to assess, based on the available data, whether the surveillance system has reached the expected thresholds of sensitivity and speed in the context of cVDPV2 circulation and security challenges.

Study Population and Sampling

The study population includes all children under 15 years of age living in Burkina Faso who developed AFP between 2020 and 2024, according to the operational definition of surveillance. The study also included cases of any age in which a clinician suspected poliomyelitis. Cases were eligible if they were registered in the national AFP surveillance database or if a duly completed investigation sheet was available at the competent national service level.

The second component of the study population consists of wastewater samples collected between 2020 and 2024 at environmental monitoring sites and recorded in the WHO AFRO database. Sampling was exhaustive: all AFP cases reported in the 70 health districts of Burkina Faso during the period, as well as all available environmental samples, were included. This is in order to limit the risk of selection bias and to obtain a representative assessment of the actual functioning of the national poliomyelitis surveillance system.

Data Collection Technique and Method

The data used are mainly from three sources: the national AFP case-by-case surveillance database, the ISS/eSurv database for active surveillance visits to priority sites, and the

environmental surveillance database for polioviruses. The data were extracted in Excel format, then consolidated and analyzed according to GPEI supervisory standards.

For each AFP case, the information analysed included age, sex, health district, date of onset of paralysis, date of notification, date of investigation, date of stool collection, date of sample submission, date of receipt at central level, date of submission of samples to the reference laboratory, the date of receipt at the reference laboratory, the status of the samples upon arrival, the laboratory results and the dates of receipt of the results at the national level. For environmental monitoring, variables included site name, location, date of collection, date of shipment, date of receipt at the laboratory, status of specimens, and virological results, including detection of enteroviruses and VDPVs.

Nominal data were removed prior to analysis. The study is part of a logic of secondary analysis of anonymized and aggregated routine data. It does not involve any intervention with the population. The results are presented in a comprehensive and non-stigmatizing manner, with a view to improving the national surveillance system.

Data Analysis Technique

The databases were pre-processed to correct deficiencies, fill in missing data where possible, and recode variables according to WHO and GPEI operational definitions. Indicators were calculated using pivot tables and descriptive statistical summaries. Results were produced by year, by health district and, for some indicators, by environmental monitoring site.

The main sensitivity indicators analyzed were: the rate of non-polio AFP per 100,000 children under 15 years of age, stool adequacy, proportion of districts meeting standards, frequency of active surveillance visits to priority sites, collection of contact samples of inadequate cases, completeness of follow-up at day 60, detection of non-polio enteroviruses in feces and detection of enteroviruses in wastewater. The main indicators of timeliness were: notification within seven days of onset of paralysis, investigation within 48 hours of notification, delivery of stool samples to the central level within 72 hours and reference laboratory within 7 days, delivery of environmental samples, and receipt of final laboratory results within the recommended timeframe (46 days).

The performance thresholds used correspond to GPEI standards: at least 3 cases of non-polio AFP per 100,000 children under 15 years of age in epidemic or priority countries, at least 80% adequate bowel movements, at least 80% expected visits to priority sites, at least 80% early notification, at least 80% investigation within 48 hours, at least 80% of samples arriving at the laboratory within the required timeframe, and an enterovirus detection rate in line with the recommendations to assess the quality of collection and transport.

Results

General Description of AFP and cVDPV2 Cases

Table 1 shows the evolution and sex distribution of the number of AFP cases by year from 2020 to 2024 in Burkina Faso.

Table 1. Distribution of AFP Cases by Sex and Year in Burkina Faso from 2019 to 2024

Gender	2020	2021	2022	2023	2024	Grand Total	Proportion (%)
F	466	620	516	483	513	2598	42
M	714	780	744	647	760	3646	58
Grand Total	1180	1400	1260	1130	1273	6243	100
Ratio (F/H)	0,7	0,8	0,7	0,7	0,7	0,7	

Source: *Burkina Faso Polio Surveillance Database 2020-2024*

As shown in Table 1, a total of 6,243 cases of AFP were reported in Burkina Faso between 2020 and 2024, with an irregular annual trend. This uneven evolution suggests a generally active surveillance, but possibly influenced by variations in accessibility, the intensity of active research activities and the dynamics of programmatic support.

AFP cases were predominantly male, with males accounting for 58% of cases compared to 42% for females. The ratio of girls to boys remained stable overall at around 0.7.

Table 2 presents the distribution of AFP cases by age group and year in Burkina Faso

Table 2. Distribution of AFP Cases by Age Group and Year (2020-2024)

Age/Year	2020	2021	2022	2023	2024	Total	%
Less than 1 year old	104	114	82	99	85	484	7,8
1- 4 years old	743	886	816	682	794	3921	62,8
5 - 14 years old	325	389	349	332	385	1780	28,5
Sup 15 years old	8	11	13	17	9	58	0,9
Total	1180	1400	1260	1130	1273	6243	100,0

Source: *Burkina Faso Polio Surveillance Database 2020-2024*

The age distribution shows a clear predominance of children under five years of age, who accounted for 70.6% of cases. The age group of 1 to 4 years was the most represented with 62.8% of cases, followed by children aged 5 to 14 years with 28.5%.

Figure 1 shows the distribution of reported cases of variant poliovirus type 2 by year in Burkina Faso from 2020 to 2024.

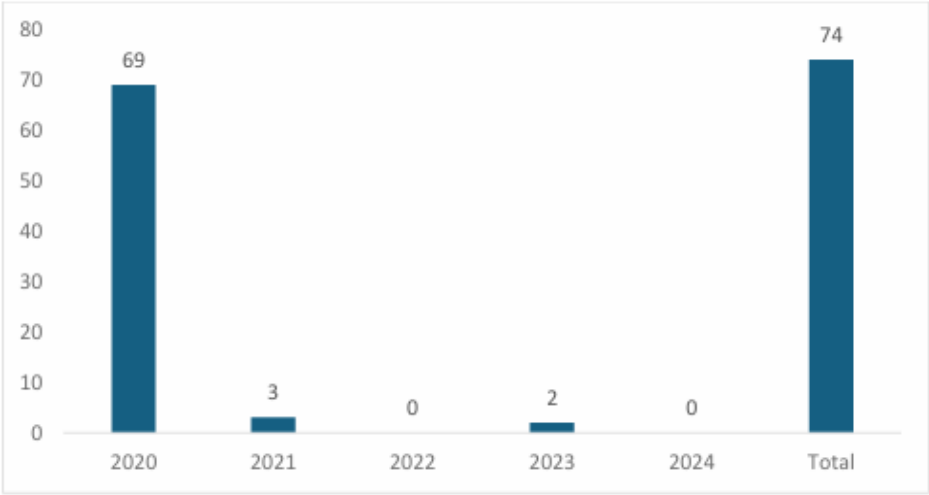


Figure 1. Evolution of the Number of Cases of Poliovirus Derived from Circulating Vaccine Strain Type 2 by Year 20220 to 2024 in Burkina Faso

Source: *Burkina Faso Polio Surveillance Database 2020-2024*

For cVDPV2, 74 detections were reported during the study period, of which 72 were from AFP cases and 2 from environmental monitoring. The majority of detections were recorded in 2020 with 69 cases, followed by 3 detections in 2021 and 2 detections in 2023. No cVDPV2 was reported in 2022 and 2024. Of the cVDPV2-positive AFP cases, 53% were male and 96% were in children under five years of age, primarily those aged 1 to 4 years.

Sensitivity of Surveillance

The sensitivity of surveillance was assessed through active surveillance visits, non-polio AFP rate, stool adequacy, contact collection, follow-up at day 60, detection of non-polio enteroviruses in stool and detection of enteroviruses in wastewater.

The number of visits to priority active surveillance sites increased substantially between 2020 and 2023, from 1,033 visits in 2020 to 7,074 in 2023, before decreasing to 4,915 in 2024. However, this quantitative improvement did not translate into the 80% standard of expected visits to high and very high priority sites. No health district has achieved this minimum performance in the 2020-2024 period. The border districts with Mali, Niger and Benin, as well as those in the Centre-North and East regions, were regularly insufficiently covered. This situation reveals a structural fragility of active surveillance in areas of difficult access.

Table 3 presents the evolution of the main indicators that assess the sensitivity of poliomyelitis surveillance in Burkina Faso by year from 2020 to 2024.

Table 3. Evolution of the Polio Surveillance Sensitivity Indicators in Burkina Faso 2020-2024

Indicators	2020	2021	2022	2023	2024	WHO Standard	Assessment
PFA NP rate (per 100000) children under 15 years of age)	10,86	13,39	12,56	10,43	11,46	≥3	Very satisfactory at the national level
Proportion of health districts that have achieved the WHO standard (%)	97	99	94	91	96	80%	Very satisfying
Stool adequacy rate (%)	86,02	89,64	88,46	95,31	94,34	≥80	Satisfactory, but heterogeneous
Proportion (%) of site visits	3,56	9,14	10,13	14,01	10,84	≥80	Insufficient
Collection of stool samples from contacts (%)	53,5	14,9	30,7	24,4	63,0	≥80	Insufficient
Follow-up at day 60 (%)	97,5	99,3	87,0	98,2	98,6	≥80	Very satisfying
Detection of NPENTs in stool (%)	13	11	12	13	13	≥10	Satisfactory
Status of Environmental Samples on Arrival at the Laboratory (%)	92,31	96,49	97,66	99,22	99,47	≥80%	Very satisfying
Enterovirus in Environmental Monitoring	15,38	24,56	37,50	16,41	40,64	≥50	Insufficient, despite an improvement in 2024

Source: *AFP monitoring databases, Environmental Monitoring and Integrated Supervision, Burkina Faso_2020-2024*

The rate of non-polio AFP per 100,000 children under 15 years of age remained generally satisfactory, ranging from 10.43 to 13.39, as shown in Table 3. At the national level, it was 10.86 in 2020, 13.39 in 2021, 12.56 in 2022, 10.43 in 2023 and 11.46 in 2024 per 100,000 children under 15 years of age, i.e. values consistently above the standard of 3. The proportion of health districts meeting the standard ranged from 91% to 99%. However, 11 health districts, or 16%, had at least one underperformance during the period; Barsalogho, Diapaga and Titao have been underperforming for at least two years. The districts of Dori and Sebba have experienced a continuous decline in performance, which is a warning signal in areas already weakened by insecurity.

Stool adequacy was also satisfactory nationally, at 86.02% in 2020, 89.64% in 2021, 88.46% in 2022, 95.31% in 2023, and 94.34% in 2024. The standard of 80% was exceeded throughout the period. Forty health districts, or 57 per cent, have consistently achieved this minimum performance. However, seven health districts underperformed for more than a year, and three districts (Baskuy in 2020, Titao in 2022, and Diapaga in 2023) underperformed on the two key AFP surveillance indicators, namely non-polio AFP rate and stool adequacy.

The collection of contact samples from inadequate AFP cases remained the main weakness of sensitivity. At the national level, the indicator has evolved irregularly: 53.5% in 2020, 14.9% in 2021, 30.7% in 2022, 24.4% in 2023 and 63.0% in 2024. Even the improvement observed in 2024 remains below the 80% norm. Less than half of the health districts met the minimum threshold for contact collection, with the lowest performance observed in 2021. This inadequacy limits the ability to properly document inadequate cases and to exclude residual viral circulation.

On the other hand, the follow-up of inadequate AFP cases on day 60 showed an overall high performance. The national proportions were 97.5% in 2020, 99.3% in 2021, 87.0% in 2022, 98.2% in 2023 and 98.6% in 2024. Apart from a relative decline in 2022, the indicator remained well above the 80% threshold. This is an important element of quality, as follow-up on day 60 makes it possible to assess the presence of residual paralysis and to support the final classification of cases.

The national detection rate of non-polio enteroviruses in feces remained satisfactory, ranging from 11% to 13%, with a national average of 12%. This level exceeds the minimum standard of 10% and reflects acceptable collection, storage, and transport quality. However, the sub-national analysis reveals strong disparities. Some districts such as Tougouri, Zabre and Boussouma had high performance, while Toma, Titao and Orodara never met the minimum standard in the five years studied.

Environmental monitoring showed more contrasting performance. Average enterovirus detection rates in wastewater remained low from 2020 to 2023, ranging from 15.38% to 37.50%, before reaching 40.64% in 2024. The proportion of sites reaching the 50% detection threshold was 0% in 2020 and 2021, 40% in 2022, 0% in 2023 and 50% in 2024. Despite an improvement after the 2024 external review and the reorganization of the site network, the national performance remains below the standard requiring 80% of sites to achieve a detection rate of at least 50%.

Speed of Monitoring

Speed was analyzed through the time it takes to notify, investigate, ship stool samples, ship environmental samples, optimize the field, and obtain lab results. This dimension is crucial, as the late detection of a VDPV delays the risk assessment, the reporting of the event and the implementation of the response.

Table 4 below summarizes the indicators used to assess the timeliness of specimen

detection, collection and processing in polio surveillance.

Table 4. Summary of Timeliness Indicators for Polio Surveillance in Burkina Faso, 2020–2024

Indicators	2020	2021	2022	2023	2024	WHO Standard	Assessment
Notification within 7 days	72,1	80,3	83,0	83,8	82,3	≥80	National improvement, persistent disparities
Investigation within 48 hours	96,4	94,9	99,0	97,8	99,3	≥80	Very satisfying
Stool arriving at the laboratory within 7 days of the date of collection of the 2nd stool	10,8	17,4	24,8	23,9	28,2	≥80	Very insufficient
Environmental samples in the laboratory within 7 days	61,54	85,96	88,28	92,97	94,12	≥80	Satisfactory since 2021
VDPV results within 46 days	94,5	99,9	100,0	96,1	54,1	≥80	To be strengthened

Source: *PFA and environmental monitoring databases, Burkina Faso, 2020-2024*

The proportion of AFP cases reported within seven days of the onset of paralysis improved nationally from 72.1% in 2020 to 80.3% in 2021, 83.0% in 2022, 83.8% in 2023 and 82.3% in 2024. The national threshold of 80% was therefore reached from 2021. However, the analysis by district shows that the country has not reached the standard that 80% of districts should report cases within seven days. The districts of Gaoua, Koupéla and Djibo remained underperforming throughout the period, suggesting the existence of persistent barriers to early notification.

The investigation of cases within 48 hours of notification was very satisfactory. The results show that, from 2020 to 2024, almost all districts reached the minimum required threshold of 80%. This indicator is one of the major strengths of the surveillance system in Burkina Faso. It reflects the ability of surveillance teams to respond promptly once the case is reported, although this performance does not fully compensate for the shortcomings in early reporting in some districts.

The timeliness of stool samples to the reference laboratory remained low. Only 6% of districts achieved the expected performance of 80% of samples arriving at the laboratory within seven days of collecting the second bowel movement in 2023. In the majority of districts, more than three-quarters of the samples did not arrive within the recommended timeframe. This weakness is particularly important in a country that does not have a polio reference laboratory on its territory and depends on international transport to Abidjan.

The analysis of average lead times confirms this logistical vulnerability. On average, 39.7% of stool samples arrived at the central level within 72 hours, with extremes ranging from 0% to 94.1%. Only the districts of Baskuy, Sig-Noghin, Nongr-Massom, Po and Boussé reached the 80% threshold. For arrival at the reference laboratory within seven days, the national average performance was only 20.7%, with extreme values of 3.2% to 62.4%. No health district has reached the minimum required threshold of 80%. This suggests that

the delivery chain between the field, the central level and the international laboratory remains one of the most critical links in the system.

The speed of shipment of environmental samples, on the other hand, has more favorable performance. At the national level, the proportion of wastewater samples arriving at the laboratory within seven days was 61.54% in 2020, 85.96% in 2021, 88.28% in 2022, 92.97% in 2023, and 94.12% in 2024. The Ouagadougou sites generally performed well after 2020, while some sites in Bobo-Dioulasso experienced delays, particularly between 2022 and 2024. Environmental samples arrived in very good condition, with the proportion in good condition ranging from 92.31% in 2020 to 99.47% in 2024.

The timeliness of final results for VDPVs was satisfactory from 2020 to 2023, with a national proportion of AFP/VDPV cases receiving results within 46 days increasing from 95.5% in 2020 to 96.1% in 2023. However, in 2024, only 3% of districts had received their laboratory results on time and 41% had received fewer results within 46 days of the onset of paralysis. This break in performance deserves a specific analysis, as it can compromise the speed of virological detection and the responsiveness of the response.

Discussion

The results show that polio surveillance in Burkina Faso between 2020 and 2024 has satisfactory overall performance, particularly for the key sensitivity indicators of non-polio AFP rate, stool adequacy, and follow-up at day 60. These results suggest that the national system can detect a high number of suspected cases and produce samples of acceptable quality. They confirm the likely impact of capacity building of actors, GPEI support and mobilization of surveillance teams after the emergence of cVDPV2.

The prevalence of AFP cases in boys and children under five years of age is consistent with the epidemiology reported in several studies in Africa. The high proportion of cVDPV2 cases in children under five years of age is consistent with Namageyo-Funa observations [11], which suggests that young children with insufficient immunity are the group most exposed to circulating poliovirus variants. This distribution reminds us that surveillance cannot be separated from the quality of routine immunization and the coverage of response campaigns.

The peak of cVDPV2 observed in 2020 can be interpreted as the joint result of effective viral circulation and increased system sensitivity after the index case was notified. The decline in detections after 2021 could reflect the effect of vaccine response campaigns implemented in accordance with the GPEI's standard operating procedures [12]. However, this decline should be interpreted with caution, as it coincides with worsening security challenges in several regions, which may reduce access to cases, site supervision, and regular active surveillance.

The rate of non-polio AFP is one of the most robust achievements of the system. National performance, ranging from 10.43 to 13.39 per 100,000 children under 15 years of age, far exceeds the WHO standard. They are higher than those reported in Niger [13] and reflect a strong capacity to detect suspected cases. However, the persistence of underperforming districts such as Barsalogho, Diapaga, Sebba and Titao indicates that the national average masks pockets of fragility. From an eradication perspective, these pockets are critical, as low local sensitivity may be sufficient to allow silent transmission.

The adequacy of stools, which is consistently above the 80% threshold, is a second strength of the surveillance system. It reflects the ability of those in the field to collect samples on time, in sufficient quantities and under acceptable conservation conditions. These results are better than those reported in some studies, notably in the Democratic Republic of Congo [14], and comparable to more successful

African experiments. However, health districts with repeated underperformance require targeted support, as the adequacy of the stool directly conditions the ability to confirm virologically.

The collection of contact samples of inadequate cases remains a major shortcoming. This indicator is essential when samples from the index case do not meet the suitability criteria, as it reduces the risk of uncertain classification and increases the probability of detection of viral circulation. The results observed in Burkina Faso aren't isolated; they're close to those reported in other countries, where the sampling proportions per contact were often below the recommendations [3]. The poor performance observed in 2021 and 2023 suggests organizational, logistical or community difficulties that must be analyzed at the health district level.

The 60th-day follow-up appears very satisfactory. It clearly exceeds the performance reported in Mauritania [15] and remains comparable or higher than those observed in other countries in the subregion. This performance demonstrates a good mechanism for recalling and following up on inadequate cases. It also improves the quality of the final classification of cases, distinguishing between residual paralysis and complete recovery.

Environmental monitoring is an area that needs to be strengthened. Despite an improvement in 2024 following the external review and reorganization of sites, enterovirus detection rates in wastewater remain below WHO standards. These results are close to those reported in Cameroon [16], but lower than the performance observed in Nigeria [17]. The problem does not seem to be only logistical, because the condition of the samples on arrival at the laboratory is very satisfactory. It could be more a matter of the choice of sites, their hydrological representativeness, the density of the population basins covered, the conditions of abstraction and the environmental seasonality.

Regarding speed, the results are mixed. Early notification has improved and investigation within 48 hours is excellent. These two indicators show a good capacity to respond as soon as a case is identified. Investigative performance is comparable to that reported in Mauritania [15] and in Niger [18]. However, health districts such as Djibo, Gaoua and Koupéla remain below the standards for early notification. contexts of insecurity, access disruptions and weak community surveillance hinder the rapid detection of AFP in several African countries [3].

The main weakness of timeliness is the shipment of stool samples to the reference laboratory. The national average of 20.7% for laboratory arrival within seven days is well below the standard of 80%, and no health district meets the expected threshold. This weakness is particularly worrying because Burkina Faso depends on an international reference laboratory. Transport delays reduce the margin available for viral isolation, intratypic differentiation (DIT), sequencing, and rapid notification of the final result. Observations in Niger [19] and in Ghana [20] confirm that logistical delays are a major constraint for virological surveillance.

Conversely, environmental monitoring has relatively strong logistics. Wastewater samples arrive at the laboratory increasingly quickly and almost always in good condition, with proportions in good condition close to 100% at the end of the period. These performances are comparable to those observed in South Africa [21]. They demonstrate that the country has an efficient packaging and transport capacity for environmental samples. The challenge is therefore to translate this logistical strength into better virological sensitivity by optimizing the site network.

The drop observed in 2024 for the receipt of final PVDV results within 46 days is a worrying signal. It may reflect laboratory constraints, sequencing delays, international network overload, or problems with the transmission of

results. As part of the GPEI procedures, an outbreak must be assessed and fully responded to within strict timelines; Any delay in confirmation can therefore affect the speed of the response. A specific analysis of laboratory delays and communication flows between the reference laboratory, the national level and the health districts is needed.

Finally, the lack of a structured surveillance system for VDPVs in individuals with primary immunodeficiency is an emerging gap. According to the WHO, only a few African countries were implementing this specialized surveillance in 2024. However, immunocompromised people can shed vaccine polioviruses for long periods and can serve as a potential reservoir. The gradual integration of this component would strengthen Burkina Faso's capacity to detect silent sources of VDPV at an early stage.

Limitations

This study has some limitations that must be considered in the interpretation of the results. These are:

1. The retrospective nature and the use of secondary data from routine monitoring expose the analysis to problems of completeness, accuracy and consistency of the information recorded.
2. The study is essentially descriptive and does not allow for a rigorous causal relationship between the interventions implemented and the evolution of surveillance performance.
3. Insecurity and difficulties in accessing some localities have likely led to under-detection of cases of acute flaccid paralysis, reduced active surveillance visits, and delays in sample collection and transport. Therefore, the absence of cVDPV2 detection in certain areas or during certain periods of the study does not formally exclude silent viral circulation.

The results suggest the following implications for strengthening future responses to cVDPV2 in Burkina Faso

1. Strengthen community-based surveillance in hard-to-reach areas through the structured involvement of community-based health workers, local leaders, traditional healers, IDP associations, and intermediaries in border areas.
2. Implement strategies tailored to areas with limited access, including remote monitoring, use of community focal points, integrated missions with other health programs, and coordination with humanitarian actors.
3. Give operational priority to districts that have repeatedly underperformed, particularly in regions affected by insecurity and along the borders, through enhanced supervision, community support and corrective plans with deadlines.
4. Make it mandatory and immediately traceable to collect stool from contacts for any case of AFP with inadequate swab, in accordance with national and international procedures.
5. Review the entire delivery chain, from the sampling site to the central level and then to the reference laboratory, in order to precisely identify the points of delay and reduce cumulative delays.
6. Decentralize collection and transit points as much as possible and use a real-time tracking system to know the location, shipping time, receipt time, and status of each sample.
7. Gradually expand environmental monitoring beyond Ouagadougou and Bobo-Dioulasso to high-risk urban or border areas, subject to technical feasibility and expected quality of sampling.
8. Conduct in-depth technical investigations in EM sites with

persistently low enterovirus detection rates to distinguish between sitting selection, sampling method, flow rate, dilution, or seasonality issues.

9. Perform a specific analysis of the performance disruption observed in 2024 to determine whether it is the result of actual delays, overloading of the laboratory network, or insufficient data completeness.
10. Regularly cross-reference surveillance data with routine immunization coverage, SIA results, zero-dose children, population movements, and security data.
11. Prioritize vaccination and active research activities in areas where low surveillance performance and low herd immunity coexist.

Conclusion

The evaluation of AFP and environmental monitoring performance in Burkina Faso from 2020 to 2024 highlights a system that is globally sensitive and responsive but marked by subnational disparities and operational shortcomings. The rates of non-polio AFP, stool adequacy, follow-up to day 60 and rapid investigation demonstrate a real national capacity to detect, investigate and document suspected polio cases. These achievements are likely linked to strengthened surveillance after the emergence of cVDPV2, GPEI support, and the commitment of health system actors.

However, several shortcomings limit the device's optimal performance. Active surveillance in priority sites remains well below standards, particularly in border districts and insecurity-affected areas. Collection of contact samples from inadequate cases remains insufficient. Environmental monitoring, although better organized in 2024, still does not meet the required thresholds for detecting enteroviruses. Finally, delivery of stool samples to the international reference laboratory is a critical link and likely delays virological confirmation and response.

In light of these results, Burkina Faso should consolidate AFP surveillance achievements while targeting low-performing districts. Priorities include strengthening community-based surveillance, improving access to difficult areas, systematizing contact sampling, optimizing international sample transport, and continuously re-evaluating environmental monitoring sites. The gradual integration of surveillance of VDPVs in immunocompromised individuals would also be a strategic step towards global polio eradication.

Conflicts of Interest

The author declares no conflicts of interest related to this study.

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Authors' Contributions

- ZONGO Inoufou (Z.I.) conceptualized and designed the study. Z.I. and SESSOUMA Abdoulaye (S.A.) cleaned the PFA surveillance database.
- Z.I. and SAWADOGO Siméon (S.S.) contributed to the concept and design of the study.
- Z.I., S.S. and Fla KOUETA (F.K.) developed the conceptual framework and methodology of the study.
- Z.I., S.A. and S.S. contributed to the analysis of the data.
- S.S., F.K., NEYA Christèle, Mâ OUATTARA, HAMA Balkissa Modibo and TOBOE Désiré contributed to the critical reading of the content of the manuscript.
- Z.I. contributed to the interpretation of the results, the writing and revision of the

manuscript, and approved the final version for publication.

Ethical Approval

The study has received approval from the Health Research Ethics Board. Informed consent was obtained from all participants and participant confidentiality was respected throughout the study.

Data Availability

All databases generated and/or analyzed during this study are available at the level of the Directorate of Prevention through Vaccinations of the Ministry of Health and from the principal investigator and can be obtained in case of reasonable need.

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Knowledge, Attitude, and Practices of Healthcare Workers towards Antimicrobial Resistance in Secondary Healthcare Facilities in South West Nigeria

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Abstract *Antimicrobial resistance (AMR) is a critical public health challenge that disproportionately burdens low- and middle-income countries, including Nigeria. Healthcare workers (HCWs) play a pivotal role in both AMR propagation and control. This cross-sectional study assessed AMR knowledge, attitude, and practices (KAP) among 329 HCWs in selected secondary health facilities across six South West Nigerian states. A structured, self-administered questionnaire captured composite AMR knowledge and attitude scores, and key AMR practice behaviours. Chi-square tests and Pearson correlation were applied at $p < 0.05$. Overall, 74.8% of respondents demonstrated adequate AMR knowledge (mean score: 12.86 ± 2.67; range: 4–17). Laboratory scientists (13.42 ± 2.43) and pharmacists (13.34 ± 2.16) recorded the highest mean knowledge scores; nurses scored the lowest (12.50 ±2.76). AMR knowledge adequacy differed significantly by professional designation ($\chi^2 = 9.58$, $p = 0.023$) and state ($\chi^2 = 40.72$, $p < 0.001$). Positive AMR attitude was recorded in 57.1% of respondents (mean score: 50.53 ± 4.15). AMR attitude was significantly associated with professional designation ($\chi^2 = 9.15$, $p = 0.027$). Practice gaps were prominent: 40.4% purchased antibiotics over the counter without a prescription, 73.6% reported stopping antibiotic courses when they felt better, and 73.6% kept leftover antibiotics for future use. Despite adequate knowledge, critical AMR practice deficits persist among South West Nigerian secondary HCWs. Targeted antibiotic stewardship programmes, integrated IPC–AMR training, and strengthened diagnostic infrastructure are urgently needed.*

Keywords *Attitude, Antimicrobial Resistance, Antibiotic Stewardship, Healthcare Workers, Knowledge, Nigeria, Practices, Secondary Healthcare.*

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Introduction

Antimicrobial resistance (AMR) has emerged as a defining public health crisis of the 21st century. The World Health Organization (WHO) lists AMR among its top ten global public health threats, with estimates placing AMR-attributable mortality at 4.95 million deaths annually in 2019, including 1.27 million directly attributable deaths [1]. Projections suggest this burden could escalate to 10 million deaths per year by 2050 absent decisive intervention [2]. The toll falls disproportionately on low- and middle-income countries (LMICs), with western sub-Saharan Africa recording the highest AMR-attributable mortality rates globally [1].

In Nigeria, the burden of AMR is incompletely characterised due to limited national surveillance infrastructure and epidemiological data gaps [3]. However, accumulating evidence documents clinically significant AMR, including methicillin-resistant Staphylococcus aureus (MRSA) and fluoroquinolone-resistant Escherichia coli in South West Nigeria [4, 5]. National estimates suggest 20–50% of antibiotic use is inappropriate, driven by over-the-counter availability without prescription, physician overprescribing, and weak infection prevention and control (IPC) implementation [6, 7].

Healthcare workers (HCWs) are pivotal actors in the AMR response. Their prescribing and dispensing behaviours directly influence selective pressure for resistance development. Their adherence to IPC measures determines the within-facility transmission of resistant organisms. Their own antibiotic use practices—particularly self-medication—reflect and propagate community-level resistance [8]. Yet the knowledge, attitudes, and practices (KAP) of Nigerian HCWs regarding AMR remain incompletely studied, particularly at the secondary healthcare level [9, 10].

Secondary healthcare facilities in South West Nigeria—comprising Lagos, Ogun, Oyo, Osun, Ondo, and Ekiti states—serve as critical first-level referral nodes, managing conditions most prone to AMR complications, including sepsis, respiratory infections, and post-surgical wound infections [11]. The AMR KAP profile of the secondary HCW workforce is therefore highly consequential for patient safety and AMR containment outcomes.

Understanding HCWs' AMR KAP is also essential for targeted programme design. The WHO Global Action Plan on AMR emphasises optimising antimicrobial use through antibiotic stewardship programmes (ASPs), which include surveillance, HCW education, and behavioural change toward evidence-based prescribing [12]. Nigeria's National AMR Action Plan (NAMAP) aligns with these imperatives, but implementation at sub-national and facility levels remains variable [3].

This study assessed the AMR knowledge, attitude, and practices of HCWs in secondary health facilities across six South West Nigerian states, and identified correlates of adequate AMR knowledge and positive AMR attitude to inform stewardship programme design.

Materials and Methods

Study Design and Setting

A cross-sectional descriptive survey was conducted in selected secondary healthcare facilities across the six South West states of Nigeria: Ekiti, Lagos, Ogun, Ondo, Osun, and Oyo. This design is appropriate for estimating the prevalence and distribution of KAP toward AMR at a single point in time [13]. The six states were purposively selected to ensure geographic representativeness of the South West geopolitical zone.

Study Population and Sampling

All categories of HCWs employed in the selected facilities were eligible, including doctors, nurses, pharmacists, laboratory scientists, laboratory technicians, and pharmacy technicians, provided they had practised at the facility for at least three months.

Proportionate stratified random sampling was applied within each facility to ensure cadre representation. A total of 329 respondents were enrolled: Lagos (n = 207), Ogun (n = 46), and Ekiti, Oyo, Osun, and Ondo (n = 19 each).

Data Collection Instrument

A validated, semi-structured, self-administered questionnaire adapted from comparable AMR and IPC KAP tools [14, 15] was used. The AMR-related sections assessed: (i) AMR knowledge—multi-domain items covering antibiotic classes, mechanisms of resistance, appropriate antibiotic indications, resistance-reducing practices, and information sources; (ii) AMR attitude—a 20-item Likert-scale composite covering prescribing philosophy, stewardship endorsement, community education, and enforcement attitudes; and (iii) AMR practices—covering antibiotic self-use, over-the-counter (OTC) purchasing, treatment completion, antibiotic storage, and facility-level stewardship exposure.

Scoring and Categorisation

Composite AMR knowledge scores were computed by summing binary item scores (1 = correct, 0 = incorrect). Composite AMR attitude scores were computed from Likert-scale responses (Strongly Agree = 4 to Strongly Disagree = 1, with reverse coding for negatively worded items). Knowledge was categorised as 'adequate' (≥ 70% of maximum) or 'not adequate' (< 70%). Attitude was categorised as 'positive' or 'negative' based on median-split cut-off values.

Statistical Analysis

Data were analysed using IBM SPSS Statistics version 25.0. Descriptive statistics—frequencies, proportions, means, and standard deviations—were calculated for all variables. Bivariate associations between categorical variables were assessed using Pearson's chi-square test; associations between composite scores were assessed using Pearson's product-moment correlation coefficient. A two-tailed p-value of < 0.05 was considered statistically significant [16].

Ethical Considerations

The relevant institutional review committee approved the study before it began. We obtained written informed consent from all participants. Participation was entirely voluntary, and anonymity was maintained; no identifying information was included in the dataset. The study followed the Declaration of Helsinki [17].

Results

Sociodemographic Characteristics

A total of 329 HCWs participated (Table 1). The mean age was 38.0 ± 8.8 years (range: 18–62). Females constituted 66.3% (n = 218). Most respondents were married (72.0%) and identified as Christian (73.9%). Nurses formed the largest cadre (56.5%), followed by doctors (28.9%), pharmacists (6.1%), laboratory scientists (4.3%), pharmacy technicians (2.7%), and laboratory technicians (1.5%). Lagos State accounted for 62.9% of respondents. Overall, 278 (84.5%) respondents had ever received AMR training, and 227 (69.0%) had done so within the preceding 12 months.

Table 1. Sociodemographic and Training Profile of Respondents (N = 329)

Variable	n	%
Gender		
Male	111	33.7
Female	218	66.3
Mean Age ± SD (range, years)	38.0 ± 8.8 (18–62)	
Marital Status		

Married	237	72.0
Single	83	25.2
Other	9	2.7
Religion		
Christianity	243	73.9
Islam	86	26.1
Professional Designation		
Nurse	186	56.5
Doctor	95	28.9
Pharmacist	29	8.8
Laboratory Scientist	19	5.8
State of Practice		
Lagos	207	62.9
Ogun	46	14.0
Ekiti	19	5.8
Oyo	19	5.8
Osun	19	5.8
Ondo	19	5.8
AMR Training History		
Ever trained on AMR	278	84.5
AMR training in last 12 months	227	69.0
Ever trained on IPC	313	95.1
IPC training in last 12 months	263	79.9

AMR Encounters in Clinical Practice

Frequency of suspected AMR case encounters was high (Table 2): 82 (24.9%) respondents encountered AMR cases daily, 70 (21.3%) weekly, and 150 (45.6%) monthly; only 27 (8.2%) reported never encountering such cases. These findings confirm the routine clinical relevance of AMR in secondary care and reinforce the imperative for AMR literacy among secondary facility HCWs [9, 18].

Table 2. Frequency of AMR Case Encounters Reported by Respondents (N = 329)

Frequency of AMR Encounters	n	%
Daily	82	24.9
Weekly	70	21.3
Monthly	150	45.6
Never	27	8.2

AMR Knowledge

Overall, 246 (74.8%) respondents demonstrated adequate AMR knowledge, while 83 (25.2%) did not (Table 3). The mean AMR knowledge score was 12.86 ± 2.67 (range: 4–17). Laboratory scientists had the highest mean score (13.42 ± 2.43), followed by pharmacists (13.34 ± 2.16) and doctors (13.32 ± 2.59); nurses had the lowest mean score (12.50 ± 2.76) and the highest proportion with inadequate knowledge (31.7%). Professional designation was significantly associated with AMR knowledge adequacy ($\chi^2 = 9.58$, df = 3, p = 0.023).

State of practice was also significantly associated with AMR knowledge adequacy ($\chi^2 = 40.72$, df = 5, $p < 0.001$): Ondo State recorded only 15.8% with adequate knowledge, compared with 94.7% in Ekiti, 78.3% in Ogun, and 76.8% in Lagos. On specific knowledge domains, 89.4% correctly identified unnecessary antibiotic use as the single most important contributor to AMR emergence; 96.4% correctly characterised AMR as microorganism insensitivity or immunity to antimicrobial drugs; and 87.5% correctly identified all four bacterial resistance mechanisms [19].

Table 3. AMR Knowledge Adequacy by Professional Designation

Designation	Adequate Knowledge n (%)	Inadequate n (%)	Mean Score (SD)
Doctor	79 (83.2)	16 (16.8)	13.32 (2.59)
Nurse	127 (68.3)	59 (31.7)	12.50 (2.76)
Pharmacist	24 (82.8)	5 (17.2)	13.34 (2.16)
Laboratory Scientist	16 (84.2)	3 (15.8)	13.42 (2.43)
Total	246 (74.8)	83 (25.2)	12.86 (2.67)

$\chi^2 = 9.58$, df = 3, p = 0.023

Table 4. AMR Knowledge Adequacy by State of Practice

State	Adequate Knowledge n (%)	Not Adequate n (%)	Total n
Ekiti	18 (94.7)	1 (5.3)	19
Lagos	159 (76.8)	48 (23.2)	207
Ogun	36 (78.3)	10 (21.7)	46
Ondo	3 (15.8)	16 (84.2)	19
Osun	16 (84.2)	3 (15.8)	19
Oyo	14 (73.7)	5 (26.3)	19

$\chi^2 = 40.72$, df = 5, $p < 0.001$

AMR Attitude

The mean AMR attitude score was 50.53 ± 4.15 (range: 34–58). Overall, 188 (57.1%) respondents demonstrated a positive AMR attitude and 141 (42.9%) a negative attitude (Table 5). Professional designation was significantly associated with AMR attitude ($\chi^2 = 9.15$, df = 3, p = 0.027): pharmacists (72.4%) and laboratory scientists (73.7%) showed the highest positive attitude rates, while nurses had the lowest (50.5%). On specific items, 98.5% agreed on the need for regular AMR training updates; 97.3% endorsed collaborative stewardship between HCWs and administrators; and 96.7% agreed AMR prevention should be a priority for all HCWs. However, 23.1% agreed it is acceptable to prescribe antibiotics for viral infections, and only 58.7% agreed that prescriptions should be

reserved for confirmed or highly probable bacterial infections [20].

Table 5. AMR Attitude Category by Professional Designation

Designation	Positive Attitude n (%)	Negative Attitude n (%)	Mean Score (SD)
Doctor	59 (62.1)	36 (37.9)	50.8 (3.9)
Nurse	94 (50.5)	92 (49.5)	50.2 (4.2)
Pharmacist	21 (72.4)	8 (27.6)	51.3 (4.0)
Laboratory Scientist	14 (73.7)	5 (26.3)	51.6 (3.7)
Total	188 (57.1)	141 (42.9)	50.53 (4.15)

$\chi^2 = 9.15$, $df = 3$, $p = 0.027$

AMR Practices

Table 6 presents key AMR practice behaviours. Practice gaps were pronounced: 133 (40.4%) respondents reported purchasing antibiotics OTC without a prescription; 282 (85.7%) reported stopping antibiotic courses when they felt better; and 242 (73.6%) reported keeping leftover antibiotics for future use. These behaviours are individually and collectively drivers of AMR and represent a fundamental knowledge-to-practice translation gap [8, 21].

Regarding facility-level stewardship, 242 (73.6%) respondents reported that their facility had guidelines for rational antibiotic use, while 37 (11.2%) reported no such guidelines. Isolation precautions for patients with multidrug-resistant organisms were not consistently implemented: only a minority reported always implementing barrier nursing [22]. AMR confidence was relatively high: 69.9% of respondents were confident or very confident in identifying AMR infections based on clinical presentation, and 76.3% based on laboratory findings; however, insufficient laboratory capacity, lack of rapid diagnostic tests, and delays in result reporting were cited as major diagnostic constraints [23].

Table 6. AMR-Related Practice Behaviours Among Respondents (N = 329)

Practice Item	Yes n (%)	No n (%)	Missing n
Purchases antibiotics OTC without a prescription	133 (40.4)	196 (59.6)	0
Stop antibiotics when feeling better	282 (85.7)	47 (14.3)	0
Keeps leftover antibiotics for future use	242 (73.6)	87 (26.4)	0
Completes full antibiotic course	282 (85.7)	47 (14.3)	0
The facility has rational antibiotic use guidelines	242 (73.6)	37 (11.2)	50

Correlates of AMR Knowledge and Attitude

Table 7 presents key bivariate associations. Prior IPC training was significantly associated with adequate AMR knowledge ($\chi^2 = 6.94$, $df = 1$, $p = 0.008$): 76.4% of those with prior IPC training had adequate AMR knowledge, compared with 43.8% among those without. Importantly, prior AMR-specific training was not significantly associated with adequate AMR knowledge ($\chi^2 = 0.33$, $p = 0.567$), suggesting that training quality and content, rather than frequency, may be more determinative [24]. A weak but statistically significant positive correlation was found between IPC and AMR knowledge scores ($r = 0.146$, $p = 0.008$). Adequate IPC knowledge was significantly associated with

positive AMR attitude ($\chi^2 = 13.21$, df = 1, $p < 0.001$) [25].

Table 7. Bivariate Associations with AMR Knowledge and Attitude

Variable	Test Statistic	p-value	Significance
Professional designation vs. AMR knowledge	$\chi^2 = 9.58$, df = 3	0.023	Significant
State of practice vs. AMR knowledge	$\chi^2 = 40.72$, df = 5	< 0.001	Significant
IPC training (ever) vs. AMR knowledge	$\chi^2 = 6.94$, df = 1	0.008	Significant
AMR training (ever) vs. AMR knowledge	$\chi^2 = 0.33$, df = 1	0.567	Not significant
Professional designation vs. AMR attitude	$\chi^2 = 9.15$, df = 3	0.027	Significant
Adequate IPC knowledge vs. positive AMR attitude	$\chi^2 = 13.21$, df = 1	0.0003	Significant
IPC KW score vs. AMR KW score (Pearson r)	r = 0.146	0.008	Significant

Discussion

This study provides a multi-state assessment of AMR KAP among secondary HCWs in South West Nigeria, offering evidence directly relevant to national AMR stewardship programme design and implementation.

The finding that 74.8% of respondents demonstrated adequate AMR knowledge is broadly encouraging and compares favourably with reports from comparable LMICs, where AMR knowledge adequacy has ranged from 50–80% [14, 15, 26]. The significantly superior AMR knowledge profile of laboratory scientists (84.2% adequate) and pharmacists (82.8%), relative to nurses (68.3%), is clinically meaningful. Laboratory scientists' routine engagement with culture, sensitivity reporting, and resistance pattern interpretation likely accounts for their higher knowledge scores [23]. The AMR knowledge gap among nurses is particularly concerning, given their dominance in the secondary HCW workforce and their central role in antibiotic administration and IPC adherence [27].

The large and highly significant variation in AMR knowledge adequacy by state ($p < 0.001$)—with Ondo State recording only 15.8% adequate knowledge versus 94.7% in Ekiti—is a striking finding. Possible explanations include differential implementation of the National AMR Action Plan across states, variation in state-level training programme reach and quality, and differences in facility-level supportive supervision and governance [3, 28]. This finding argues for state-disaggregated AMR surveillance and capacity-building assessments.

Despite generally adequate knowledge, AMR attitude outcomes were more mixed: only 57.1% demonstrated positive attitudes. The significant association between professional designation and AMR attitude ($p = 0.027$), with nurses demonstrating the lowest positive attitude rate (50.5%), parallels the knowledge findings. This knowledge–attitude gap mirrors findings from multiple comparable African settings and likely reflects workload pressure, patient demand for antibiotics, peer prescribing norms, and perceived inadequacy of diagnostic support [29].

The AMR practice findings are the most alarming aspect of this study. Despite relatively adequate knowledge, 40.4% of respondents purchased antibiotics OTC without a prescription, 73.6% stopped antibiotic courses when feeling better, and 73.6% retained leftover antibiotics. These behaviours by HCWs themselves are individually well-established drivers of AMR [8, 21] and signal a

profound knowledge-to-practice translation gap. That HCWs self-medicate with and misuse antibiotics, undermines their credibility as AMR stewardship advocates and suggests that knowledge- or attitude-only interventions may be insufficient without structural reform—including stronger prescribing regulations, professional accountability mechanisms, and accessible diagnostic infrastructure [30].

The finding that IPC training—rather than AMR-specific training—was significantly associated with adequate AMR knowledge ($p = 0.008$) reinforces the evidence for integrated IPC–AMR programme design. It suggests that IPC training platforms may provide a more consistently accessible and quality-assured vehicle for AMR capacity building than standalone AMR training, which may be more variable in content and reach [25]. Leveraging existing IPC training infrastructure to embed AMR stewardship content represents a practical and efficient approach for resource-constrained settings [12].

The high self-reported diagnostic confidence (69.9% and 76.3% clinically and laboratory confident, respectively) should be interpreted carefully in the context of well-documented laboratory capacity limitations in Nigerian secondary facilities. Overconfidence in AMR identification, without confirmatory susceptibility testing, may delay recognition of resistant cases and lead to inappropriate management [23]. Strengthening laboratory capacity for antibiotic susceptibility testing is therefore a critical system-level priority.

This study has several limitations. The cross-sectional design precludes causal inference. Self-reported practice data are subject to social desirability bias and likely overestimate appropriate behaviours. The Lagos-dominated sample (62.9%) may limit generalisability to less urbanised and rural secondary facilities. Future studies should incorporate validated observational assessments, longitudinal designs, and ensure balanced multi-state sampling to better capture geographic heterogeneity in AMR KAP [13, 16].

Conclusion

Healthcare workers in South West Nigeria's secondary health facilities generally demonstrate adequate AMR knowledge, but this knowledge does not consistently translate into positive AMR attitudes or appropriate antibiotic use practices. Critical practice deficits – OTC antibiotic purchasing, premature treatment discontinuation, and leftover antibiotic retention – persist even among knowledgeable HCWs, signaling a profound knowledge-to-practice gap. Significant knowledge disparities by professional cadre and state underscore the inadequacy of generic national interventions. Integrated IPC–AMR training, targeted nurse-focused educational programmes, enforced prescribing guidelines, and strengthened laboratory diagnostic infrastructure are the foundational pillars of an effective AMR response in this context.

Conflict of Interest

The authors declare no conflict of interest.

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Author Contributions

Peter Idowu Omoniyi: conceptualisation, data collection, formal analysis, and manuscript drafting. George Ikpe, Abiodun Olaiya Paul, Chukwuma Grant Madubuko, Omowumi O Okedare, Golibe Ugochukwu, Shadrach Dimang: supervision, critical review, and editing. All authors approved the final manuscript.

Ethical Approval

The relevant institutional review committee approved this study before data collection. We

obtained written informed consent from all participants. The study adhered to the Declaration of Helsinki.

Data Availability

The dataset supporting the conclusions of this article is available from the corresponding author on reasonable request, subject to applicable ethical approval conditions.

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Nigeria Rising Population: Perceived Factors Responsible among Residents of Three Local Government Areas of Niger State: A Cross-Sectional Survey

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Abstract *Nigeria is widely known as the most populous country in Africa; however, the nation has been plagued by a weak economy, insecurity, infrastructural deficits, low industrialization, poor healthcare services, and other consequences that reduce quality of life and shorten lifespan. When the population of a geographical location is far above the available resources, chaos is the answer, which is the situation in the nation that has been projected to overtake the population of China in 2100. This study investigated the perceived factors, consequences and solutions of the rising population in three local government (LGA) of Niger state. A descriptive survey was conducted using questionnaires in KoboCollect among residents chosen randomly in selected wards; descriptive analysis was done with SPSS. We analyzed 3758 respondents; 86.9% were in the 21-50 years age range, the sample was male-skewed, the desired number of children (M) was 5.30, and there was no significant difference in child preference by gender. Majority (62.6%), agreed there is overpopulation, perceived factors were religion belief (56.5%), cultural belief (14.4%), husband decision (11.3%), and polygamous family practice (4.1). Increased births were attributed to emotional satisfaction (32.1%), improved social amenities (17.3%), while 32.1% disagreed on all the factors. Identified consequences of overpopulation included poor healthcare (37.0%), unemployment (26.1%), insecurity (10.1%), and a sub-standard educational system (9.5%). There is a need for population stakeholders' roundtable meetings for urgent, decisive, measurable actions before the breaking point is reached, to enable citizens to live quality lives and exhibit their potential in their fatherland.*

Keywords *Consequences, Factors, Niger State, Overpopulation, Perception, Solutions.*

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Introduction

Human population, according to Britannica, "is defined as the whole number of inhabitants occupying an area such as a country or the world. It is continually being modified by increases and losses, such as births, immigration, deaths and emigration [1]. The total population of a geographical entity, is usually calculated through a process called census. A census is used to collect data such as age, sex, occupation, residence and other population characteristics; the two common types of censuses are "de jure" and "de facto" [2]. The data obtained are used for planning, to provide or improve services in the areas of infrastructure, socio-economic, healthcare, business, workforce, etc.; politically, it is for policymaking, resource allocation, security, etc. Furthermore, for population projections and dynamics to help in gaining insight into the past, present and future trend, and associated challenges; provision of data is another important usage of population data to obtain accurate, reliable demographic vital statistics using birth rates, death rates, migration patterns, age and gender distributions. Lastly, is the protection of the environment and the inhabitants [3].

The total world population is projected to reach 10.3 billion in the mid-2080s from 8.2 billion in 2024 (an additional 2.1 billion), and 10.2 billion at the end of this century or beyond 2100. Population growth, population ageing, urbanization and international migration are four major demographic trends shaping our world according to the United Nations Department of Economic and Social Affairs World Population Prospect 2024 [4]. According to population transition in 2024, 63 countries (28% of the world population) have peaked and now declining, while 48 countries (14%) peak period, has been projected between 2025 and 2054. The remaining 126 countries are likely to continue growing through 2054, and projected to peak later in this century or beyond; unfortunately, Nigeria falls within this last group. The reasons is youthful age structure conducive to population growth and fertility levels that remain above the replacement level [4]. Since human population is dynamic, factors that affect the size of the population includes diseases, environment, socio-economic, customs, technological development in the field of medicine, and public health [5].

Nigeria is currently the most populous country in Africa, with a population of 237,527,782 in 2025, 6th in the world [6], and is projected to be 3rd by 2050; the country's population trend quadrupled within 50 years, with an estimate of 63,374,000 in 1975 to 233,343,000 in 2025. These trends bring challenges and opportunities; addressing the challenges and leveraging the opportunities are crucial to safeguarding our planet and achieving the 2030 Agenda for Sustainable Development goals (SDGs) [4]. However, some school of thought believed Nigeria is not overpopulated, with arguments based on the country endowment with vast abundant, arable land for agriculture, and natural resources (oil, gas, solid minerals, etc.). In addition, geographical location with few natural disasters, human capital with brainpower (which had been demonstrated worldwide), entrepreneur spirit and rich cultural diversity. They asserted that with good management, the above should be assets toward the country development, irrespective of the population figures [7]. It is sad, that the resources, rather as vehicles for accelerated growth, the opposite is the case due to mismanagement, politicization, ethnic mistrust, corruption and the lack of able and dedicated leadership to manage the country as obtained in other nations with the same colonial history.

Data have shown that unregulated population has negative impact on the social, economic, health, education, environment, and other lives of the populace. Data of some measurable indices in countries with manageable population and good governance have been demonstrated to be satisfactory, the

populace enjoying better standard of living and quality of life, compare to those in unregulated population growth and poor governance [8]. The enormity of the contrast and challenges can be further expatiated by a compare with countries in different population transition zones, manageable population and Nigeria (Table 1). South Korea is a country in the first transition in which population have peaked and now declining [9-11]**.** Thailand is in the second transition with population projected to peak between 2025 and 2054 [12, 13, 6]; while South Africa and Nigeria [14, 15, 6, 11] are countries with population that are likely to continue growing through 2054 [11**].** It is worth mentioning that the Nigeria population data has relied on projections and estimates from World Bank, UN, and other population related organization; census in the country had been riddled with regional manipulation and politicization which has impeded the development and advancement of the country, the last official national census was conducted in 2006 [16, 17]. In order to find solutions to the rising population and the detrimental effects, the perception of the citizens as stakeholders and the building blocks of the projected figures are important; thus, the aim of this study is to explore the perceived factors, consequences, and possible solutions responsible for the rising population in the country among residents of three LGAs of Niger State.

Table 1. Comparison between Nigeria and Three Countries in Different Population Transitions

Country → Indicators ↓	**Nigeria**	**South Africa**	**Thailand**	**South Korea**
Demographic				
Total Population	237.53M (2025) 223.80M (2023)	64.75M (2025) 60.41M (2023)	71.62M (2025) 71.80M (2023)	51.67M (2025) 51.71M (2023)
Population Growth %	2.1 (2025)	1.1 (2025)	-0.1 (2025)	−0.09 (2025)
Population Density (ppl per sq km of land)	261.0 (2025)	53.0 (2025)	140.0 (2025)	531.0 (2025)
Economic				
Gross Domestic Product US$ (GDP)[1]	290.79B (2025)	427.18B (2025)	577.01B (2025)	1,87.79T (2025)
GDP Growth (Annual %)	4.0 (2025)	1.1 (2025)	2.4 (2025)	1.0 (2025)
GDP Per Capita [GDP/PPP (USD)[2]	1,224.3(2025)	6,597.7 (2025)	8,056.6 (2025)	36,227.0 (2025)
Inflation Rate %	23.0 (2025)	3.2 (2025)	−0.1 (2025) Deflation	2.1 (2025)
Poverty Rate (annual %)	41.8 (2026)	17.4 (2026)	0.0 (2026)	0.1 (2026)
Unemployment Rate (% of total labor force)	3.1% (2025; basically, informal/unorganized sectors like agriculture, trading, etc.; not easy to measure)	32.4% (2025) More formal, developed, and easy to measure	0.8 (2025)	2.68 (2025)
MEDIAN AGE (Years)	18.1 (2025)	29.7 (2025)	40.6 (2025)	46.2 (2025)
Net Migration	−15,258 (2025)	146,370 (2025)	27,509 (2025)	−2,787 (2025)
Environment				
Access to Safe Water %	29.9 (2024)	77.0 (2024)	100 (2024)	99.28 (2024)

Housing (Homeless)	28M; 13% (highest in the world) 2nd Slum population in the world (available houses more than the populace)	55,719 (2022)	2,700 (2022)	8,986 (2022)
Access to Electricity %	62.5 Unreliable & Epileptic (2024)	90.2 (2024)	100 (2024)	100.00 (2022)
Security (Global Peace Index)[3]	2.91 (131st out of 134 countries)	2.51 (120th)	2.05 (70th)	1.84 (17th)
Healthcare				
Fertility Rate (total per woman)	5.14 (2022)	2.34 (2022)	1.32 (2022)	0.78 (2023)
Infant Mortality Rate IMR (per 1000 live births)	68.50 (2022)	27.50 (2022)	7.0 (2022)	2.40 (2022)
Under 5 Mortality Rate[4]	105 (2023)	35 (2023)	9 (2023)	18 (2023)
Maternal Mortality ratio MMR/100,000	1,047 (2025) Currently rated as the worst place on the planet to give birth)	100.6 (2025)	34 (2025)	5.0 (2025)
Life Expectancy at Birth (in years)	54.78 (2025)	66.0 (2025)	77.0 (2025)	84.6 (2025)
Healthcare Index[5]	49.1 (2025)	63.8 (2025)	77.5 (2025)	82.8 (2025)
Education				
Out of School Children (5 – 14 years)	10.5M (2024) Highest in the world according to UNESCO)	919,817 (2024)	71,223 (2024)	2,581 (2024)
Literacy Rate % (15 years and above who can read and write)	60 (2024)	95 (2024)	94 (2024)	99 (2024)

(Source: World Bank Data, Wordiometer, Hasell, et al.)

[1]Standard measure of the goods & services produced over a period; [2]Economic well-being of a country; [3]Internal & external violent conflict, terrorism act, homicide, military expenditure as a % of GDP; [4]Measure of a country health system; [5]Cumulative outcome of life expectancy; IMR; disease prevalence; healthcare access, service, workforce density, quality, financing and expenditure, out-of-pocket payment and health insurance coverage

Materials and Methods

Study Design and Setting

A community cross-sectional survey was used to collect data from residents of selected wards in Gurara, Tafa, and Suleja LGAs in Niger State. Gurara, Suleja and Tafa are among the 25 LGAs of the state in the North-Central region of Nigeria, and the state's projected population was 6,783,300 (2022). The LGAs are inhabited by people of different ethnicities, making the communities suitable for the aim of this study; they comprise both rural and semi-urban communities based on population, not on development or infrastructure. The majority of the residents work in the informal/unorganized sectors. The 2022 projected population for Gurara, Suleja, and Tafa was 155900, 368900, and 143900, respectively [18]. Each LGA consists of 10 wards, and five wards were

selected from each LGA. The proximity of the three LGAs to the Federal Capital Territory (FCT) allowed representatives from all the geopolitical zones to be present.

Sample Size

The sample size was calculated independently for each LGA using the Taro Yamane (Slovin's) formula for a known (finite) population [19].

$$n = \frac{N}{1+N(e)^2}$$

where, n = sample size; N = known population size; e = acceptable sampling error of 0.05 at 95% Confidence Level. The total calculated sample size was 1,318; Gurara 439, Tafa 439, and Suleja 440, with the inclusion of a 10% non-response rate.

Sample Technique

A stratified sampling method was used. Each LGA was stratified according to the already known administrative wards; five wards were randomly selected from each LGA. Simple randomization was used to select respondents from each ward. The inclusion criteria for participants were adults aged 21 years and above, both genders, community residents, and Nigerians. The exclusion criteria were non-residents, below 21 years, non-Nigerians and non-consented individuals.

Data Collection

The questionnaires were in English, structured, researcher-administered, and loaded onto KoboCollect, a mobile application program used for collecting data in the field [20]. Interpretations were done for respondents who did not understand the English language, confidentiality was promised, and no respondent's name was asked. The field officers were experts in data collection, versed in English and other local languages. The survey followed a pilot study that was conducted in a different ward. The questionnaires were pre-tested and the Cronbach Alpha coefficient was **.74**. Training and briefing of the field workers were done in April and May 2026, and data collection was between May and June 2026.

Data Analysis

The summarization of the data was done with pivot table in Excel and analyzed in IBM SPSS version 27. A total of 3764 respondents, who were residents of the 3 LGAs were interviewed, 3758 analyzed, the remaining 6 were rejected secondary to data incompleteness. Descriptive statistics included frequencies, percentages, means to summarized the data, and compare attempted between some variables.

Results

Demographic Characteristics of Respondents

Among the 3758 respondents analyzed, females were 1668 (44.4%) and males were 2090 (55.6%); based on LGA, Gurara, Suleja, and Tafa had 998, 1673 and 1087, with a similar female-to-male ratio pattern. Majority were in the 31-40 (34.8%), 21-30 (30.4%), 41-50 (21.7%) years ranges, only 13.1% were above 51 years. A very high proportion, 90.3% were engaged in the informal/unorganized sector, 9.3% civil servants and only 7 respondents identified as unemployed. On education attainment, 43.5%, 38.3% had secondary and higher education respectively, 9.2% had no formal education. At the time of the data collection, 65.9% respondents were married, 24.6% single; 57.6% practiced Christianity and 41.1% Islam. Monogamy was the family type preference of most respondents (75.5%), polygamy (22.9%), while a minority 1.6% supported single parenting.

By geopolitical zone, most respondents were from the North Central (41.6%), South East (15.1%), South South (14.4%), South West (12.7%), and North West (12.2%), while the North East had the Fewest (4%). The desired number of children averaged (M = 5.30,

SD = 3.42); however, gender preference was slightly higher for male children (Table 2).

Table 2. Current Number of Children, Desired and Gender Preference from Respondents

Items	Mean	Std. Deviation
Number of Children Currently	3.18	3.10
Desired Number of Children	5.30	3.42
Desired Number of Male Children	2.82	2.32
Desired Number of Female Children	2.54	1.85

Perceived Causes of Overpopulation

62.5% respondents agreed that Nigeria is overpopulated, 19.3% were not sure, and 18.0% disagreed; above average, attributed rising population to religious beliefs (56.5%), cultural beliefs (14.4%), and husband decisions (11.3%) (Table 3).

Table 3. Perceived Factors Responsible for Rising Population in Nigeria from Respondents

Factors	Frequency	Percentage %
Age At Marriage	610	3.1
Cultural Belief	2795	14.4
Educational Status	534	2.8
Ethnic Background	340	1.8
Extended Family Influence	324	1.7
Gender Preferences	324	1.7
Husbands Decision	2182	11.3
Polygamous Family Practice	786	4.1
Political Vote Gain	525	2.7
Religious Belief	10954	56.5
Total	19374	100.0

On possible factors responsible for increased birth in the country, emotional satisfaction and improved social amenities were agreed by 32.1 and 17.3% of respondents respectively, while a significant 32.5% did not agree with any of the options (Table 4).

Table 4. Perceived Factors Contributing to Increase Birth in Nigeria from Respondents

Factors	Frequency	Percentage %
Advanced Technology	87	1.6
Emotional Satisfaction	1799	32.1
Food Security	312	5.6
Improved Health System	150	2.7
Improved Security	154	2.8
Improved Social Amenities	967	17.3
None Of The Above	1821	32.5
Raised Economic Power (Better Living Condition)	308	5.5
Total	5598	100.0

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Perceived Consequences of Overpopulation

Over two-thirds of the respondents (59.7%) agreed that overpopulation is one of the causes of reduced life expectancy at birth. More than average did not agree that the government should make a law limiting the number of children a man (56.6%) and a woman (54.5%) can have in their lifetime. On average, 4-5 children were the most common choice for men (61.6%) and women (61.4%), respectively. Poor healthcare 37.0%, unemployment 26.1%, insecurity 10.1% and a sub-standard educational system 9.5%) were the common factors the respondents associated with overpopulation in Table 5.

Table 5. Perceived Consequences of Overpopulation in Nigeria from Respondents

Consequences	Frequency	Percentage %
Bad Governance	583	3.2
Bad Roads	594	3.3
Communal Clashes & Land Disputes	410	2.3
Environmental Pollution of Land, Air & Water	221	1.2
Food Insecurity & Hunger	296	1.6
Insecurity	1823	10.1
Poor Healthcare System	6668	37.0
Poor Housing And Slums	285	1.6
Sub-Standard Educational System & Illiteracy	1712	9.5
Unemployment	4708	26.1
Unsafe Water	315	1.7
Unstable & Poor Electricity Supply	402	2.2
Total	18017	100

Perceived Solutions to Overpopulation

Table 6 summarized the possible solutions to overpopulation according to the respondents; over two-thirds agreed to all the suggested incentives and proffered solutions; however, the positive responses were under two-thirds on raising the legal age a woman should start to give birth (57.7%).

Table 6. Proffered Solutions and Incentives for a Controlled Population in Nigeria

Suggested Solutions	Frequency	Percentage %
More Access to Family Planning	3314	88.2
Men Involvement in Family Planning	2549	67.8
Investment in Girl Child Education	3431	91.3
Enforcing Legal Age of Marriage	2793	74.3
Raising the Legal Age, a Woman Starts Giving Birth	2169	57.7
Gender Equality	2669	71.0
Suggested Incentives for a Maximum of 2 Children		
Monetary	3307	88.0
Scholarship	3469	92.3
Free Housing	3393	90.3
Reduced Tax	3442	91.6

Health Insurance	3500	93.1
Loan Offer	3344	89.0
Employment Offer	3532	94.0

Compare of Perspectives Based on Geographical Zone, Religion, Education, Gender and LGAs

Respondents' responses across different geographical zones, religions, educational backgrounds, gender status, and LGAs followed the same pattern as the total respondents; therefore, no statistical comparison was conducted.

Discussion

The survey has explored the opinions of randomly selected residents across three local governments areas of Niger State about the factors, consequences and solutions of Nigeria's rising population; in response to the projection that the country's population is on the path of surpassing China by 2100, the United States by 2050, respectively, to become the second and third-most populous globally [21]. With the above projections, it is no longer deniable that the Nigerian population is growing at an alarming rate; thus, 62.6% of the respondents agreed that the country is overpopulated, similar to findings from qualitative interviews by Population Matters in which more than 700 people from every region of the country; themes covered in the interviews were knowledge about population, gender, environment, sexual and reproductive health and human rights [8]. The slight male-skewed gender of 55.6% for males and 44.4% for females obtained in this survey is comparable to the country's recent projected total population by gender of 50.62% and 49.38% respectively, which had ranked the country as the "sixth-largest male surplus in the world", in contrast to the global slightly female-skewed gender population. This male skew has been said to be a characteristic of most young population countries, with advantages and disadvantages in the areas of workforce, military, marriage, social crimes, gender inequalities, etc. [22].

Officially, Nigeria's unemployment rate of 4.48% can be rated as low, compared to some other African countries like South Africa (32.7%) and Ghana (12.8%); thus, it is therefore, not surprised that only 7 respondents identified as unemployed in this study, while the remaining 99.6% of respondents assented to be employed. However, this notion of a low official unemployment rate is fueled by the fact that most citizens work in the informal/unorganized sectors, the country's largest employers of labor [23]. In addition, the International Labor Organization (ILO) now counts anyone who worked for one hour in the past week and got paid as employed. The specific employment of the respondents, however, revealed that 90.75% work in the informal/unorganized sectors; occupations identified were business/trade, craftsmanship/artisan, crop/livestock, transportation, teaching, housewife, security guard, clergy, cleaner, herbalist, etc. [24, 25]. These jobs are mostly self-employed, private, small, and unregistered businesses; largely intermittent and irregular in nature; and offer very low wages, little job security, limited labor union affiliation and legal protection, and no pensions, health, or hazard insurance [26]. These disadvantages keep younger people pursuing jobs in the formal/organized sectors, which are limited and often unavailable, due to a dearth of industries in the country and reliance on importation of finished products.

The overwhelming response of religion belief as the primary cause of the rising population can be consider to substantiate the country title as the "fifth country with the most religious people in the world" [27]. This finding

is very worrisome when compare to the indices of other top four nations on the list . Cultural belief and husband decision which ranked second and third respectively as perceived factors, demonstrated how people are attached to their roots and their procreation also been dictated by it. Similarly, the husband factors portray that androcentrism and patriarchy are still entrenched in the country. Polygamy, age of marriage, educational status which ranked fourth, fifth and sixth respectively are known documented factors that can affect population rise directly and indirectly [28]. It is worth mentioned that political vote gain, ethnic background, and extended family influence perceived as minor factors in this study, is contrary to the opinions in some quarters. These factors have been attributed to high birth rate, especially in the northern part of the country [29]. Sadly, positive factors like advanced technology, food security, raised economy power; health system, security, and social amenities improvements, which are supposed factors for increased population growth received low perception among the respondents; thus, 32.5% of the respondents did not attribute any of these factors as a cause, rather, 32.1% perceived emotional satisfaction for the increasing birth rate. This could be ascribed to national failure with the assumption that these enabling factors are non-existent in the country context, or a mirage to the populace.

Considering the current economy downturn, high inflation, insecurity and the associated untold hardships, it will be expected that families will self-limit the number of children being borne, resulting in decreased fertility rate outcome. Conversely, from the study, the obtained desired number of children (M = 5.30) is higher than the recent national total fertility rate of between 4.2 and 4.5 [30], a far cry from progress toward a managed population, and a wake-up call against the realization of overtaking China. The reason for this cannot be dissociated from the deeply rooted religion inclination of the populace beliefs in “God as the giver and sustenance of children” and similar to the outcome of a study in Malawi [31]. In contrast, most countries at the same population as Nigeria are putting in place measures to curtail their population, the country should not be an exemption. Another setback from the study against population control in the country, is the disagreement by slight majority (56.6%) on laws to regulate the number of children to be borne by both male and female, a weapon that had been used successfully in countries like China, Vietnam and some states in India, etc., though with some controversies and criticism about the modality of implementation, some of these policies have been suspended in some nations. [32]. Similarly, the majority acceptance of “average of 4-5 children” to be borne by a woman in her lifetime is laden with negative consequences to the health of women; the country already rated as “the worst place to give birth on the planet”. It is worth noted that the slight preference of male children (M = 2.82) to female (M = 2.54) is a welcome shift from the old school, the demonstration of a cultural shift in the acceptance of the girl child’s potentials which had been the norm in a highly cultural setting as Nigeria; the desired for male children was also identified as one of the factors responsible for high birth rate in a cross-sectional study in Urban slum of Enugu, a Southeast state of the country [33].

The consequences of overpopulation are devastating in any climes, and are in tandem with the perceptions from this study; thus, poor healthcare system (37.0%), unemployment (26.1%), insecurity (10.1%) and sub-standard education (9.5%) stood out as negative sequelae. These factors can be regarded as precursors, and cannot be dissociated from the others such as poverty, illiteracy, poor housing, bad roads, frequent communal clashes and land disputes; food insecurity and hunger, environmental pollution (land, air and water, unsafe water), and poor intermittent electricity

supply [34]. The aftermath of these are the poor ranking in some indices that had given the country derogatory labels internationally. Few examples are, "the poverty capital of the world" 62% multidimensional, 75% rural and 42% urban) [13], "top 6th of African countries where inflation is rising fastest in 2026", "161st position in human development index", based on life expectancy at birth, educational and standard of living dimensions according to the UN human development index" [35], "highest population of out of school children at 10.5m" [36]", "highest people with homelessness and 2nd slum population in the world" [37]. Lagos, the country mega city, is "one of the world's least liveable urban centers in 2026", occupying 168th position among 173 cities across the world; based on stability, healthcare, culture and environment, education, and infrastructure [38]. Poor healthcare is reflected in the country's poor healthcare index of 49.1, a cumulative outcome of life expectancy, IMR, disease prevalence, healthcare access, services, workforce density, quality, financing and expenditure, out-of-pocket payment, and health insurance coverage [39]. Furthermore, the average life span of the country is currently at 54.6 to 54.9 years (2026), in contrast to the global average of 73.4 years, and regarded as "the lowest in the world" according to UN World [40].

The insecurity plaguing the country has earned it the "131st position among 134 countries in global peace index as "a place unsafe to live"; this ranking was attributed to the overpopulation, poverty, and low literacy level. The high level of insecurity can be linked to high unemployment of youth, the "expected pillars and cornerstone" of industrialization, turned into bloody, thirsty, religious zealots depriving communities of their ancestral lands, homes, social lives and happiness [41]. These mass abductions and kidnappings are setbacks to developments and industrialization, with no investor willing to bring their money into the country.

Complex as population control is, it is significant that majority of the respondent supported measures to curb the rising population with the provided options. These measures include more access to family planning, which is low in the country at a prevalence rate of 17% as against other African countries like Malawi (66%), Kenya (65%), Rwanda (64%), Capo Verde (56%), and South Africa (55%); additionally, men's involvement in family planning has been demonstrated to increase women uptake of family planning with fewer births [43]. Since girls are the harbinger of population explosion, girls' education is a profitable investment to reduce multiple births by delaying the age of marriage, and first child birth. These strategies were similar to the findings of Population Matters in conjunction with Civil Society Legislative Advocacy Center (CISLAC)/Transparency International Nigeria (TI-Nigeria) [8]. Nigeria currently does not have a single, universally enforced legal age of marriage and thus, legal age of first birth is ambiguous. Although, adult suffrage is 18 years and serves as minimum age of marriage, however, religious and cultural undertone in some parts of the country make this difficult to implement, and young girls are given out in marriage as early as 15 years of age [44]. A new dimension to this malady is the introduction of politico-religious motivated, state government sponsored "mass wedding" which is becoming the order of the day in some northern states; the aftermath of these marriages can better be imagined with number of unwanted children, divorces, separation, poverty, out-of-school children (the country is already battling with having the "highest out of school children in the world" at 10.4M according to UNESCO), vulnerable youths for recruitment into terrorism, etc., and the resultant rise in population.

The overwhelming agreement accorded to the suggested incentives (monetary, scholarship, free housing, reduced tax, health insurance, loan offer, employment offers) from

the study are worth experimenting, toward a manageable population. Although, each of these solutions are feasible, possesses merits and demerits, short and longtime outcomes and challenges. They are capital intensive, especially with the current economic climate of the country, thus, the political-will by policy makers must be certain. Another shortfall are non or partial implementation of policy, overbearing religiosity, multiple ethnic interests, deep cultural influence, unstable political climate and corruption in the country. Other foreseeable obstacles are, of lack of ownership, reliance on foreign donors to fund policy with "a square in a round hole" tradition, laden with insincerity, non-involvement and mobilization at the grassroot, lack of proper accountability, monitoring and evaluation. [45, 46]

Suggestions

A willing administration to effect control on the rising population of the country will firstly, conduct a real time and accurate census of the country with international standard. Secondly, put in place season professionals and stakeholders on population to study the social-economic, environmental, health parameters and indices which are (being) affected by the rising population. Thirdly, establishment of the policy framework, devoid of religion, ethnicity, corruption and with legal backing. Fourthly, is awareness campaigns, advocacy and education at all level, about the advantages and benefits of a moderate family size, manageable population, and the resultant benefits. Fifth, government must by obligation fulfil its part as regard the incentives to be promised. Sixth, to immediately put in motion the industrialization and development revolutions to reduce the current sufferings due to the overpopulation effects. Lastly, is vigilance in monitoring and evaluation of the rising population figures, to avoid Nigeria population from surpassing China as being projected.

Conclusion

The findings from the study have identified some perceived factors responsible for the country rising population according to the residents of the study setting. There is the need for policy and political leaders to be proactive and decisive on the way forward at all levels of government. All stakeholders should be concerned and sensitized irrespective of religious, geographical, ethnic, and sociocultural affiliations. Short, medium, and longtime measures that can lead to controlled population must be urgently activated. The inevitable catastrophe of the rising population must be stopped, and those who understand the impending consequences should not be silence.

Limitation

There was delay in obtaining the ethical approval; also, apathy of the respondents because of the worsening insecurity and dwindling economic situations; and reliance on projected population figures, since the fact that the country has not conducted census since 2006. The survey setting, being in the North-Central geopolitical zone, could have resulted in the higher frequency of respondents from the zone, and a source of bias.

Further Research

A national survey with similar objectives should be conducted with equal representatives from all the ethnic groups in the country. Quantitative studies is also advised to dig deeper into some of the factors identified from this study among the populace, and other stakeholders with equal representatives.

Conflict of Interest

The authors have declared that no conflict of interest exist.

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Author Contributions

Conceptualization: OG/AJG/TG[4]; Methodology: OG/TG[5]; Data Collection: AJG/OG/JSC; Writing: OG/UU/TG[5]; Reviews: TG[4]/SG/UU/TG[7]; Ethical Approval: AAA/OG/JSC; Supervision: AJG/SG/TG[7]

Ethical Approval

Approval was obtained from the state ministry for local government, community development and chieftaincy affairs; additionally, each respondent was briefed about the aim of the study and voluntary informed consent duly obtained before being interviewed.

Data Availability

All data for this research will be made available on request through the corresponding author following standard guidelines.

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Design and Implementation of Community-Based Health Insurance Schemes in Northern Uganda: Evidence and Policy Implications

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Abstract *Achieving Universal Health Coverage remains a global challenge. Globally, over 100 million people are pushed into poverty annually due to high out-of-pocket expenditures. In Uganda, community-based health insurance penetration remains low. The gap is widest in post-conflict Northern Uganda, where poverty is high and health financing is fragile. This study investigated the status, design and implementation of community-based health insurance schemes in Northern Uganda. A descriptive cross-sectional study was conducted in Northern Uganda between March and May 2026. Using purposive and stratified sampling, 27 participants were engaged through Key informant interviews, In-depth interviews and Focus group discussions to generate qualitative data. Data were analyzed thematically using Braun and Clarke's framework. Four themes and 12 related sub-themes emerged. By status, schemes were mainly characterized by operational discontinuity. By design, participants proposed shifting from a member-managed to a provider-managed model, but implementation relied mainly on costly grassroots mobilization. Findings showed that scheme sustainability is structurally dependent on donor subsidies, and the recent withdrawal of support compromised operations. The absence of the National Health Insurance Scheme and formal regulation has weakened the schemes, while expectations of free care remain a major socio-cultural barrier. Community-based health schemes in Northern Uganda remain trapped in a cycle of weak design, low enrollment, and donor dependence. The sector needs to transition to legally recognized, government-subsidized, provider-managed schemes with expanded benefits and integrated governance.*

Keywords *Community-Based Health Insurance, Donor Dependence, Health Financing, Health Insurance Models, Universal Health Coverage, Uganda.*

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Introduction

Globally, achieving universal health coverage remains a challenge. The World Health Organization estimates that 150 million people face financial catastrophe annually due to health payments, and over 100 million are pushed into poverty [1].

Community-based health insurance (CBHI) schemes globally operate on the principle of risk pooling through regular members' premium contributions, reducing out-of-pocket payments, but they differ in design [2, 3]. Three broad models exist: the basic model implemented as member-managed, provider-managed, or third-party-managed; the modified Basic model with user fees, subsidies and expanded pooling; and the Nationwide model requiring political commitment and integration into national financing [4, 5].

In sub-Saharan Africa (SSA), the challenge is compounded by a high burden of disease, low public health spending, and large informal economies. Most household pay directly for care, leading to delayed treatment and financial hardship [6]. CBHI has been promoted across the region to extend financial protection to rural and informal populations. Evidence from Burkina Faso, Cameroon, and other SSA countries indicates that CBHI can reduce costs and improve access, but low enrollment, high dropout, weak governance, and sustainability challenges have constrained implementation [7].

In EastAfrican, CBHI has been piloted as part of national Universal Health Coverage (UHC) strategies. Rwanda and Kenya have integrated community schemes into national systems, while in Tanzania and Uganda, CBHI remains largely fragmented and partner-driven. However, results vary, and issues of low take-up and retention threaten viability. In Uganda, CBHI began in the mid-1990s and has largely operated under Basic and Third-Party managed models through NGOS (Non-Governmental Organizations), CBOs (Community-based Organizations) and VSLAs (Village Saving and Loan Associations) with pilots in Amuru, Gulu, Kabale and Kasese [8, 9]. Despite over three decades, penetration remains negligible at 1.1% against a 25% policy target [10]. The gap is widest in high-need areas like the Acholi sub-region in Northern Uganda, with poverty at 63% and post-conflict vulnerabilities [11-13]. The commitment to UHC is undermined by a fragile and inequitable health financing system. And, only 68.5% of total health expenditure is covered through domestic public and pooled financing [10]. Furthermore, 82% of Ugandans report concern about affording essential care and 68% have foregone needed treatment because of cost, highlighting serious gaps in access and equity [14].

Implementation has occurred without a clear legal framework, producing policy contradictions that have impeded scale up [10, 15]. Despite CBHI's long presence, critical gaps persist in evidence on whether existing models, design structures and implementation arrangements align with community needs in undeserved settings. This limits understanding of the root causes of low enrollment, restricted benefits, financial instability and inequities. As Uganda prepares to introduce a National Health Insurance scheme, the absence of robust evidence on CBHI performance including Northern Uganda risks excluding community mechanisms from national planning and service delivery. Therefore, this study aims to investigate the status, performance and design of CBHI schemes in Northern Uganda to generate evidence for policy and practice.

Materials and Methods

Study Design and Setting

Uganda is a geographically and culturally diverse country split into administrative units including regions and sub-regions. A community-based cross-sectional multiple-case study was carried out between March and May 2026, in Acholi sub-region of Northern

Uganda. The study was conducted among two schemes: Karin and Amuru-Kilak CBHI schemes. The "Karin" CBHI scheme was first introduced in 2010, as part of post-conflict health financing interventions located in Gulu city. Whereas the Amuru CBHI scheme was first introduced in 2011 in Amuru district. The district is located 60km northwest of Gulu city. Gulu City is the largest city in Northern Uganda about 340 Km north of Kampala Capital City. The region experienced a 20-year armed conflict from 1986 to 2006 which resulted in low socio-economic development.[18] The economy is predominantly informal, with about 80% of residents engaged in subsistence farming and small-scale trade.

Sample Size and Sampling Procedure

Participants were selected using purposive sampling. Data saturation determined the minimum number required for the interviews. Stratified sampling ensured representation from both scheme members and non-members, across age groups, education levels, and geographic areas, to capture variation in scheme experiences. VHTs (Village Health Teams) were sampled from the VHT register obtained from health facilities, while VSLA members were sampled from group records. A sample size of 27 participants was determined.

Data Collection Methods

Primary data were collected using semi-structured guide for Key Informants, Focus Group Discussions and In-depth interviews. Secondary data were obtained through a desk review of relevant documents. The KIIs were conducted with scheme managers, healthcare providers, local leaders, and officials from the Uganda Cooperatives Health Alliance to obtain information on revenue collection, risk pooling, governance, premium levels, enrolment criteria, provider networks and member satisfaction. We conducted FGDs separately with VSLA members and VHTs to capture diverse perspectives on scheme design and implementation. IDIS were conducted with enrolled community members and healthcare providers. A desk review was also done for policy documents, scheme registers, annual plans, committee minutes, the National Health Insurance Bill 2021, and relevant national and international literature on CBHI. To ensure validity and reliability, the interview guides were pretested on 5% of the target population on a setting similar to the study area before the main data collection. Four research assistants (RAs) with graduate level training in research and public health, conducted the interviews. The RAs were based in Gulu City and unaffiliated with the scheme in the study sites. Data collectors were proficient in the local language, Acholi, and English, received training and were closely supervised to maintain quality. Supervisors and the principal investigator conducted daily oversight of field activities to ensure adherence to protocols.

Data Processing and Analysis

Data was analyzed using thematic approach manually following Braun and Clarke's framework [16], which involves transcription, coding, theme identification, and categorization. The interviews were transcribed verbatim in English, translated from local language "Acholi'' to English by those proficient in the local language and checked for consistency. Data was coded and insights and emerging patterns were identified. Data was summarized and synthesized, keeping the key expressions of respondents as illustrative cases to express major contextual observations in this study. Triangulating FGDs, IDI and KIIs achieved interactive comprehension.

Ethical Considerations

The Research and Ethics Committee of Nsambya Hospital, a teaching hospital of Uganda Martyrs University, approved the study. Permission to conduct the study was sought from Texila University in George Town,

Guyana. Administrative authority was obtained from the City Health Officers of Gulu. The participants were briefed on the study and informed consent was granted. Information obtained was kept confidential and securely stored. With the aim of preserving anonymity and privacy of study participants, full names of participants are not disclosed, nor did we collect data on participants' age, or gender. Data collectors and researchers had no prior relationship with the study participants.

Results

Description of Study Participants

In total, 27 participants were interviewed: three Focus Group Discussions (FGDs) comprising of five members (VSLA Group Leaders in Amuru district, VHTs from Unyama and Agonga wards in Gulu City), five In -Depth Interviews (IDI), and seven Key Informant Interviews (KII) in table 1. To avoid duplication of information, each respondent participated in only one data collection activity-either the FGDs, IDI or KII.

Table 1. Characteristics of Study Participants

Position	Interview type	Location
CBHI Focal Person	KII	St. Mary's Hospital Lacor, Gulu City
Health In-charge	KII	Gracious Medical Centre, Amuru District
CBHI Official	KII	Uganda Cooperatives Health Alliance, Kampala Capital City
City Health Officer	KII	Gulu City
District Health Officer	KII	Gulu District
Village Health Team personnel	FGD	Gulu City
Billing Manager	IDI	St. Mary's Hospital Lacor, Gulu City
Director	KII	Karin Clinics, Gulu City
CBHI Focal Person	KII	Unyama Ward, Gulu City
VSLA Group Leader	FGD	Amuru District
Health Facility In-charge	IDI	Agonga Ward, Gulu City
CBHI Focal Person	IDI	Agonga Ward, Gulu City

The Status, Performance and Design of CBHI schemes in Northern Uganda

Four main themes with 12 related sub-themes emerged from analysis of the interviews. The main themes were: (i) status of community-based health insurance schemes, (ii) design of CBHI schemes, (iii) implementation experiences, and (iv) sustainability and policy environment. Respondents' quotations are indicated by the prefix of their position, and each has a unique numerical suffix. The themes and related sub-themes are summarized in Table 2.

Table 2. Summary of Theme, Sub-theme and Code Framework

Major Theme	Sub-themes	Codes
Theme 1: Status of CBHI scheme	Operational continuity	Suspension and "On Hold" status
	Limited management systems & Integrity	Internal fraud and Accountability
	Weak institutionalization and Poor leadership commitment to CBHI	• Lack of policy mandate • Low facility Uptake

Theme 2: Design of CBHI scheme	Financial viability challenges of CBHI at facility level	• Failure to manage financial crisis • Health financing reform (Shift from member managed to Provider managed)
	Premium structure & Pricing	Low premiums against high utilization costs (Tiered pricing)
	Benefit package & Exclusions	• Coverage limits • Inclusion of chronic care
Theme 3: Implementation experiences	Mobilization & Advocacy	• Grassroots engagement • Leveraging "Success stories" and peer advocacy
	Service delivery challenges	Staffing Issues
	Community behavioral barriers of value for money	• "Refund" Mentality • Prioritization of death over health
Theme 4: Sustainability and Policy environment	Financial dependence on external subsidies	• Subsidy requirements • Donor withdrawal impacts
	Policy & Governance frameworks	• Lack of formal regulation • Absence of National Health Insurance Bill (NHIS) • Adoption of government absorption models
	Socio-cultural barriers to sustainability	• Community mindset and Expectation of free health services

Theme 1: Status of Community-Based Health Insurance Schemes

Operational continuity

Suspension and "On Hold" Status

In this study, status of CBHI scheme was expressed by participants as the main theme in understanding the critical gaps in the existing CBHI models. Operational continuity in the administration of CBHI services to scheme members was regarded as continuation for the functioning of the scheme. The suspension and "On Hold" Status of the scheme reflected a lack of operational continuity. One of the IDI respondents expressed that:

> "*We decided at some point to first put CBHI on hold so that we can just try and see what is going on. we put it on hold like for almost a year.*" (Health Managers, Karin Gulu City)

Similar expressions were reported by FGD respondent:

> *"The program started very well. but the program was no longer there. I don't know what happened to stop."* (VSLA, Amuru District)

Limited Management Systems and Integrity

Internal Fraud and Accountability

Some members asserted that to some extent internal fraud and accountability compromised management and integrity of the scheme. Subsequently, contributing to the poor status of the CBHI scheme. This was asserted by an IDI respondent:

"*Along the way there was also a lot of fraud in the CBHI program. Where We found out that communities or groups who paid money to some staff it was not declared." (*Health Managers Karin, Gulu City)

Weak institutionalization and Poor leadership commitment to CBHI

Lack of Policy Mandate

Some participants noted the lack of government policy and regulation on CBHI has resulted in poor official support from local leaders. Thus, limited government ownership was mentioned as a critical gap in the development of scheme that align with community needs and pooling of financial resources. This was highlighted by an IDI participant:

"*Although some leaders have joined individually and benefit from the scheme, they cannot act as public ambassadors for CBHI du to the absence of formal government backing." (*Health Managers, Karin Gulu City)

Low Uptake

However, some participants expressed low uptake was due to poor leadership commitment and not merely weak government institutions. The KII respondent said ardently that:

"*Some political leaders and government officials attend meetings only caring about how much they will be paid, and they don't communicate the information back to their councils, and out of 25 facilities trained only seven actually engaged communities and developed MOUs* ''*(*Uganda Cooperatives Health Alliance Official)

Theme 2: Design of CBHI Schemes

Financial viability challenges of CBHI at Facility level

Manage Financial Crisis

Study participants described the challenges of health financing land scape and nature of support preferred to strengthen the role of CBHI in the provision of health services as i) technical capacity building and, ii) provision of tools and supplies. One IDI participant lamented that financial sustainability problem exist due to low enrolment:

'CBHI works with numbers. So, when we do not have adequate numbers, we run a loss. and that has happened a lot of times.' *(*Health Managers, Agonga Ward Gulu City)

Then expressed the need for a partnership and support to easily manage financial crisis particularly external funds so as to subsidize service costs and avert operation capacity gaps at the facility level. The IDI participant said:

"*We also realize that for a local initiative like ours, CBHI needed a partnership for support….software that can help us easily manage it*." (Health Managers, Karin Gulu City)

Health Financing Reform

Some participants indicated a critical gap in the design of the existing community prepayment model (member managed) - indicating such schemes tend to cover a limited geographical area; dependence on social solidarity and trust amongst community members may undermine the establishment and continuity of such schemes. Some members proposed a shift from member-managed to provider-managed. One key informant participant said:

"*We are now redesigning to shift from one in which community share their input to a provider - driven redesign with limited community management……. enabling providers to primarily cover expensive inpatient and offset operational costs*." (Health Managers, Karin Gulu City)

Premium Structure and Pricing

Tiered premium

Some participants reported that the current CBHI model uses a tiered premium structure with pooled billing and donor subsidies which presents a viability challenge of low member

contributions against high service costs. One IDI participant said:

> "*A key financial challenge was that the tiered premiums collected were too low to cover the actual cost of care, creating dependence on donor subsidies. With small, age categorized contributions pooled by groups of 30 or 40……. ages 0-5years paid about 2,500UGX (US$0.66), ages 6-12years paid 5,000UGX (US$1.33), and adults paid 7,500UGX (US$1.99).”* (CBHI Focal Person, Agonga Ward Gulu City)

Then added:

> *“The person would come to seek care when they have paid a premium of 2,500 UGX (US$0.66), but you would get treatment worth 40,000UGX (US$10.63) ……. Sometimes they would get surgical procedures. As such, the scheme had to bill the hospital quarterly, or the provider sought and sought external support to bridge the gap between member payments and hospital expenditures.”* (CBHI Focal Person, Agonga Ward Gulu city)

Benefit Package and Exclusions

Coverage Limits and Inclusion of Chronic Care

Participants reported a critical design gap in the benefit package, describing it as having defined limits and not fully covering all services, particularly chronic care. They noted that when care must be outsourced, beneficiaries must make additional out-of-pocket contributions on top of their premiums, which undermines financial protection. This was expressed vividly by a key informant.

> "*On package limits and extra contributions…. we implement in packages and inform beneficiaries of the limits. If a service is outsourced, they may need to contribute on top of the package*." (KII-Health Managers, Karin Gulu City)

Participants also reported that excluding chronic care for non-communicable diseases such as hypertension and diabetes from the benefit package is a design fault. In a community with high poverty and already low enrollment, this gap led to dropouts because members with long-term conditions could not get the care they need despite paying premiums. Thus, weakens risk pooling.

> "*Lessons show that even if it means the premium goes up, you must include a benefit package for chronic care*.'' (Uganda Cooperatives Health Alliance Official)

Despite the challenges, many participants indicated members perceived value in the CBHI premiums because they reduced out-of-pocket costs when illness occurred frequently. Speaking her mind, an FGD surmised:

> "*Many members feel the co-payment of 5,000UGX (US$1.33) is affordable. Within three months, a child is likely to fall sick, so the amount we spend is much less compared to paying the full price each time.*" (FGD-VSLA Amuru District)

From another perspective, the IDI noted that enrollment was feasible in school settings. This is because the premium was framed as a relocation of an existing fee rather than an extra payment.

> "*Students have a medical fee of 20,000UGX (US$5.32); the scheme requires only 10,000UGX (US$2.66). As such, cutting the direct health cost by 50% avoids adding a new financial burden.*" (CBHI Focal Person, Agonga Ward Gulu City)

Theme 3: Implementation Experiences

Mobilization and Advocacy

Grassroots Engagement

The findings showed there is a major implementation gap due to heavy reliance on labour intensive, face to face mobilization to drive enrollment. Teams had to move to households spread apart which is costly and difficult to sustain.

"*We move village to village ……. Monday to Monday mobilizing people from local markets and VSLA groups to enroll.*" (FGD-VSLA Amuru District)

Leveraging Success Stories and Peer Advocacy

Findings from this study indicate community uptake of CBHI remained a challenge due to low buy-in from key decision makers and skepticism about the insurance model. Men, as heads of households, were often reluctant to enroll and community members questioned the value of paying premiums if they did not fall sick, reflecting a poor understanding of risk pooling. Despite this, the scheme's strength came from peer influence. Some participants described the enthusiasm of pioneer clients (friends and relatives who were already enrolled in the scheme) referred to as "Karin Friends'', shared testimonies of accessing surgery and other services, and their success stories became the main driver that convinced others to join. Participants said endorsements from trusted individuals had a profound influence. One Key informant participant said that:

> "*Success stories from those that made it to surgery…. made other people come*." (CBHI Focal Person, Unyama Ward Gulu City)

This was supported by another KII participant:

> "*The scheme uptake is low. Men are often not buying in as heads of households, which is a challenge…… However, 'Karin friends' inspiring positive testimonies changed the narrative towards CBHI's.*" (Health Managers, Karin Gulu City)

Service Delivery Challenges

Staffing Issues

Findings showed staff turnover was an implementation challenge which disrupted continuity and increased costs. One KII reported that:

"W*hen you equip a team and they move, you have to reinvest resources to retrain a new team, which affects continuity*." (Health In-charge, Amuru District)

Community Behavioural Barriers of Value for Money

The "Refund" Mentality

Some participants revealed that a major barrier to retention was poor understanding of how insurance works. Many community members expected direct refunds if they did not use services, and saw premium payments as a loss rather risk pooling. This perception made them reluctant to renew, especially during periods when no one in the household fell sick. An IDI participant narrated that:

"*The biggest complaint was If I don't fall sick, will my money be given back?*." (VHT Gulu City)

Prioritization of Death over Health

Findings show that the community has not appreciated the role CBHI plays. Interestingly, participants reported that many people drew parallels between saving for health and death. A participant said that:

> "*Many find it difficult to save money for health when they are not sick. But, save for death. If I don't fall sick, where does my money go? People have joined "death groups" where they save money for funerals—buying a coffin, food, and music—but it is difficult for them to save money for healthcare to delay death.*" (KII-Uganda Cooperatives Health Alliance Official)

Theme 4: Sustainability and Policy Environment

Financial dependence on external subsidies

Subsidy requirements

Finding shows the scheme could not sustain itself on member premiums alone. Even the lowest premium levels were unaffordable for many households in high-poverty communities, so without external subsidies the hospitals and providers would incur losses. This created a

structural dependency where CBHI could only function if outside funding filled the gap between what members paid and the actual cost of care. One KII participant said:

"*No, they cannot manage without subsidy. Even, the lowest premiums….are a struggle for some. Without subsidy, the hospitals and providers would suffer…*" (CBHI Focal Person, Agonga Ward Gulu city)

Then added:

"*If there's no one from outside to pay, it cannot work.*" (CBHI Focal Person, Agonga Ward Gulu City)

Donor Withdrawal Impact

The withdrawal of donor support has created a major financing gap for CBHI implementation at community level. Respondents reported that previously, key health promotion based CBHI activities and community mobilization were supported by USAID and other health partners. With the current absence of funding, these essential activities have stopped completely. This loss of external funding has left local health teams without resources to sustain awareness, recruitment, and day-to-day CBHI operations, making it difficult to maintain momentum and coverage for the scheme.

"*At present, we have no funding. Essential activities like printing flyers and leaflets require financial resources. In the past, this was provided by USAID. health partners and other donors. But that funding has now ceased.*" (KII-Health Managers, Karin, Gulu city)

Policy framework and governance frameworks

Lack of formalization and Political buy-in for CBHI

Participants reported that a critical barrier to scale-up was the absence of formal government recognition for CBHI. Respondents noted that community members viewed health services as a government responsibility and were resistant to paying premiums, making it difficult to gain traction from the community level upward.

"*CBHI……is not being adopted by our local leaders because its is not a policy. it's not a government regulation or government policy. The government needs to formalize somethings as a policy because starting from down here, people are very stubborn, they know government provides everything.*" (KII-Health Managers, Karin Gulu City)

Absence of a National Health Insurance Scheme (NHIS) Undermining CBHI Viability

Many participants noted lack of a formal National health Insurance Scheme was a major structural challenge to CBHI viability. Without an NHIS framework, CBHI operated as an isolated community project with no legal mandate, guaranteed funding, or integration into the public system. Political processes further destabilized progress- an insurance bill that could have provided government support stalled due to elections. Respondents emphasized that if government started paying facilities directly, enrolled members could actually access care, but until NHIS is in place, CBHI remains fragmented, donor dependent, and vulnerable to political delays:

"*There was an insurance bill connected to the government, but it was affected by the elections. Now that elections are done, if the government pays those facilities, people who have subscribed can access care*." (KII-Health Care Leader, Gulu City)

Adoption of Government Absorption Models

Respondents identified government absorption as the key pathway to making CBHI viable and equitable. They proposed that government should take ownership of the scheme, similar to the Parish Development Model (PDM), and roll it out to the grassroots where community structures already exist. For financial sustainability and equity, participants recommended that government prioritize and

pay premiums for vulnerable groups-the elderly, persons with disabilities, and the poorest- who cannot afford to contribute:

" ……. *if the government can absorb the program, like the PDM program, and take it to the grassroots….it might work.* ''*(*KII-CBHI Focal Person, Agonga Ward Gulu City)

Similarly, another FGD expressed that:

"*The government should prioritize the vulnerable, the elderly, and the disabled. They should pay the premiums for those who cannot afford them.* ''(FGD-VHT's, Karin, Gulu City)

Socio-Cultural Barriers to Sustainability

Community Mindset and Expectation of Free Health Services

Some respondents reported prevailing community mindset round healthcare a fundamental barrier to CBHI adoption. Many people were accustomed to receiving free services through government facilities and donor programs, and therefore resisted the idea of paying premiums. Respondents noted that without deliberately addressing this attitude, any insurance-based intervention would struggle to gain acceptance. Shifting perceptions from "*health is free*'' to "*health requires shared contribution*'' was identified as the first and most important step for CBHI to succeed.

"*We have to fight the mindset first…. because people are used to free things……the mindset needs to be worked on for any intervention like that to succeed.*" (KII-Health Care Leaders, Gulu District)

Discussion

Community based health insurance is promoted globally as a mechanism for risk pooling to reduce catastrophic health expenditure [17]. However, findings from Gulu city and Amuru district show CBHI in Northern Uganda remains fragile, poorly designed and unstainable.

Status of CBHI Schemes

The CBHI schemes were characterized by operational discontinuity, with frequent suspension for months due to financial collapse. The absence of a government policy mandate limited leadership support, as leaders could not act as "public ambassadors ''without formal backing. Internal fraud was also reported, eroding member trust. This aligns with sub-Saharan Africa evidence where CBHI collapses due to weak governance and lack of state integration [18]. In Uganda, with penetration at 1.1% against a 25%target and poverty at 63% in Acholi, the lack of institutionality has constrained scale up [19].

Design of CBHI Schemes

Three design flaws emerged. First, the member-managed model was financially unviable due to low enrollment:''CBHI works with numbers.'' Respondents proposed a shift to provide-management to cover inpatient costs and improve pooling, consistent with reforms in Rwanda and Kenya that improved financially stability [20]. Second, premiums were structurally underpriced. A tiered premium of 2,500-75,000 UGX (US$0.66-9.94) could not cover treatment costs of 40,000 UGX (US$10.63), creating dependence on donor subsidies. With only 68.5% of Uganda's health expenditure from domestic pooled funds, this model could probably be unsustainable [21]. In contrast, previous studies found that subsidies increased health insurance uptake. Thus, it is sustainable [22]. Third, exclusion of chronic for NCDs led to dropouts. This contradicts UHC principles of comprehensive coverage [23]. However, members still perceived value in co-payments, suggesting demand exists if benefits align with community needs.

Implementation Experiences

Implementation relied on costly, labor-intensive multiplication, Low male buy-in and skepticism about risk pooling were common, consistent with findings from Ethiopia and

Nigeria [24]. However, peer advocacy through "*Karin Friends*'' faith positive testimonies drove enrollment, confirming that visible benefits are key drivers of uptake. This similar to a Tanzanian study done in 2020 among informal workers [25]. Behavioral barriers included a "*refund mentality*'' and prioritization of "*death group*'' over health savings. As such, behavior change communication could improve implementation of CBHI schemes.

Sustainability and Policy Environment

Schemes were structurally dependent: If there's no one from outside to pay, it cannot work. Withdrawal of USAID and other donors halted core activities. This reflects sub-Saharan Africa evidence on donor volatility undermining CBHI [26, 27]. The absence of NHIS and legal framework left CBHI isolated. Respondents proposed government absorption, similar to PDM, with subsidies for vulnerable groups. This aligns with the nationwide CBHI model requiring political commitment and leadership and the expectation of free care remains a major socio-cultural barrier [28].

Strength and Limitations of the Study

The study captured a wider range of experiences and perspectives by including health providers and experts from health insurance and facilities. Also, a mixed use of focus group discussions, in-depth interviews and key informants added methodological depth that improved the study's rigour, reflexivity, trustworthiness and analytical richness. Social desirability bias may have affected some responses during data collection; however, using multiple sources enhanced the study's reliability and credibility.

Conclusion

The CBHI in Northern Uganda is in a cycle of weak design, low enrollment, and donor dependence. For CBHI to contribute to UHC, it must transition to integrated, provider-managed schemes within a national framework. Priorities include formal regulation, actuarial premiums with subsidies, expanded benefits, and investment in governance. As Uganda develops NHIS, community mechanism should be reformed and integrated rather than abandoned.

Recommendations for Policy and Practice

Policy

Absence of a policy mandate limits leadership support and scale up. There is a need to fast -track the National Health Insurance Bill and formally recognize CBHI as a complementary UHC mechanism under Ministry of Health regulation.

Adopt government subsidies for the vulnerable. Premium are unaffordable and schemes cannot survive without external funding. Government should pay premiums for the elderly, PWDs, and poorest household similar to the PDM model, to ensure equity. Shift to Provider managed models, as member managed schemes seems to have failed due to low numbers, weak management and sustainability.

Practice

We suggest redesigning financing, addressing underpriced premiums, and removing the exclusion of chronic care, which are contributing to financial losses and dropouts. Conduct actuarial pricing and expand benefits to include NCDs (non-communicable diseases). And frame premiums as a reallocation of existing costs in schools and VSLA groups.

Also, strengthen governance and accountability by engaging in digital systems, regular audits, and train managers on financial and insurance principles. Finally, use peer-led mobilization and health education, including peer success stories, to drive district-wide enrollment. For CBHI to contribute to UHC, it must be legally recognized, government-subsidized, provider-managed and community-driven. Without these reforms, CBHI will

remain fragmented and unable to protect poor households from catastrophic health costs.

Conflict of Interest

The authors declare that they have no competing interests, financial or otherwise, that could have influenced the conduct, analysis, or publication of this study.

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Ethical Approval

The Research and Ethics Committee of Nsambya Hospital, a teaching hospital of Uganda Martyrs University, granted ethical approval for this study. Administrative permission was obtained from relevant local authorities in Gulu City, Gulu and Amuru Districts. We obtained written informed consent from all participants before data collection. The study maintained confidentiality and anonymity throughout.

Data Availability

The datasets generated and analyzed during the current study are not publicly available due to the qualitative nature of the data and the need to protect participant confidentiality. De-identified data may be made available by the corresponding author upon reasonable request.

Author Contributions

HO conceptualized the study, designed the methodology, coordinated data collection, conducted analysis, and drafted the manuscript. EO, JK, MO, and RKB contributed to study design, interpretation of findings, critical review of the manuscript, and approval of the final version. All authors read and approved the final manuscript.

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A Bayesian Spatial Hierarchical Analysis of Cervical Cancer Screening Uptake in Ethiopia

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Abstract *Cervical cancer is the fourth most common cancer among women globally, with the highest burden in sub-Saharan Africa, where screening coverage remains far below the World Health Organization's 70% elimination target. Evidence on screening uptake in Ethiopia has been limited to small, facility-based studies unable to characterise national geographic patterns. This study aimed to identify individual-level and geographic determinants of cervical cancer screening uptake among Ethiopian women using a spatial Bayesian approach. Data were drawn from the 2024–25 Ethiopia Demographic and Health Survey (N = 20,864 women aged 15–49). A Bayesian hierarchical logistic regression model with a Besag–York–Mollié (BYM2) spatial random effect and a cluster random effect was fitted via integrated nested Laplace approximation, with fits compared across four nested specifications using the Watanabe–Akaike Information Criterion. Weighted national screening prevalence was 5.89%. Uptake rose with household wealth, education, and mass media exposure, and was higher among currently (aOR = 2.66) and formerly (aOR = 2.50) married women than never-married women. Region and cluster jointly explained 11.3% of residual variance, but only 23.2% of the regional component was spatially structured. Most of the more than 50-fold disparity between Addis Ababa (16.4%) and Somali (0.3%) reflected population composition rather than a residual regional effect, though a smaller, genuine geographic disparity persisted after adjustment. Screening uptake in Ethiopia is shaped jointly by individual-level disadvantage and geographic disparities not fully explained by population composition. Closing this gap will likely require expanded individual-level access, direct health-system investment in underserved regions such as Somali, and spatially explicit, subnational monitoring to ensure progress reaches the communities currently furthest behind.*

Keywords *Bayesian Spatial Analysis, Cervical Cancer Screening, Demographic and Health Survey, Ethiopia.*

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Introduction

Cervical cancer is the fourth most common cancer in women worldwide, and in 2022, there were about 660,000 new cases and 350,000 deaths recorded [1]. Unlike the case with most other cancers, cervical cancer is almost always the result of a persistent infection with high-risk types of human papillomavirus (HPV), the infection leading to a well-established, step-by-step progression from HPV infection through precancerous cervical intraepithelial lesions to invasive carcinoma [2, 3]. Because of this clear cause and the long latency period between infection and the development of invasive disease, cervical cancer is one of the most preventable forms of cancer by ensuring that precancerous lesions are properly screened for and treated in a timely manner.

Even though cervical cancer can be prevented, the burden of the disease is still very uneven: more than 90% of the deaths take place in low- and middle-income countries, sub-Saharan Africa having the highest rates of both incidence and mortality of the disease worldwide [4, 5]. This inequality mainly reflects unequal access to organised screening and early treatment, not differences in disease biology. In response, the World Health Organization (WHO) launched its Global Strategy to Accelerate the Elimination of Cervical Cancer as a Public Health Problem in 2020, which the World Health Assembly approved. The strategy set out the "90–70–90" targets: 90% of girls should be fully vaccinated against HPV, 70% of women should be screened using a high-performance test by the ages of 35 and 45, and 90% of women who have precancer or invasive cancer should receive treatment, all by 2030 [6, 7]. Modelling studies carried out in low- and lower-middle-income countries show that meeting these targets, especially those relating to screening coverage, could prevent tens of millions of cases and deaths from cervical cancer over the next century [8, 9].

The main and practical part of the elimination strategy is screening. Established methods such as visual inspection with acetic acid, cytology-based testing, and HPV DNA testing reduce both incidence and mortality from cervical cancer, provided adequate follow-up is carried out [10-12]. Yet global screening coverage remains far below the WHO's target of 70% and varies considerably between and within countries [13, 14]. Coverage in Sub-Saharan Africa is especially low and is unevenly distributed. Consistent evidence from the region shows that age, education level, household wealth, place of residence, health insurance status, marital status, exposure to health information through mass media, and women's autonomy in making healthcare decisions are key factors affecting screening uptake [15-18]. A study in Kenya also found sociodemographic and healthcare-access factors central to screening uptake, offering a pertinent methodological comparison for the current study [19].

In the case of Ethiopia, there is very little direct evidence available at the population level regarding uptake of cervical cancer screening and the factors that influence it. Rather, the existing studies from Ethiopia have concentrated on the prevalence of precancerous or abnormal cervical lesions among women who are already visiting particular health facilities, for instance, among women attending clinics in West Wollega in western Ethiopia [20], and in Harar in eastern Ethiopia [21]. Although these facility-based studies offer useful clinical data, by nature they address only the prevalence of lesions among women who previously received screening or clinical care at a single location, not screening uptake and its determinants across the wider population. Consequently, they cannot show how screening behaviour, or the spatial pattern of such behaviour, differs across regions of Ethiopia. To date, no study has used a nationally representative sample to examine the determinants of cervical cancer screening

uptake together with an explicit spatial modelling approach that can distinguish between variations in screening behaviour at the individual, community, and regional levels.

It is not just a methodological gap but a substantial one. Behavioural patterns related to health, such as undergoing cancer screening, are influenced by individual characteristics, the immediate community environment, and wider regional factors, which may not align with administrative boundaries. Spatial hierarchical models offer a sound approach to separating these sources of variation, particularly when some administrative areas have small sample sizes [22-25]. The development of approximate Bayesian inference has made it possible to use such models with large, nationally representative survey data of the type regularly collected by the Demographic and Health Surveys (DHS) programme [26].

This study aims to fill the gap by using data from the 2024–25 Ethiopia Demographic and Health Survey. More precisely, it has three objectives: (1) to find the sociodemographic and behavioural factors at the individual level that are associated with the uptake of cervical cancer screening among reproductive-age women in Ethiopia; (2) to measure the degree to which the rate of uptake of screening differs in a systematic way according to geographic region and survey cluster, beyond what can be accounted for by individual characteristics; and (3) to assess whether the regional differences in screening uptake show a spatially structured pattern involving neighbouring regions or instead reflect unstructured, region-specific variability. The study intends to produce evidence that can help to better direct cervical cancer screening programmes geographically in Ethiopia and thus contribute to national and global efforts towards the elimination of cervical cancer.

Materials and Methods

Study Design and Data Source

This study utilised data from the 2024–25 Ethiopia Demographic and Health Survey (EDHS-8), a nationally representative, cross-sectional household survey conducted by the Ethiopian Statistical Service with technical support from The DHS Program [27]. Fieldwork was conducted between August 2024 and April 2025, employing a stratified, two-stage cluster sampling design. In the first stage, enumeration areas (clusters) were selected with probability proportional to size, stratified by region and urban or rural status. In the second stage, households were randomly selected within each cluster. This sampling strategy produces nationally representative estimates suitable for policy and programme planning. The survey's final report provides a comprehensive description of the sampling methodology. Analyses were performed using the Individual Recode (women's) dataset.

Study Population

The EDHS-8 surveyed 21,395 women aged 15 to 49 years. Women who responded 'do not know' to the question regarding cervical cancer screening (n = 531, 2.5%) were excluded through complete-case analysis, as this missing outcome data was minimal and not systematic [28]. The final analytical sample comprised 20,864 women, ensuring alignment with the survey's screening measure and supporting accurate policy interpretation.

Study Variables

The dependent variable was a binary indicator of whether a woman had ever undergone cervical cancer screening. Individual characteristics were selected a priori based on existing literature on cervical cancer screening uptake in sub-Saharan Africa. These included age, highest educational attainment, household wealth quintile, place of residence, health insurance status, current marital status, exposure to mass media, and number of living

children. Geographic region was modelled as a spatial random effect, and the primary sampling unit as an unstructured random effect, rather than as fixed effects (see Bayesian Spatial Hierarchical Model for details). This modelling approach helps identify population-level patterns to inform targeted screening policies.

Region Adjacency Structure

The spatial adjacency matrix at the regional level needed for the spatial random effect was obtained directly from the administrative boundary shapefile in the DHS Spatial Data Repository for the particular survey round, not from general geographic knowledge. The regions that were neighbours were determined computationally by identifying those which shared a common polygon boundary using the spdep package [29]. Verification was carried out using both strict polygon adjacency and a 500-metre buffer in order to take into account possible gaps caused by digitisation of the boundary files; in both cases, the results were the same. As a result, 23 adjacencies between regions were found among the 14 regions.

Statistical Analysis

Descriptive and Preliminary Analyses

The survey's sampling weights, stratification, and clustering were taken into account when the weighted descriptive statistics were calculated for the outcome and all the covariates. Preliminary bivariate associations between wealth, education, and urban/rural residence were examined to assess collinearity among the key socioeconomic covariates prior to modelling.

Bayesian Spatial Hierarchical Model

This study used a Bayesian hierarchical logistic regression model with a Besag–York–Mollié (BYM) spatial random effect for region [22], using the BYM2 reparameterisation [23], and an exchangeable (unstructured) random intercept for primary sampling unit (cluster), fitted using integrated nested Laplace approximation (INLA) [26]. The BYM2 parameterisation decomposes the region-level random effect into a spatially structured component, which allows neighbouring regions to share information (spatial smoothing), and an unstructured component capturing region-specific variation not explained by geographic proximity, with a mixing parameter $\phi \in [0, 1]$ governing the proportion of variance attributable to the spatially structured component. The model is specified as:

$$logit(\pi_{ijk}) = \beta 0 + X_{ijk}\beta + u_j + v_k$$

In this context, π_{ijk} stands for the probability that woman i in cluster j and region k was ever screened for cervical cancer; X_{ijk} is the vector of the individual-level covariates; $u_j \sim \text{Normal}(0, \sigma^2_u)$ denotes the unstructured random effect at the cluster level; and v_k is the BYM2 spatial random effect for region k. Penalised complexity (PC) priors were used for all the variance components (the probability that σ is greater than 1 is 0.01 for both the regional and cluster precisions, and the probability that ϕ is less than 0.5 is 2/3 for the spatial mixing parameter), in line with the current recommended practice for BYM2 models [23, 30]. The fixed-effect regression coefficients, including the intercept, were given weakly informative Normal (0, 1000) priors. The Bayesian spatial hierarchical model was fitted without the use of survey weights, since design-induced imbalance was dealt with structurally by including the region and cluster random effects as well as the individual-level covariates related to the sampling design (see Weighted Sensitivity Analysis section). This approach allowed regional-level inference while accounting for both clustering and spatial dependence.

Model Comparison

In order to provide empirical support for the hierarchical spatial structure, four nested models were evaluated using the Watanabe–Akaike Information Criterion (WAIC) [31, 32]:

(1) a null model containing only an intercept; (2) a model with only the individual-level covariates; (3) a model that included both the covariates and an unstructured cluster random effect; and (4) the complete Bayesian spatial hierarchical model, which incorporated the covariates, the BYM2 spatial region effect, and the cluster random effect. Any differences in WAIC (ΔWAIC) exceeding 10 were regarded as decisive evidence of an improved model fit, in accordance with the standard interpretation guidelines, and were used to show the additional value of the spatial and clustering structure.

Variance Decomposition

The extent to which the variance in the total outcome could be attributed to grouping at the cluster and region levels was determined by means of the intraclass correlation coefficient (ICC), which was calculated on the latent (logit) scale using the formula $\sigma^2_u / (\sigma^2_u + \pi^2/3)$, where $\pi^2/3 \approx 3.29$ is the amount of fixed residual variance associated with the standard logistic distribution [33]. For the region-level BYM2 effect, we decomposed the total ICC into spatially structured and unstructured components using the posterior mean of ϕ.

Weighted Sensitivity Analysis

Because the Bayesian spatial hierarchical model did not include DHS sampling weights, we ran a sensitivity analysis by fitting a weighted Bayesian multilevel logistic regression model in brms [34] (R interface to Stan [35]), applying the DHS sampling weights via a pseudo-likelihood weighting method. This sensitivity model used the same individual-level covariates as the Bayesian spatial hierarchical model, with the region specified as a fixed effect (instead of as a spatial random effect, since design-consistent weighting is not currently well established for spatial random-effects models) and a random intercept for cluster. The agreement between the Bayesian spatial hierarchical model and the sensitivity model was assessed by calculating the Pearson correlation between the log-odds estimates from the two models for all the individual-level covariates that are common to both models (region was omitted from this comparison since it is parameterised differently in the two models) and by looking at the proportion of covariates that had the same direction of effect.

Additional Robustness Checks

For the Bayesian spatial hierarchical model, we carried out two further robustness checks. The first involved assessing the overall fit of the model using the log pseudo marginal likelihood (LPML), obtained from leave-one-out conditional predictive ordinates (CPO) calculated using INLA's built-in cross-validation method. The second check was a prior sensitivity analysis in which the Bayesian spatial hierarchical model was refitted using two different PC prior specifications for the precision parameters relating to the region and cluster: a more restrictive prior (such that $P(\sigma > 0.3) = 0.01$) which favours a smaller variance, and a more relaxed prior (such that $P(\sigma > 3) = 0.01$) which allows for a larger variance, the prior on ϕ remaining unchanged. This analysis showed that the substantive conclusions had not been affected by the particular prior choice made in the main analysis.

Software

The analyses were carried out with R (version 4.5) [36]. The Bayesian spatial hierarchical model was fitted using the R-INLA package [26], and the weighted sensitivity model was fitted with brms [34]. The survey-weighted descriptive statistics were calculated using the survey package [37]. For spatial data processing, the sf [38] and spdep [29] packages were used, with the regional boundaries and the cluster GPS coordinates being obtained from the DHS Program Spatial Data Repository [39].

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Results

Sample Characteristics and Descriptive Patterns

Of the 20,864 women who made up the analytic sample, 1,161 had previously been screened for cervical cancer, which equates to a weighted national prevalence of 5.89% (see Table 1). Table 1 and Figure 1 show the unweighted and weighted sample characteristics, along with the weighted screening prevalence in each covariate category. Screening prevalence rose steadily with age, going from 1.80% among women aged 15 to 19 years to a maximum of 10.66% among those aged 40 to 44 years, before dropping slightly to 10.17% among women aged 45 to 49 years (Figure 1A). There was also a clear gradient according to level of education, ranging from 5.06% among women with no formal education to 13.61% among those who had higher education (Figure 1B), and according to household wealth, from 1.18% among the poorest to 11.93% among the richest (Figure 1C), this being the steepest gradient among all the variables examined. Women living in urban areas were screened at more than twice the rate of those in rural areas (9.78% compared with 3.83%; Figure 1D). The difference in screening prevalence between women with health insurance and those without was only modest, amounting to 6.40% versus 5.46% (Figure 1E). Women who were currently or formerly married had a considerably higher screening rate than those who had never been in a union (7.19% and 9.09%, respectively, compared with 2.15%; Figure 1F), and screening prevalence increased as mass media exposure increased, from 3.60% among women with no media exposure to 11.24% among those with high exposure (Figure 1G).

The prevalence of screening varied greatly across geographic areas, being more than 50 times higher in Addis Ababa (16.36%) than in the Somali region (0.30%), and the national weighted average of 5.89% is provided for reference (Figure 2a). A choropleth map is used in Figure 2b to show the geographic distribution of this variation, illustrating a general trend of higher screening prevalence in and around Addis Ababa as well as in parts of Amhara, and a much lower prevalence in Somali, in Oromia, and over much of the south and southwest of the country.

Table 1. Sample Characteristics and Weighted Cervical Cancer Screening Prevalence Among Women Aged 15–49

Characteristic	N	Weighted % Screened	SE
Age Group (years)			
15–19	4,688	1.80	0.32
20–24	3,639	2.85	0.44
25–29	3,818	5.28	0.66
30–34	2,739	8.42	1.04
35–39	2,584	9.44	1.06
40–44	1,763	10.66	1.19
45–49	1,633	10.17	1.18
Education			
No education	6,935	5.06	0.55
Primary	7,898	4.74	0.57
Secondary	3,819	5.96	0.58

Higher	2,212	13.61	1.25
Wealth Quintile			
Poorest	5,255	1.18	0.26
Poorer	3,604	3.39	0.48
Middle	3,207	4.12	0.62
Richer	3,153	5.59	0.63
Richest	5,645	11.93	1.08
Residence			
Urban	7,666	9.78	0.96
Rural	13,198	3.83	0.33
Region			
Tigray	1,730	4.72	0.62
Afar	1,352	4.27	0.69
Amhara	1,735	8.73	0.92
Oromia	2,100	3.91	0.79
Somali	1,404	0.30	0.16
Benishangul-Gumuz	1,031	4.72	0.87
Central Ethiopia	1,402	4.94	0.70
Sidama	1,880	3.03	0.48
Southwest Ethiopia	1,437	3.50	1.18
South Ethiopia	1,624	3.32	0.48
Gambella	1,241	5.97	0.73
Harari	1,096	8.31	0.86
Addis Ababa	1,671	16.36	1.17
Dire Dawa	1,161	10.18	1.44
Health Insurance			
No	13,405	5.46	0.46
Yes	7,459	6.40	0.51
Marital Status			
Never in union	6,197	2.15	0.29
Currently in union	12,715	7.19	0.55
Formerly in union	1,952	9.09	1.06
Media Exposure			
No exposure	11,861	3.60	0.38
Low exposure	6,240	7.81	0.61
Moderate exposure	2,336	9.37	1.38
High exposure	427	11.24	2.21

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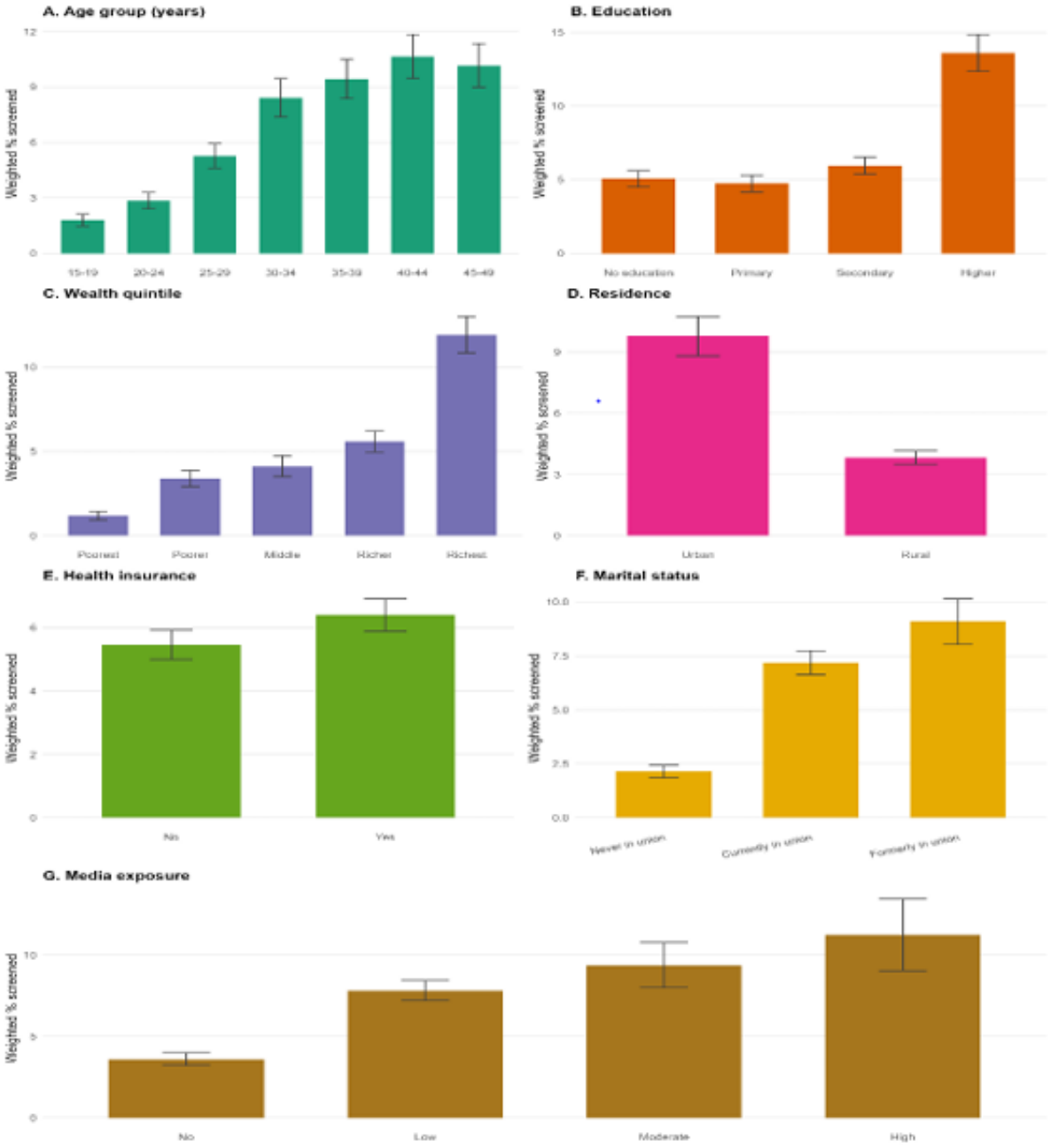


Figure. 1. Weighted Cervical Cancer Screening Prevalence by (A) Age Group, (B) Education, (C) Wealth Quintile, (D) Residence, (E) Health Insurance, and (F) Marital Status. Error Bars Represent 95% Confidence Intervals

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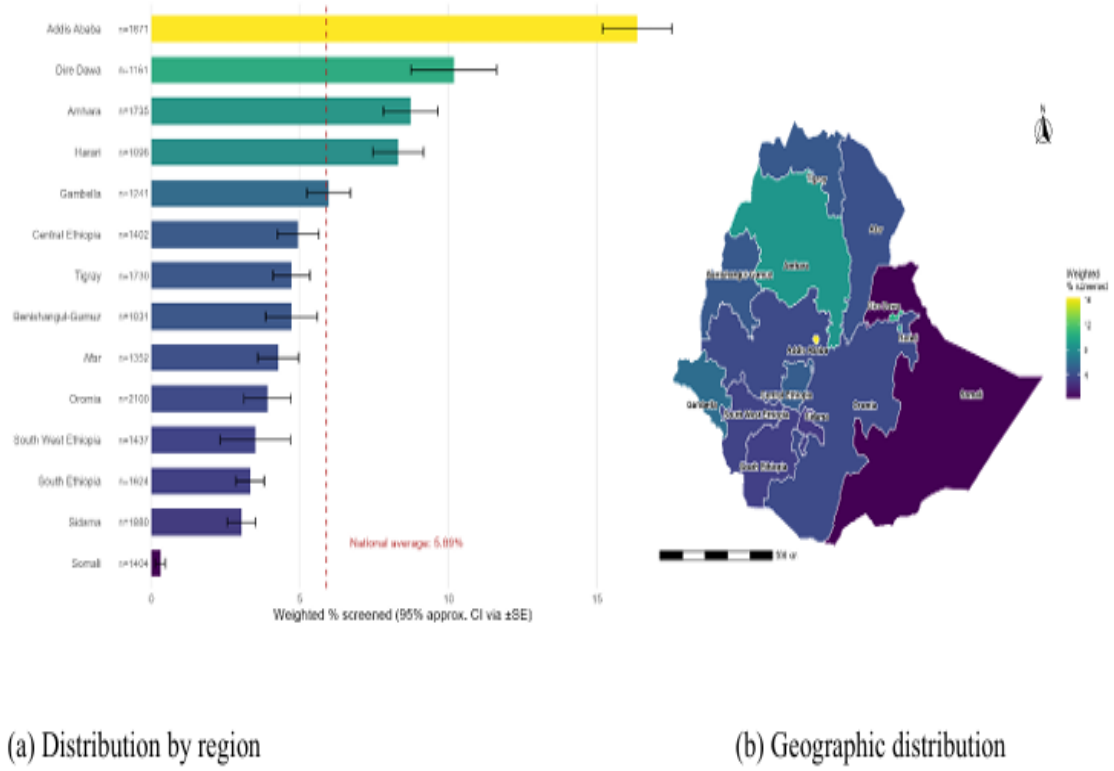


Figure 2. Regional Distribution of Cervical Cancer Screening Prevalence. (a) Regions Sorted by Weighted Percentage Screened; the Dashed Line Indicates the National Weighted Average (5.89%), with Unweighted Sample Sizes (n) shown for Each Region. (b) Choropleth Map of Weighted Prevalence Estimates for Cervical Cancer Screening, with Color Intensity reflecting the Percentage of Women Ever Screened by Region

Model Comparison and Variance Decomposition

To provide empirical support for the Bayesian spatial hierarchical modelling approach, four nested models were compared using the Watanabe–Akaike Information Criterion (WAIC; see Table 2, Panel A). The fit of the models improved considerably and consistently at each stage: incorporating the individual-level covariates into the null model lowered the WAIC by 1283.06 points; then, by adding an unstructured cluster (PSU) random effect, the WAIC was reduced by an additional 122.59 points; and finally, when the BYM2 spatial region effect was included together with the cluster effect, the WAIC decreased by another 52.38 points, thus resulting in the overall best-fitting model. Each of the three successive improvements greatly surpassed the conventional threshold of ΔWAIC > 10, which is used to signify a decisive improvement in model fit, and this offers clear empirical evidence in favour of the complete spatial hierarchical specification as compared to simpler alternatives. It is noteworthy that the effective number of parameters fell from 214.2 in the model that had only the unstructured cluster effect to 187.7 in the full model that also included the BYM2 spatial region effect, even though the latter model had a strictly greater random-effect structure. This shows that when region-level spatial dependence was explicitly modelled, the cluster-level random effect did not need to absorb as much of the geographically patterned variation and could therefore achieve a better fit with a more economical use of its parameters.

The variance decomposition presented in the final model (Table 2, Panel B) showed that 6.8% of the residual variance in screening uptake was due to unstructured variation between clusters (PSU-level intraclass

correlation coefficient, ICC = 0.068). At the same time, an additional 5.2% was attributable to differences between regions (region-level ICC = 0.052), giving a total cluster-and-region ICC of 11.3%. When the region-level variance was decomposed using the BYM2 mixing parameter, it was found that only 23.2% of the regional variation was spatially structured, meaning that it followed a pattern among geographically adjacent regions ($\phi = 0.232$, 95% credible interval: 0.017, 0.696), the rest 76.8% being due to unstructured, region-specific heterogeneity not accounted for by geographic proximity.

Table 2. Model Comparison and Variance Decomposition for Cervical Cancer Screening Uptake, Bayesian Spatial Hierarchical Model

Panel A: Model Comparison (WAIC)

Model	WAIC	Effective Parameters	ΔWAIC (vs. Previous Model)
1. Null (intercept only)	8965.82	1.0	—
2. + Individual-level covariates	7682.76	22.1	1283.06
3. + Covariates + unstructured PSU effect	7560.17	214.2	122.59
4. + Covariates + BYM2 spatial region effect + PSU	7507.79	187.7	52.38

Panel B: Variance Decomposition (Final Model, Model 4)

Component	ICC	% of Total Variance
PSU-level (unstructured)	0.068	6.8%
Region-level (total)	0.052	5.2%
Spatially structured component	0.012	1.2%
Unstructured component	0.040	4.0%
Combined (region + PSU)	0.113	11.3%

Proportion of region-level variance spatially structured (ϕ): 0.232 (95% CrI: 0.017, 0.696)

Individual-Level Determinants of Screening Uptake

Since the Bayesian spatial hierarchical model has been determined to best fit the data, the present study examines the individual-level factors associated with uptake of cervical cancer screening. The adjusted odds ratios (ORs) for each covariate from this model are given in Table 3 and also shown in Figure 3, together with the corresponding estimates from the weighted sensitivity model for comparison. Age still showed a strong, monotonic relationship that plateaued with respect to screening uptake, even after taking into account the other covariates: the odds increased from 1.44 (95% CrI: 1.05, 1.96) for women in the age groups 25–29 to a peak of 5.40 (95% CrI: 3.82, 7.63) for those in the age groups 40–44 when compared with women in the 15–19 age group, before then decreasing slightly to 4.27 (95% CrI: 2.99, 6.12) for women in the 45–49 age groups. Both education and household wealth exhibited clear, independent dose-response patterns: relative to women with no formal education, those with higher education had 1.79 times the odds of screening (95% CrI: 1.40, 2.29), and compared with women in the lowest wealth quintile, those in the richest quintile had 3.19 times the odds (95% CrI: 2.17, 4.69), which was the steepest monotonic adjusted gradient among all the covariates in the model.

Marital status was closely linked to the likelihood of undergoing screening: compared with women who had never been in a union, the odds for currently married women were 2.66 times greater (95% CrI: 2.11, 3.36) and those for formerly married women were 2.50 times greater (95% CrI: 1.89, 3.29). There was a consistent dose-response relationship with respect to exposure through mass media, the odds being 1.89 times higher (95% CrI: 1.33, 2.68) for women who had high exposure than for those with no exposure. Women with health insurance had odds of screening that were only slightly higher (OR = 1.41; 95% CrI: 1.23, 1.63). Women who resided in rural areas had lower odds of screening when compared with those who lived in urban areas, although the credible interval included the null value (OR = 0.78; 95% CrI: 0.60, 1.01). For each additional child a woman had, the odds of screening were very slightly reduced (OR = 0.90 per child; 95% CrI: 0.86, 0.94). In general, the direction of the associations was the same across almost all the covariates in both the Bayesian spatial hierarchical model and the weighted sensitivity model (Table 3), with the exception that the point estimates for wealth and marital status were somewhat higher in the weighted model; this comparison is looked at in detail in Sensitivity Analyses section.

Table 3. Adjusted Odds Ratios (95% Credible Interval) for Cervical Cancer Screening Uptake: Bayesian Spatial Hierarchical Model (BYM2, Unweighted) Versus Weighted Multilevel Sensitivity Model

Characteristic	**BYM2 Model, OR (95% CrI)**	**Sensitivity Model, OR (95% CrI)**
Age group (ref: 15–19)		
20–24	1.01 (0.75, 1.38)	0.85 (0.62, 1.18)
25–29	1.44 (1.05, 1.96)	1.28 (0.94, 1.77)
30–34	2.53 (1.83, 3.49)	2.16 (1.57, 3.01)
35–39	3.94 (2.84, 5.46)	3.32 (2.38, 4.64)
40–44	5.40 (3.82, 7.63)	4.56 (3.19, 6.53)
45–49	4.27 (2.99, 6.12)	4.13 (2.86, 5.94)
Education (ref: No education)		
Primary	1.28 (1.05, 1.56)	1.11 (0.92, 1.33)
Secondary	1.62 (1.29, 2.04)	1.12 (0.89, 1.40)
Higher	1.79 (1.40, 2.29)	1.62 (1.27, 2.08)
Wealth quintile (ref: Poorest)		
Poorer	1.61 (1.16, 2.21)	2.06 (1.41, 3.06)
Middle	1.69 (1.22, 2.35)	2.41 (1.65, 3.56)
Richer	2.57 (1.86, 3.55)	2.63 (1.78, 3.90)
Richest	3.19 (2.17, 4.69)	5.03 (3.22, 8.03)
Residence (ref: Urban)		
Rural	0.78 (0.60, 1.01)	0.91 (0.66, 1.26)
Health insurance (ref: No)		
Yes	1.41 (1.23, 1.63)	1.34 (1.17, 1.55)
Marital status (ref: Never in union)		
Currently in union	2.66 (2.11, 3.36)	3.53 (2.72, 4.56)

Formerly in union	2.50 (1.89, 3.29)	2.82 (2.09, 3.78)
Media exposure (ref: No exposure)		
Low exposure	1.30 (1.08, 1.57)	1.23 (1.02, 1.48)
Moderate exposure	1.44 (1.15, 1.80)	1.50 (1.19, 1.88)
High exposure	1.89 (1.33, 2.68)	1.59 (1.06, 2.34)
Living children		
for each additional child	0.90 (0.86, 0.94)	0.89 (0.85, 0.93)

BYM2 model: Bayesian spatial hierarchical model. Sensitivity model: weighted Bayesian multilevel logistic regression (brms).

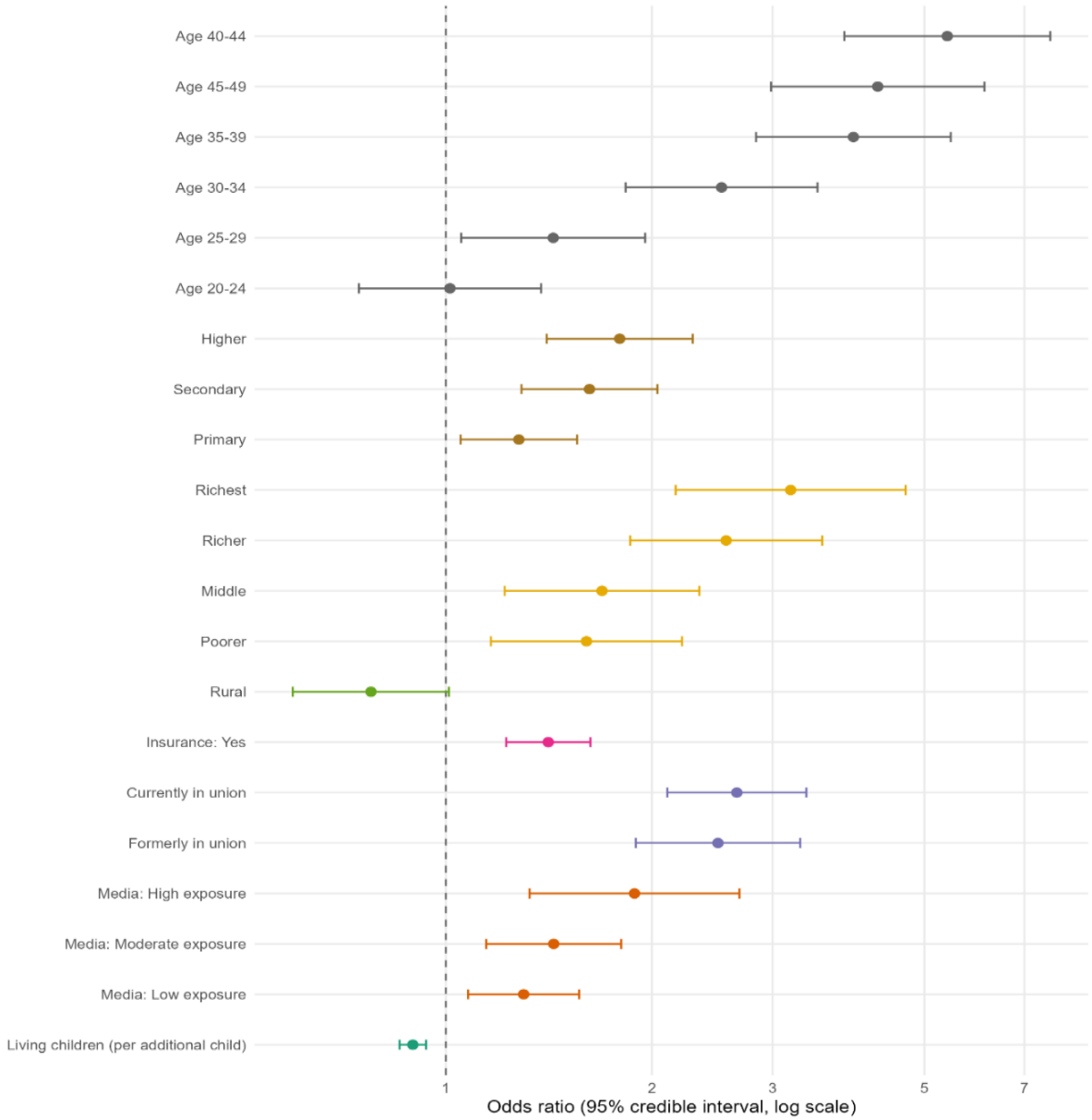


Figure. 3. Adjusted Odds Ratios for Cervical Cancer Screening Uptake as Estimated by the Bayesian Spatial Hierarchical Model (BYM2); the Points Represent the Posterior Mean Odds Ratios and the Horizontal Bars Display the 95% Credible Intervals. A Dashed Vertical Line Indicates the Null Value (OR = 1); the x-axis is on a Logarithmic Scale. Different Colours Identify the Various Covariate Domains

Spatial Patterns in Screening Uptake

In addition to the individual-level associations, the Bayesian spatial hierarchical model also provides region-specific estimates that separate the geographic pattern in screening uptake from the individual-level covariates already taken into account. Figure 4a shows the posterior mean adjusted relative risk (RR) for each region, in other words, the region-specific deviation from the national trend that is left after having adjusted for age, education, wealth, residence, insurance, marital status, media exposure, and parity. The adjusted relative risk was highest in Addis Ababa (RR = 1.91) and Amhara (RR = 1.66) and lowest in Somali (RR = 0.32) and Southwest Ethiopia (RR = 0.72), showing that large regional differences in screening uptake continue to exist even after adjusting for the sociodemographic characteristics of each region's population. The posterior exceedance probability for each region is shown in Figure 4b, this being the probability that its adjusted regional effect is positive, which means that, after taking into account the individual-level covariates, the screening uptake in that region is higher than that in the other regions, with proper regard to the posterior uncertainty rather than depending solely on point estimates. Both Amhara and Addis Ababa had exceedance probabilities at or around 1.00, indicating near-certainty that their adjusted screening uptake was higher than that of the other regions. On the other hand, Somali had an exceedance probability of 0.00, indicating near-certainty that its uptake was lower. Some regions, such as Tigray (0.53) and Harari (0.51), had exceedance probabilities close to 0.5, showing a high degree of posterior uncertainty about whether their true adjusted screening patterns differ meaningfully from those of the other regions.

To better describe the geographic pattern, Figure 4c shows the model-smoothed screening prevalence estimates, which have been adjusted to match the distribution of the individual-level covariates in the sample and thus are on the same scale as the unadjusted prevalence estimates in Figure 2b. The smoothed prevalence varied from 0.89% in Somali to 5.08% in Addis Ababa, which represents a considerably narrower range than the unadjusted, raw prevalence estimates (0.30% to 16.36%; Table 1). Figure 5a illustrates this shrinkage on a regional basis by linking each region's raw prevalence to its respective smoothed estimate. The greatest degree of shrinkage was seen in Addis Ababa, where the raw prevalence of 16.36% dropped to a smoothed estimate of 5.08% after taking into account the characteristics at the individual level, showing that a large part of Addis Ababa's apparent screening advantage is because its population is wealthier, more educated, and more urban rather than being the result of a geographic effect specific to the area. On the other hand, Somali exhibited relatively little shrinkage (0.30% raw versus 0.89% smoothed), in agreement with its low screening prevalence being the result of both individual-level disadvantages and an independent regional effect. Finally, the map shown in Figure 4d separates the part of the BYM2 regional effect that is purely spatially structured before combining it with the unstructured part. Since the spatial mixing parameter mentioned in Table 2 is modest and estimated imprecisely (ϕ = 0.232, 95% CrI: 0.017, 0.696), the pattern displayed here appears visually flatter and more attenuated than that of the combined adjusted effect in Figure 4a, which shows that while the geographic clustering of screening uptake among adjacent regions is real, it is comparatively small when compared with the region-specific, non-spatially-patterned heterogeneity.

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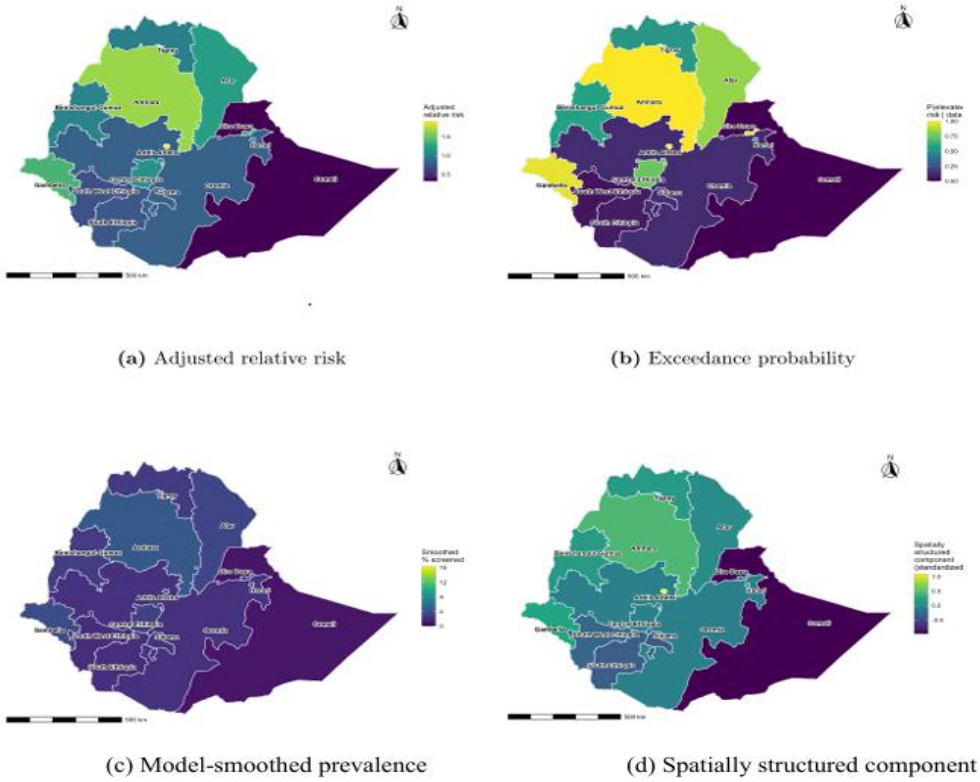


Figure. 4. Spatial Patterns of Cervical Cancer Screening Uptake as Determined by the Bayesian Spatial Hierarchical (BYM2) Model. (a) The Posterior Mean of the Adjusted Relative Risk for Each Region. (b) The Posterior Probability that Each Region's Adjusted Effect is Positive, Indicating Higher-than-typical Screening Uptake Relative to Other Regions after Adjustment for Individual-Level Covariates. (c) The Model-Smoothed Screening Prevalence for Each Region, on a Scale Directly Comparable to the Raw Prevalence Map in Figure 2b. (d) The Purely Spatially Structured part of the Regional Effect, on a Standardised Scale, Isolating the Neighbourhood-based Smoothing Pattern from the Unstructured Part of the Overall Effect shown in Panel (a)

Apart from the regional spatial effect already described, the Bayesian spatial hierarchical model also contained an unstructured random intercept for the primary sampling unit (cluster), which captured the remaining cluster-by-cluster differences in screening uptake that could not be accounted for by the individual-level covariates or the regional spatial effect. As shown in Table 2, this variation at the cluster level (PSU) made up 6.8% of the total residual variance (ICC = 0.068), similar in size to the regional variance, but structurally different from it since no spatial smoothing was applied between clusters. The odds ratios for the fitted cluster-level effects ranged widely (median OR = 0.97; interquartile range: 0.88, 1.15; full range: 0.59, 3.51), which shows that there is still meaningful heterogeneity in the rate at which screening is taken up among individual clusters even after having taken into account the individual-level characteristics and the region in which each cluster is situated. Figure 5b displays the variation at the cluster level at each cluster's geographical location, together with the region boundaries for reference. Unlike the region-level effect, no spatial smoothing was applied to the cluster-level effects and instead elevated- and reduced-odds clusters were scattered throughout the regions rather than grouping together to form distinct sub-regional clusters of their own, this being in line with the unstructured (as opposed to spatially structured) specification employed for this random effect.

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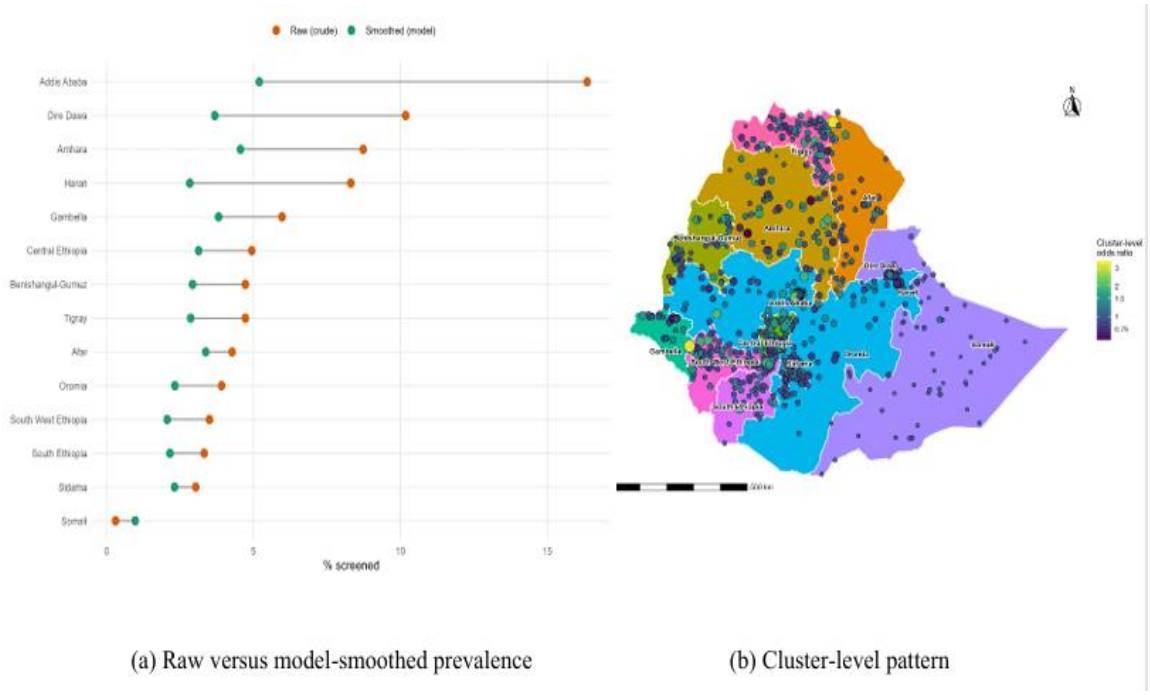


Figure. 5. Regional Shrinkage in Cervical Cancer Screening Rates and Variation at the Cluster Level as Described by the Bayesian Spatial Hierarchical (BYM2) Model. (a) A Comparison of the Actual Screening Prevalence by Region with that Which has been Smoothed by the Model, Showing the Phenomenon of Partial Pooling (shrinkage). (b) Pattern at the Cluster Level, with each Cluster's Estimated Odds Ratio Without Structure (Blue Denoting Reduced Odds, Red)

Sensitivity Analyses

In order to determine whether the main conclusions of the Bayesian spatial hierarchical model were affected by the choice not to include the DHS sampling weights, we compared its estimates with those from the weighted multilevel sensitivity model as described in the Methods (see Table 3). For the 21 individual-level covariates that were common to both models, the Pearson correlation between the log-odds estimates from the two models was 0.93, and the two models agreed on the direction of the effect for 20 out of 21 covariates (95.2% agreement on the sign). The one covariate for which the models differed was the age group 20–24, since both models found an effect close to the null (BYM2 model: OR = 1.01, 95% CrI: 0.75, 1.38; sensitivity model: OR = 0.85, 95% CrI: 0.62, 1.18), the credible intervals in both cases overlapping considerably and each containing 1; this indicates consistent evidence of no meaningful effect in either model rather than a real discrepancy in the substantive conclusions. The point estimates for wealth and marital status were slightly higher in the weighted sensitivity model than in the Bayesian spatial hierarchical model (see Table 3). Nevertheless, the overall pattern and statistical significance of the associations were the same in both specifications, which supports the robustness of the reported associations to survey weighting.

Prior Sensitivity

In order to check that the findings reported were not due to the particular prior distributions employed for the variance components in the Bayesian spatial hierarchical model, the model was refitted using a more restrictive prior ($P(\sigma > 0.3) = 0.01$), a more diffuse prior ($P(\sigma > 3) = 0.01$), as well as the default prior used in the main analysis ($P(\sigma > 1) = 0.01$). The fit of the model was similar in all three cases (WAIC: 7507.79 with the default prior, 7514.45 with the tighter prior, and 7505.99 with

the wider prior), and the estimated proportion of region-level variance that was spatially structured remained stable across the different specifications (ϕ = 0.232, 0.228, and 0.234, respectively). The fixed-effect odds ratios also changed only slightly depending on the prior specification; for instance, the odds ratio for the richest wealth quintile compared to the poorest was 3.19 with the default prior, 3.23 with the tighter prior, and 3.17 with the wider prior. Thus, the substantive conclusions from the Bayesian spatial hierarchical model were not a result of the particular prior distributions selected for the main analysis.

Goodness of Fit

The overall fit of the model was evaluated by means of the log pseudo marginal likelihood (LPML), which was obtained from the leave-one-out conditional predictive ordinates (CPO) calculated using INLA's built-in cross-validation method (LPML = -3753.97). During the calculation of the CPO, there were no numerical failures. There was no indication of systematic model misspecification: although a small number of observations (n = 209, namely those corresponding by design to the lower approximately 1% of the CPO distribution) had comparatively lower cross-validated predictive densities, these cases were spread out over various regions, age groups, and wealth categories and were not confined to any one particular subgroup.

Discussion

Based on nationally representative data from the 2024–25 Ethiopia Demographic and Health Survey, the present study looked not only at who is screened for cervical cancer but also at where and whether geography has an impact on the likelihood of screening when individual circumstances are taken into account. Three results are particularly noteworthy. First, individual characteristics such as age, education, wealth, marital status and exposure to mass media were strong predictors of screening uptake, wealth being the one with the steepest monotonic adjusted gradient (age reached a higher peak odds ratio, but its association was non-monotonic, rising then declining slightly at the oldest ages), a finding that is in line with patterns previously observed in other parts of sub-Saharan Africa [15-17]. Second, considerable geographic variation remained even after making the adjustments, with both region and cluster together accounting for 11.3% of the residual variance; yet only a small and imprecisely estimated part of the regional component (23.2%) showed a spatial pattern among adjacent regions, the majority of it being due to unstructured, region-specific heterogeneity, a difference that earlier, geographically limited studies of Ethiopia [20, 21] were unable to identify. Third, when the raw regional estimates were compared with the model-smoothed ones, it became clear that a large part of the striking disparity seen in the unadjusted data, especially the more than 50-fold difference between Addis Ababa and Somali, is due to the different population compositions of the regions rather than to a residual place effect. Nevertheless, a smaller and real geographic disparity still remained. Taken together, these findings suggest that in order to close the geographic gap in screening in Ethiopia it will be necessary to tackle both the individual-level barriers to access [18] and the residual, place-based disparities that continue to exist even among women who are otherwise similar.

The pattern of ages seen here, rising during mid-adulthood before levelling off, more or less matches the age group that the WHO elimination strategy aims at, with the organisation specifically recommending screening at age 35 and 45 [6, 12]. The fact that the adjusted odds reached their peak between ages 40 and 44 rather than continuing to increase indicates that opportunities for coming into contact with screening services are more focused in mid-adulthood than the WHO's upper screening-age benchmark of 45 alone

would suggest. The socioeconomic gradient, which increases with both levels of education and higher wealth, agrees with the wider body of regional evidence [14-17] and with a well-established pattern that when new health interventions are scaled up, they initially benefit wealthier households disproportionately [40]. Notably, the difference between urban and rural areas decreased considerably. It approached no difference when both wealth and education were kept constant, meaning that the urban advantage found in the raw data is mostly mediated by socioeconomic characteristics rather than being due to the fact of living in an urban area, a key point since it means that reaching disadvantaged women in urban areas should be just as important as extending services to rural areas.

Marital status was one of the strongest factors identified, likely because married and previously married women tend to have had more contact with reproductive health services, including family planning, antenatal, and postnatal care, in keeping with the evidence that healthcare decision-making autonomy influences the rate of screening throughout the region [18]. Media exposure also showed a similar dose-response pattern, as it has previously been found in research conducted in sub-Saharan Africa to be related to uptake [15, 16]; since media exposure is easier to change than structural factors such as wealth, it may be one of the more actionable factors identified in this study. Having each additional child was linked to slightly reduced odds of undergoing screening, a small effect which should be interpreted with caution due to the possibility of unmeasured confounding from other demands on women's time.

The main contribution of this study is its spatial analysis. When the two findings are considered together, they tell a more complete story than either one alone: although there remains a real geographical difference in the uptake of screening after adjusting for individual characteristics, most of this difference is unstructured rather than showing a smooth pattern across neighbouring areas. The fact that an adjusted geographical effect remains, with Addis Ababa and Amhara plausibly being higher and Somali plausibly lower, even among women who are similar in background shows that the place where a woman lives influences her chance of undergoing screening via channels that the individual-level survey data, such as the density of health facilities, the extent of programme coverage, and historical patterns of health investment cannot capture. The fact that this effect remains after adjustment for the factors most frequently cited in the regional literature [15, 16] implies that to close the geographical gap in Ethiopia it will be necessary to implement supply-side, health-system interventions that are specifically directed at the underperforming regions, not just rely on individual-level interventions.

At the same time, the fact that only a modest portion of this regional variation (23.2%) shows a spatial structure is itself significant: if access to screening were mainly determined by smoothly varying factors such as terrain or the movement of people across borders, a more pronounced spatial pattern would have been expected. The fact that the pattern observed is largely unstructured is rather more in keeping with access to screening being influenced by factors that operate within administrative regions, for example, the timing of the rollout of programmes or decisions regarding the investment in facilities, than by continuous geographic gradients, a difference which a conventional non-spatial comparison could not have shown [22-24]. The substantial decrease seen for Addis Ababa (from 16.36% raw to 5.08% smoothed) as compared with the relatively small decrease for Somali reinforces this point: it is plausibly possible to close the gap in places like Addis Ababa through targeted, individual-focused interventions. At the same time, regions such as Somali are likely to need direct investment in the health system.

More generally, these findings indicate that national-level coverage estimates alone can mask disparities of this magnitude, highlighting the importance of subnational, spatially explicit monitoring to track progress towards global elimination targets [6].

These results point to several specific priorities. Firstly, since the degree of unexplained disparity is concentrated in Somali, in south-west Ethiopia and in other poorly served areas, it makes sense to make supply-side investments that are directly aimed at the worst-performing regions rather than to adopt a single nationwide programme, since most of the regional differences are unstructured. It cannot be assumed that successful interventions will spread to adjacent regions just because of their proximity. Secondly, the distinction between compositional and contextual factors indicates two complementary approaches: in cases where the disparities are mainly compositional, efforts should be made to improve individual-level access (for example, by offering fee waivers, carrying out targeted outreach and involving community health workers), and where the disparities are not compositional, direct investment in the health system should be made. Thirdly, the strong socioeconomic gradient, together with the small urban-rural difference, both indicate that it is important to focus on affordability and awareness for women from disadvantaged backgrounds, regardless of whether they live in urban or rural areas, rather than concentrating solely on expanding services geographically [6, 12]. Fourthly, the finding relating to marital status supports integrating screening into the existing family planning, antenatal and postnatal care services, as the World Health Organization already recommends [12], while at the same time making a deliberate effort to reach women who have never been married and who do not fall within these services. Finally, the age pattern shows that outreach should be increased earlier, in a woman's thirties, rather than being focused on women who are already approaching the World Health Organization's upper age limit of 45.

Strengths and Limitations

The main advantages of this study are its large and nationally representative sample, which is big enough to identify differences at the regional and cluster levels, something that smaller, facility-based studies carried out in Ethiopia [20, 21] were not able to describe; the use of a verified region adjacency structure that was obtained directly from the DHS Program's own shapefile and not merely approximated; the clear separation of spatial variation from unstructured geographic variation and of compositional disparities from contextual regional disparities, a distinction that a standard type of analysis is not capable of making; and the agreement between several robustness checks (WAIC model comparison, weighted sensitivity analysis, prior sensitivity analysis, and cross-validated goodness-of-fit) which supports the reliability of the study's conclusions.

It is also necessary to point out the study's limitations. Since the study is cross-sectional, it can only show associations and not make any causal inferences. The outcome was self-reported and did not specify the type of screening carried out, which does introduce some potential for recall or social desirability bias; however, the good agreement between the unweighted and weighted models is reassuring on this point. The primary model did not include the survey weights directly because, at present, there is no established method for applying design-consistent weighting in spatial random-effects models; this represents a real methodological limitation, although the weighted sensitivity analysis indicates that it did not have a substantial impact on the substantive conclusions. The DHS does not record facility-level or health-system variables, so while it is possible to interpret the unstructured regional variation as being due to

region-specific programme factors, this interpretation remains indirect and has not been directly tested. Finally, a small number of respondents (2.5%) who did not know their screening status were excluded from the analytic sample; although this exclusion was minor and did not seem systematically linked to the variables examined, it cannot be completely ruled out as a source of bias.

Conclusions

This study offers a nationally representative and spatially explicit description of cervical cancer screening uptake in Ethiopia, going beyond information about who is screened to show where access to screening is inadequate and why. Although individual factors, especially income, education, and marital status, continue to be major influences on uptake, a real and mostly unstructured geographic imbalance still remains even when these factors are taken into account, with the worst situation being found in Somali areas and other regions that have historically been poorly served. By distinguishing between the compositional and contextual origins of this imbalance, it becomes clear that narrowing the gap will require two complementary strategies rather than relying on a single national policy. In areas where the regional disparities are mainly due to population composition, such as in Addis Ababa, considerable progress can be achieved by improving individual-level access through fee waivers, by carrying out targeted outreach to women from disadvantaged socioeconomic backgrounds, and by integrating screening into current family planning, antenatal, and postnatal care services. In areas where disparities remain independent of population composition, as is the case in Somali regions, individual-level interventions on their own are not likely to be enough and will probably have to be supplemented by direct investment in regional health-system capacity, such as increasing the number of health facilities, ensuring adequate availability of health workers, and developing community outreach infrastructure. Since mass media-based health communication is relatively cheap and can be quickly implemented, it might act as an additional complement to these structural investments, especially when it comes to reaching women who do not normally come into contact with the health system, such as those who have never married. More generally, the study shows that national screening coverage figures, no matter how accurate they are, can conceal disparities of the size documented here. As Ethiopia and other countries in the region move towards achieving the WHO's cervical cancer elimination goals [6], these results highlight the need for spatially explicit, subnational monitoring, not just for tracking overall progress but also to make sure that the particular regions and communities that are currently falling behind are not left behind as national indicators improve.

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Conflict of Interest

The authors declare no conflicts of interest.

Ethics Approval and Consent to Participate

Not applicable. This study involved a secondary analysis of de-identified, publicly available survey data from the Ethiopia Demographic and Health Survey (EDHS-8). The Ethiopian Statistical Service and ICF International obtained ethical approval for the original data collection, including clearance from the relevant national ethics review bodies in Ethiopia, before survey implementation. Because this study did not involve collecting primary data or direct contact with human participants, separate institutional review board approval was not required for this secondary analysis, consistent with the DHS Program's data use policies.

Consent for Publication

Not applicable. Informed consent was obtained from all survey respondents by the Ethiopian Statistical Service and ICF International at the time of the original data collection. The authors of this secondary analysis had no direct contact with study participants and used only de-identified data made available through the DHS Program.

Availability of Data and Materials

Data for this study were taken from the Ethiopia Demographic and Health Surveys (EDHS), which is freely available online at https://dhsprogram.com.

Authors' Contributions

Conceptualization, D.B.B. and E.E.; methodology, D.B.B. with input from E.E.; software, D.B.B.; formal analysis, D.B.B.; investigation, D.B.B.; data curation, D.B.B.; writing — original draft preparation, D.B.B.; writing — review and editing, E.E.; supervision, E.E.

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Stakeholders' Perceptions, Expectations, and Proposed Improvements for Noncommunicable Disease Surveillance and Response in the Butembo Branch of the North Kivu Provincial Health Division, Democratic Republic of the Congo: A Qualitative Study

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Abstract *Noncommunicable diseases (NCDs) remain insufficiently integrated into surveillance and response functions in the areas covered by the Butembo provincial health division branch, North Kivu, RDC. This study aimed to explore stakeholders' perceptions, expectations, and suggestions for improvement. A descriptive qualitative study with an exploratory focus was conducted among 25 stakeholders selected through purposive sampling. Data were collected through semi-structured individual interviews and subjected to manual inductive and deductive thematic analysis. Participants' accounts converged on recognizing the growing burden of NCDs while lamenting the limited consideration given to these diseases in health priorities. Surveillance was limited to the reporting of incomplete indicators that were rarely used locally. According to participants, out-of-pocket payments, poverty, insecurity, supply shortages, limited diagnostic capabilities, and inadequate longitudinal patient follow-up undermined clinical response. The lack of referral pathways, dedicated resources, supervision, and structured community involvement exacerbated these difficulties. Participants recommended increased commitment from the health system toward NCDs, a more inclusive information system, and the effective integration of referral, longitudinal follow-up, and community participation into primary health care.*

Keywords *Continuity of Care, Health Response, North Kivu, Noncommunicable Diseases, Primary Health Care , Surveillance.*

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Introduction

Noncommunicable diseases (NCDs) are on the rise worldwide in terms of mortality and morbidity and are believed to be responsible for premature deaths, most of which occur in low- and middle-income countries [1] in the context of demographic transition, the burden of these diseases may continue to weigh heavily on the countries in fragile contexts [2, 3]. The leading causes of these diseases are primarily cardiovascular diseases, various cancers, diabetes, and chronic respiratory diseases associated with four risk factors: tobacco use, a sedentary lifestyle or physical inactivity, harmful use of alcohol, and an unhealthy diet [4-6].

In the WHO African Region, health systems are under severe strain due to the coexistence of health emergencies and NCDs [7, 8], which complicates the supply chain for essential medicines and modern treatment technologies. The shortage of adequately trained human resources and systems to ensure continuity of care for chronic conditions further illustrates the fragility of health systems in addressing the challenges associated with NCDs [9, 10].

In the Democratic Republic of the Congo (DRC), data—though still incomplete—reveal an alarming increase in the contribution of NCDs to mortality among the Congolese population [11]. However, the lack of reliable data limits the understanding of the scale of the crisis and, consequently, the ability to implement urgent and appropriate response measures; this is particularly true for North Kivu Province, which has never undergone a WHO STEPwise-type population-based survey to assess the extent of the problem [12].

In the field of NCDs, surveillance goes beyond the compilation or periodic reporting of data to instead incorporate information on risk factors, morbidity, health system capacity, the social determinants of health, and the quality of health care services [13-15]. Promoting surveillance at all levels of the health care pyramid would contribute to early detection with a view to an appropriate response to public health events [16]; hence the need to establish integrated indicator systems capable of simultaneously measuring the dimensions of structure, response, and outcome as suggested by Zhang et al. [17].

In the 17 health districts of Butembo provincial health division branch, a previous quantitative study found that certain reporting indicators, namely, completeness, timeliness, feedback, and quality of data entry were more relevant than other surveillance indicators, including the monitoring of risk factors. The survey also highlighted major shortcomings in the area of response to NCDs [18]. Nevertheless, it could not determine, in particular, how decision-makers perceive and interpret seemingly favorable indicators when the scope of surveillance remains limited, why NCDs are less prominent in the concerns of certain coordination bodies, or how providers, patients, and community actors cope with supply shortages and gaps in follow-up.

International experience in humanitarian settings shows that organizational, relational, and informational mechanisms shape the continuity of chronic care in ways availability indicators do not fully capture, as demonstrated by Akik et al. [19]. A qualitative approach is therefore necessary to understand the meanings attributed to shortcomings, the constraints encountered, perceived responsibilities, and acceptable solutions. To our mind, these dimensions have not yet been studied collectively among leadership teams, data managers, providers, community liaisons, patients, and partners in the health districts of the Butembo Provincial Health Division Branch.

This study aimed to explore stakeholders' perceptions and experiences of NCD surveillance and response, analyze their expectations, and identify areas for improvement relevant to the local context.

Materials and Methods

Study Design and Approach

To understand the stakeholders' perceptions, expectations, and proposals regarding NCD surveillance and response, a descriptive qualitative study with an exploratory focus was conducted; this allowed a deep examination of the participants' experiences, practices, organizational constraints, and the meanings they attribute to the functioning of the established system. Interpretive analysis was used to understand surveillance and response to NCDs based on the stakeholders' experiences, in accordance with the recommendations of Braun and Clarke [20].

Study Setting

The North Kivu Butembo provincial health division Branch in the DRC serves as the setting for this study. This provincial health division covers 17 health districts, which, within the Congolese health system, represent the operational levels of and planning, coordination, and supervision of as well as health facilities, health information management organization of the response to priority health issues, while the health facilities located within these health districts serve as the structures for NCD surveillance and response through the services provided by the various actors in the health system.

Selection of Participants

The participants in this study were primarily stakeholders directly or indirectly involved in the surveillance, coordination, prevention, diagnosis, management, or community-based follow-up of NCDs, as well as recipients of these services. Participants were selected through a reasoned selection process based on their experience, their role in NCD surveillance and response, and their ability to provide relevant information on the subject [21]. The group comprised 25 individuals, including 5 supervising nurses, 3 data managers (DM), 2 district management officers (MDO), 2 clinicians, 2 head nurses (HN), 2 Community Health Workers (CHWs), 2 community facilitators from the health districts, 2 representatives of chronically ill patients, 2 technical and financial partners, 2 nutritionist-dietitians, and 1 traditional healer.

The final number of interviews was determined based on the principle of thematic saturation, defined as the point at which new data no longer contributed any new insights relevant to the study's objectives. The principle of analytical sufficiency was also applied, to obtain a sufficiently rich understanding of the organizational and contextual mechanisms under study [22-24]. Starting with the 18th interview, an increasing redundancy of information was observed; the following seven interviews did not reveal any new major themes.

Data Collection

Data were collected between June and July 2026 by the principal investigator through individual semi-structured interviews lasting an average of 50 minutes, conducted in French and Kiswahili. An interview guide was developed based on the study's objectives and the main conceptual dimensions of NCD surveillance and response. The interviews were recorded with the participants' consent and then transcribed in full by the principal investigator. Throughout the interviews, field notes were used to document certain nonverbal elements. No refusals to participate were recorded, and no interviews were excluded from the analysis. The researcher's familiarity with the local context was an asset for data collection. However, a reflective approach and consideration of divergent viewpoints helped minimize the researcher's influence on interpreting the results.

The following dimensions were explored through the interviews:

1. Perceptions of the importance and prioritization of NCDs;

2. The organization of surveillance at the health district and health facility levels;
3. Surveillance of risk factors, morbidity, complications, and mortality;
4. The availability and use of data collection and reporting tools;
5. The analysis and local use of data;
6. The availability of human resources, equipment, medications, and diagnostic tools;
7. The organization of prevention, screening, care, and follow-up for patients;
8. Referral and counter-referral mechanisms;
9. Coordination, supervision, and community participation;
10. Participants' expectations and their suggestions for improvement.

Data Analysis

The interviews were transcribed and then subjected to thematic analysis. Coding was guided by emerging themes from the field, using both deductive and inductive approaches. Units of meaning were identified, grouped into codes, and then organized into themes and subthemes corresponding to the main dimensions of NCD surveillance and response. The thematic analysis was particularly relevant since the aim was to study experiences, perceptions, and the institutional mechanisms put in place [21, 25, 26]. Data analysis was conducted manually and began concurrently with data collection to allow for a progressive deepening of insufficiently explored issues [27]. It followed six interdependent steps based on a practical approach presented by Naeem et al. and Saunders et al. [28, 29].

1. Familiarization with the data through repeated reading of the transcripts.
2. Generating initial codes from relevant segments.
3. Grouping related codes into provisional categories and themes.
4. Examining the themes in light of the coded excerpts and the entire corpus.
5. Defining, delimiting, and naming the themes.
6. Writing an analytical report linking the themes, interpretations, and illustrative verbatim quotes.

To illustrate the results, the most representative verbatim quotes from certain participants were chosen based on their ability to shed light on the topic at hand. However, the study also considered divergent or minority viewpoints to avoid reducing the results to a single, uniform position. Participants were asked to verify the accuracy of their statements and ensure their interpretations aligned with the corresponding subtheme. Targeted validation with certain participants (*member checking*) allowed verification of the accuracy of the transcription of their comments and the consistency of the interpretations with the corresponding subthemes. This process led to the correction of certain transcription inaccuracies and, where necessary, to the refinement of the interpretation of the collected comments [30].

Ethical Considerations

Ethical approval was sought and obtained in advance from the Ethics Committee of Lukanga Adventist University (CER/UNILUK/CER-FRIDI-UNILUK/2026/0028). The study also received written authorization from the Head of the North Kivu Butembo Provincial Health Division (No. 251/178/DPS-NK/BN/2026). Participation in the study was voluntary and informed. Participants signed a consent form describing the research objectives, confidentiality and anonymity guarantees, and the option to refuse to answer certain questions before data collection.

Results

A total of 25 stakeholders from various professional, institutional, and community backgrounds participated in the study, enabling the collection of diverse perspectives on the surveillance and response to NCDs.

Stakeholders' Perceptions of Prioritizing NCDs

The majority of participants acknowledged that NCDs are a priority given the high incidence of cases and deaths linked in particular to diabetes, strokes, asthma, hypertension, cancers, and many other conditions, both in healthcare facilities and in the community. While acknowledging the scale and consequences of NCDs, the majority of participants are aware that these diseases do not receive as much attention from the health system as communicable diseases, some of which are relatively mild. A supervising nurse stated: *"All it takes is for a single case of Mpox to be reported in the area, and you'll see a major mobilization in terms of cascade training for a disease with a very low case-fatality rate; yet noncommunicable diseases that claim more lives do not receive as much attention" (NS-01).*

It also became apparent that not all NCDs receive the same level of attention. Diabetes and hypertension are the two NCDs that are monitored relatively more closely than others. Another key informant stated: *"In analysis meetings, only diabetes, high blood pressure, and strokes seem to capture the attention of the district management team (NS-02).* The limited involvement of technical and financial partners specifically committed to working alongside the health districts to support NCD surveillance and response was cited as one of the challenges of the system in place, as highlighted by a district officer: *"Currently, when a program lacks financial support, its results remain mixed at the operational level… Similarly, at the central and intermediate levels, progress in this area is slow due to a lack of financial support… Entire programs remain shelved due to a lack of funding…" (DMO-01).*

Regarding NCD coordinators at the DMO level, the reality is that this role is not formally defined at the district level. Activities related to NCDs are considered "secondary activities" of the supervising nurse in charge of curative care: *"In reality, the health district does not officially have an NCD coordinator: the supervising nurse in charge of curative care handles it. It goes without saying that, given their many responsibilities, it is difficult for them to fully assume this role" (NS-03).*

From a technical standpoint, the majority of participants cited the lack of support for local stakeholders in a context where virtually all capacity-building activities are primarily focused on communicable diseases: *"In any case, training on surveillance and response to NCDs is almost nonexistent. In the field, community health workers do not receive enough specific training on these diseases, apart from a few rare training sessions—mainly on community-based screening for diabetes and high blood pressure" (IS-04).*

At the community level, participants highlighted the lack of training for stakeholders on risk factors, case definitions, preventive measures, screening, continuity of care, and community-based follow-up for patients with chronic diseases. Under the current NCD management framework, the contribution of Community Health Workers is limited. One CHW stated: *"…we only monitor the diseases on the list we were given; we don't monitor these diseases [NCDs], perhaps because they aren't transmitted from person to person; yet they continue to cause many deaths in the community" (CHW-01).*

Perceptions Regarding the Quality of Surveillance

Participants from various categories acknowledged that NCD surveillance in its current format amounts to passive case registration without any focus on monitoring NCD risk factors. The reporting templates currently in use do not allow for in-depth data collection on NCDs. This could affect the quality of the data produced and its analysis at the operational level: *"One need only analyze the data presented in our annual activity reports to see that NCDs are not sufficiently*

documented, unlike communicable diseases or perinatal issues" (*NS-01).*

Added to this is the challenge posed by the reliance of a segment of the population on traditional medicine and even certain non-integrated modern health facilities that operate in isolation from the established surveillance system*: "In any case, we do not have control over information regarding NCDs in traditional-modern health facilities and those operating illegally without being integrated into the reporting system" (DM-01).*

Regarding the paradox of both high timeliness and high completeness observed in the analysis of data extracted from DHIS2, participants believe that these data should be viewed with caution: *"These DHIS2 reporting indicators are merely apparent performance, as they only reflect that the partially collected information on NCDs was reported promptly and from a sufficient number of health facilities, while obscuring the reality surrounding important details about a phenomenon that is insufficiently monitored…" (NS-04).*

Perception of the Clinical Response

Several participants acknowledged that the clinical response in the North Kivu Butembo provincial health division faces the challenge of a health system based on household income in a context of poverty and insecurity. Furthermore, the inadequate supply of quality medications, reduced d access to care in certain areas—especially rural ones—healthcare staff not supported by the government, limited diagnostic resources, untrained and unsupervised community health workers, demanding nutritional care, and a lack of supporting partners… are among the challenges raised by providers. A member of the district management team states: *"Frankly, managing NCDs is beyond our capabilities given the many challenges involved; the Ebola experience [2018–2020] has shown us that as long as an initiative isn't financially supported by partners, nothing can work. Current performance is clearly good in the health districts supported by partners" (DMO-02).*

The clinical response is thus compromised; one patient stated*: "We face the challenge of long-term treatment, periodic follow-up exams, and a very demanding diet; sometimes we are forced not to report health concerns because we don't want to be a burden to our children, from whom we must receive everything" (PAT-01).*

Perceptions of Coordination and Supervision

Given the lack or limited nature of budget lines dedicated to NCDs, these conditions are rarely the focus of specific discussions at the DMO level, unlike communicable diseases, vaccination activities, maternal and child health issues, nutrition, and other activities directly supported by partners. A nutritionist-dietitian noted: *"The district management team is overwhelmed by vertical programs: the Expanded Program on Immunization, integrated management of childhood illnesses, etc. If there is no focal point, no budget for NCDs, no coordination, no specific meetings, no standardized case reporting…" (ND-02).*

Perceptions of Referral and Long-Term Follow-Up of Patients

A recurring observation in the interviews is that, even though referrals and counter-referrals are handled satisfactorily between health facilities, it is the long-term follow-up of these patients that poses a problem. Chronic patients, who are not well organized into associations, manage on their own to meet their care needs, and healthcare providers do not have enough time for this follow-up. A head nurse stated: *"We don't have enough time to provide home follow-up for patients we've lost track of. They may move from one facility to another, but there isn't always someone to support them in their follow-up…that's why they're left to their own devices" (HD-01).*

Expectations and Areas for Improvement

Participants' expectations were expressed in several ways. First, the allocation of sufficient resources dedicated to NCDs, and the effective involvement of health authorities and community stakeholders. Regarding the involvement of health authorities, one IS stated: *"Surveillance doesn't always work well due to a lack of clear instructions from higher-ups… all it takes is a simple letter from the provincial health division instructing local stakeholders to report specific information, and everything will automatically run smoothly" (SN-01).*

Participants proposed several other areas for improvement, including:

1. Appoint an NCD coordinator in each health district and allocate a budget to them.
2. Create standardized reference and cross-reference sheets for NCDs.
3. Train health care providers at all levels on NCD surveillance and response.
4. Use community health workers for active case finding.
5. Expand and integrate NCD-related indicators into the health information system.
6. Ensure a continuous supply of essential medicines.
7. Promote associations for people with chronic diseases.
8. Organize regular integrated supervision sessions that include NCDs.

Discussion

This study highlighted a discrepancy between participants' recognition of the growing burden of NCDs in terms of morbidity and mortality and the limited extent to which this is reflected in the operational priorities of health districts. Participants described a health system more concerned with communicable diseases, perinatal issues, humanitarian crises, and other programs receiving clearly identified external funding and support, to the detriment of NCDs, which currently do not appear to constitute an epidemiological priority. The absence of a formal NCD focal point, a structured community- a -based approach, specific budget, dedicated NCD meetings, and ongoing capacity-building for stakeholders clearly illustrates this lack of institutionalization.

This finding is consistent with analyses conducted in the WHO African Region, where programmatic progress on the ground remains uneven and where the level of preparedness of primary health care facilities remains generally insufficient for NCDs in a context where humanitarian crises are the health system's primary concern [8, 10]. This finding had also been highlighted by Kabir et al. [31], who, in a systematic review , demonstrated an overall low level of preparedness among countries in fragile contexts to address NCDs; with only diabetes and hypertension showing more or less satisfactory levels of preparedness, whereas these levels are significantly low for the other major NCDs, namely cardiovascular diseases, cancers, and chronic respiratory diseases.

A second major finding of the study concerns the essentially non-comprehensive nature of this surveillance. Although reporting was notably prompt and complete, these figures should be viewed as apparent administrative achievements that do not guarantee the comprehensiveness or validity of the data, nor their use for action. This interpretation follows the paradox highlighted in a study conducted at the Butembo provincial health division Branch [18]: reports are submitted on time yet document only a fraction of relevant events, whereas functional surveillance of NCDs should integrate risk factors, morbidity, complications, mortality, quality of care, clinical outcomes, and the system's capacity to address NCDs; it should then translate this information into local decisions[13-15]. A Vietnamese study has indeed shown that data collection is insufficient when the system lacks the analytical and coordination capabilities,

resources, and a culture of using data for decision-making [32].

The study also cited the case of non-integrated health facilities and the use of traditional medicine as factors that may increase the risk of underreporting of NCDs despite apparent completeness and timeliness. This situation is consistent with the findings of a study conducted by the DRC's Ministry of Public Health, Hygiene, and Prevention [33], in which an analysis of DHIS2 data revealed that of nearly 16,010 health facilities surveyed, only 12,050 were recorded in the system. Approximately 25% of health facilities, primarily private facilities, were therefore not reporting their data to the system. This finding suggests a coverage bias and, consequently, a likely underestimation of the problem's scale, given that satisfactory timeliness and completeness can coexist with the exclusion of a significant volume of data from non-integrated facilities. A study conducted in Lubumbashi by Mutombo et al. [34] showed that 79.4% of respondents had previously sought treatment through traditional African medicine, either alone or in combination with modern medicine. Although this result cannot be directly applied to the context of Butembo, it underscores the potential importance of health data that may fall outside the formal reporting system. Hence the need, according to the WHO [35], to incorporate comparisons with other sources into data analysis.

The third key finding of this study is the difficulty in organizing an appropriate clinical response. Participants linked the discontinuity of care to the challenge of out-of-pocket payments by households, poverty, insecurity, drug shortages, limited diagnostic resources, and a shortage of trained personnel. These constraints are particularly severe for NCDs, whose management requires repeated consultations, periodic examinations, and long-term treatment. Under such circumstances, patients are at risk of delayed care, interruption of their treatment, or financial dependence on their families and friends. This lack of preparedness in primary health care facilities contributes to fragmented care pathways and disruptions in continuity of care, against a backdrop of poor coordination among stakeholders [19, 31]. In such an environment, there is an urgent need to accelerate the integration of NCDs into emergency and financial protection plans for affected communities, in accordance with WHO recommendations [36].

The lack of long-term patient follow-up, despite the existence of a theoretically defined referral system between facilities, demonstrates that the one-time transfer of a patient does not, in itself, guarantee continuity of care. Continuity of care requires a documented reverse referral, a registry to enable follow-up, well-organized appointments, efforts to locate patients who have been lost to follow-up, and a functional link between health facilities, communities, and families. This is where the role of community health workers becomes particularly important, especially in resource-limited countries, provided they are sufficiently trained, supervised, and integrated, as has been documented in Uganda and Tanzania [37]. However, the community health workers interviewed reported that they lacked both a clear mandate and sufficient training to effectively provide this type of care. This finding is consistent with the study conducted in Cape Town by Doresha et al. [38], who also documented that community health workers were not sufficiently prepared to provide high-quality services in the area of NCDs; hence the importance of strengthening their capacity to ensure greater effectiveness.

Finally, participants proposed a range of solutions, most of which focused on effectively integrating NCDs into the normal functioning of the health system. Designating a point person, adopting more comprehensive indicators, integrating supervision, ensuring consistent medication availability, standardizing referral procedures, and

involving communities directly address the challenges identified in the study. The promotion of patient associations deserves special attention because they are effective in resource-limited African settings and have enormous potential to strengthen mutual support, therapeutic education, and continuity of care without shifting the responsibility for funding inadequate care onto patients [39, 40].

Conclusion

According to study participants, there is a real disparity between the burden of NCDs and their limited integration into the surveillance and response system currently in place in the health districts of Butembo provincial health division Branch. Respondents believe that, at this stage, surveillance is limited primarily to reporting a small number of indicators that are not very useful and are derived solely from integrated health facilities. They also believe that the response to NCDs is compromised by the user-fee system, insecurity, and shortages of supplies, low community participation, and the fragility of continuity of care. The proposed improvements focus on integrating NCDs into health district priorities, strengthening stakeholder capacity, implementing ongoing supervision, designating formal points of contact, and expanding the information system. They also include establishing functional mechanisms for referral, counter-referral, and community-based monitoring.

Recommendations

The Department of Public Health (DPS) and the health districts should designate NCD focal points and allocate budget lines specifically dedicated to NCDs. The information system should expand its indicators to include complications, deaths, risk factors, and patient follow-up; gradually integrate non-affiliated private facilities; and regularly triangulate data with other sources. Health facilities should have protocols, diagnostic tools, essential medicines, and documented mechanisms for referral, counter-referral, and tracing patients lost to follow-up. Finally, providers and community liaisons should be trained and supervised, while patient associations should be supported and guided by the health system.

Limitations

This study has certain limitations. Purposive sampling and the small sample size do not allow statistical generalization, but they align with the study's exploratory aim and enabled the collection of diverse professional and community perspectives. Self-reported data may be influenced by memory bias or social desirability; however, the inclusion of divergent viewpoints and the use of verbatim quotes strengthened the credibility of the analysis. Finally, despite the absence of systematic triangulation with official records and the fact that the principal investigator conducted the analysis, repeated transcript readings, progressive analysis until saturation, and cross-checking of testimonies helped minimize the risk of subjective interpretation.

Conflict of Interest

The authors declare no conflicts of interest.

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Authors' Contributions

The lead author participated in all stages of the study, including its design, data collection and analysis, and the drafting of the manuscript. The other authors critically reviewed the manuscript, proposed substantial improvements, and approved the final version.

Ethical Approval

This study received ethical approval from the Ethics Committee of the Adventist University of Lukanga (No. CER/UNILUK/CER-FRIDI-UNILUK/2026/0028). Informed consent was obtained from all participants.

Data Availability

The qualitative data supporting this study are not publicly available because of their sensitive nature and the need to protect the confidentiality of the stakeholders and beneficiaries interviewed. Anonymized data may be obtained from the corresponding author upon reasonable request, subject to applicable ethical requirements.

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Effect of Nutrition Education Intervention Based on Health Belief Model on Dietary Diversity Practices of Pregnant Women in Rural Western Ethiopia: A Cluster Randomized Controlled Trial, 2026

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Abstract *Inadequate dietary diversity during pregnancy is a major public health concern in Ethiopia, contributing to maternal undernutrition and adverse pregnancy outcomes. Theory-based nutrition education interventions have shown promise but have not been rigorously evaluated in remote, low-resource settings using cluster-randomized designs. This study aimed to assess the effect of a nutrition education intervention based on the Health Belief Model (HBM) on dietary diversity practices of pregnant women in rural western Ethiopia. A community-based pretest-posttest cluster-randomized controlled trial was conducted among 328 pregnant women (164 per arm) selected from 22 kebeles in Nuer Zone, Gambella Region, from March to June 2026. A 24-hour dietary recall was used to assess dietary diversity. Generalized Estimating Equations (GEE) fitted with a negative binomial distribution and Difference-in-Differences (DiD) were used to assess the intervention effect. At baseline, both groups exhibited comparable proportions of inadequate dietary diversity (intervention 75.3%, control 73.0%). At endline, the proportion of pregnant women with adequate dietary diversity rose from 24.7% to 73.5% in the intervention group but declined from 27.0% to 6.9% in the control group. In the adjusted GEE model, the intervention led to 42.5% greater relative increase in Dietary Diversity Score (IRR = 1.425, 95% CI: 1.322–1.535, $p < 0.001$), indicating robust improvement in dietary diversity and protection against seasonal dietary decline. An HBM-based nutrition education intervention significantly improved dietary diversity among pregnant women in rural western Ethiopia. Integrating behaviorally informed nutrition education into routine antenatal care services is recommended to improve dietary diversity of pregnant women in resource-limited settings.*

Keywords *Cluster-randomized Controlled Trial, Dietary Diversity, Education Intervention, Health Belief Model, Maternal Nutrition, Pregnant Women, Rural Ethiopia.*

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Introduction

Dietary diversity refers to the variety or number of different food groups consumed by an individual over a given time [1]. Pregnant women should consume a variety of foods rich in bioavailable energy, protein, vitamins, and minerals to support appropriate maternal weight gain and promote a healthy intrauterine environment for fetal growth and development [1]. According to studies, the overall energy requirement increases by 13% during pregnancy [2]. In low-income countries in Africa and Asia, monotonous cereal-based foods (starchy staples), which are poor sources of micronutrients, are the main cause of the highest burden of maternal undernutrition compared to other regions [3]. Poor maternal nutrition during pregnancy leads to dreadful health consequences for both the mother and the fetus [4]. It causes adverse birth outcomes such as intrauterine growth restriction, low birth weight, and preterm birth [5]. These consequences cause an estimated 800,000 newborn deaths each year globally [4]. Moreover, it is associated with child stunting and wasting [6]. Sub-Saharan Africa and South Asia are severely affected by maternal undernutrition due to chronic micronutrient deficiencies [7].

Factors influencing dietary diversity practices of pregnant women encompass multifaceted sociocultural, economic, and environmental factors, leading to disproportionate variations in the burden of undernutrition across geographical regions, countries, and societies [8]. Studies indicated that a substantial number of pregnant women worldwide have limited knowledge of what constitutes a "diversified diet", comprising nutrient-dense animal-source foods, vegetables, and fruits for optimal nutrition [9]. Ethiopia is a highly diverse country, comprising more than 80 ethnicities with different food cultures and traditions. It has diverse climates and landscapes with varying rainfall, creating large differences in crop production and agricultural practices that affect food security and dietary diversity. Ethiopian government has striven to promote maternal nutrition over the past two decades. In its healthcare delivery policy, it integrated nutrition counselling into routine antenatal care services to improve nutrition knowledge of mothers [5]. It developed Food-Based Dietary Guidelines (FBDG) as a game-changing solution to transform the country's food system, provide evidence-based recommendations for healthy, diverse, and sustainable diets, and improve nutrition literacy [10]. Besides, Ethiopia introduced the Women's Development Army (WDA) and the Health Development Army (HDA) initiatives to enhance community empowerment and engagement in promoting maternal and child healthcare practices [11]. Despite these efforts, inadequate dietary diversity among pregnant women in Ethiopia remains high, ranging from 39.3% to 66.1% [9]. In 2015, only one-fifth (20.3%) of reproductive-age women had minimum (adequate) dietary diversity [12]. In line with this, Ethiopia has a high prevalence of undernutrition among pregnant women, surpassing the average (20%) in Africa [13, 14]. The prevalence of inadequate dietary diversity among Ethiopian women is high in rural settings [15]. According to a case study review of program implementation experience to improve maternal nutrition in Ethiopia, education and counselling provided through routine health systems were ineffective in changing nutrition behaviours [16].

Ideally, behavioural interventions are developed and tested using theory in the settings where they occur to understand the causal determinants of behaviours and the pathways of change [17]. Theory provides a framework for testing hypotheses, identifies constructs that influence behaviour, and suggests techniques to incorporate into behavioural interventions [18]. The Health Belief Model is a widely used theory in health promotion and disease prevention programs

[19]. It is a psychological model that predicts health behaviours by focusing on individuals' perceptions and beliefs [9]. The Health Belief Model is organized into six constructs: perceived susceptibility to illness (disease-related condition), perceived severity of illness, perceived benefits of adopting a healthy behaviour, perceived barriers to behaviour, self-efficacy, and cues to action [19]. According to this model, health behaviour is determined by an individual's perception of the threat of illness and belief in the effectiveness of a course of action in preventing the illness at affordable costs [19]. Behavioral researchers found that the Health Belief Model effectively improved complex health and nutrition behaviors across populations and cultures [20]. In a study of pregnant women in Iran, a Health Belief Model-based education intervention significantly improved nutrition knowledge from 3% to 31% [21] (Figure 1).

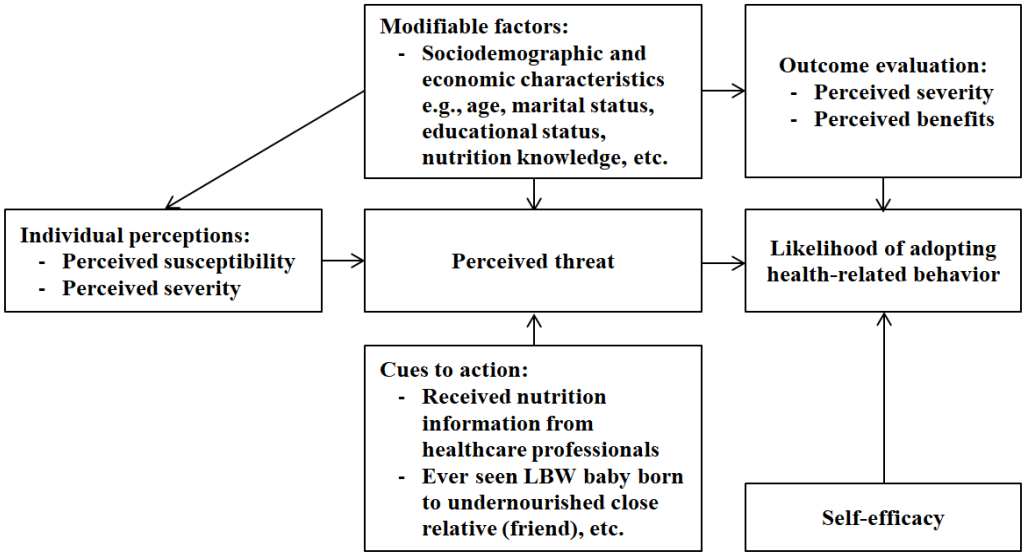


Figure 1. Theoretical Framework for Promoting Dietary Diversity among Pregnant Women using the Health Belief Model [9, 19, 20].

While numerous studies have explored nutrition education interventions in Ethiopia [3], few have employed cluster-randomized designs to evaluate behavioral factors influencing dietary diversity practices among pregnant women in rural pastoralist settings, with limited theory-based evidence in the unique, pastoralist western lowlands of Ethiopia, where the food culture and livelihood patterns differ markedly from agricultural highland communities. Understanding the pathways shaping women's dietary practices in these settings is crucial for designing effective, contextually appropriate education interventions. This study therefore aimed to assess the effect of a nutrition education intervention, grounded in the Health Belief Model, on the dietary diversity practices of pregnant women in rural western Ethiopia. The findings will inform the development of socially and culturally appropriate nutrition education strategies to improve dietary diversity among pregnant women in similar settings.

Methods and Materials

Study Design and Setting

This community-based, two-arm, parallel-group cluster-randomized controlled trial with baseline and endline assessments assessed the effect of a nutrition education intervention based on the Health Belief Model on dietary diversity practices among pregnant women in Nuer Zone, Gambella Region, western Ethiopia, from March to June 2026. Nuer Zone is located in the western lowlands of Ethiopia

at 876 kilometers from Addis Ababa. It is found at the longitude of 8°10′N to 8.167°N and latitude of 33°34′E to 33.567°E with an elevation of 400-340 meters above sea level. The zone is rural, with populations predominantly agro-pastoral, relying on traditional crop cultivation, livestock rearing, and fishing for livelihoods. Subsistence farming lacking crop diversity is widely practiced in the zone, with maize as the primary food crop. In addition, the food system is largely weak because of transportation challenges and the lack of local food markets, contributing to poor dietary diversity and undernutrition. Administratively, Nuer Zone comprises five districts and 121 kebeles (smallest administrative units). According to the 2026 projection, it has a total population of 206,598, including 53,922 women of reproductive age and 6,198 pregnant women. In terms of healthcare services, the zone has one primary hospital, eight health centers, and 47 health posts.

Study Populations, Inclusion, and Exclusion Criteria

The source population comprises all pregnant women residing in rural western Ethiopia. The study population includes pregnant women identified through community-based screening in selected districts of the Nuer zone. Pregnant women in their first or second trimester (up to 16 weeks) were eligible, as the intervention was designed to be implemented before delivery. Pregnant women at gestational age greater than 16 weeks, women who require special diets (or nutrition therapy) for any medical condition that may interfere with dietary intake, pregnant women identified as having deliberate plans to emigrate from the study area before the intervention period, and those who lived in the study setting for less than 6 weeks were excluded from the study.

Sample Size Determination

Sample size was calculated using G*Power version 3.1.9.7 [22] for a two-sample t-test (independent means). With $\alpha = 0.05$, power = 0.80, an allocation ratio of 1:1, and an effect size of 0.4, we obtained a sample of 156. Accounting for the design effect of 2 and a 10% non-response rate, the final sample size becomes 328 (164 participants per arm). Effect size was considered based on the findings of a cluster-randomized trial in West Gojam zone, Ethiopia, with a mean Dietary Diversity Score (DDS) of 5.4 ± 1.8 in the intervention compared to 4.5 ± 1.6 in the control group at endline, yielding a Cohen's d effect size of 0.4 [8].

Sampling Procedure and Randomization

A multi-stage stratified sampling technique was employed to recruit study subjects. Initially, four districts were selected from the five districts of the Nuer zone using a pseudo-random number generator. In the second stage, the selected districts (Lare, Jikaw, Makuey, and Wanthoa) were stratified into pairs based on geographic proximity and similar population density and health service availability, then randomly assigned to either the intervention or control arm. In the third stage, 20% of kebeles (representative clusters) were selected from each district using a random number generator, making a total of 22 kebeles in both arms. A household screening (pre-study household survey) was carried out in these kebeles to identify eligible pregnant women and establish a sampling frame. Finally, the study used systematic random sampling to select participants.

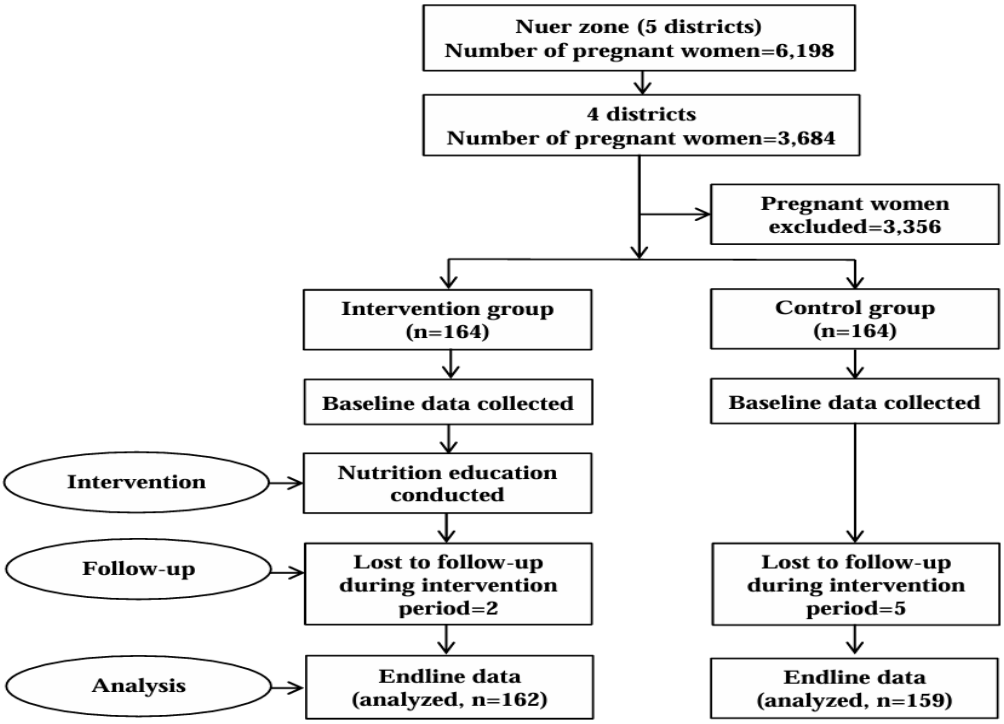


Figure 2. Flowchart of Study Participants Through the Phases of Intervention in Rural Western Ethiopia.

Blinding

Data collectors and outcome assessors were blinded to group allocation to minimize measurement bias. Although participants could not be blinded to the intervention because of its behavioral nature, both groups were blinded to the specific hypotheses and outcome measures to reduce performance bias.

Theoretical Framework

This study applied the Health Belief Model as the theoretical framework to guide the nutrition education intervention. The HBM posits that an individual's beliefs about the risks and consequences of a health condition, combined with beliefs about the effectiveness of recommended actions, predict engagement in health-promoting behaviors [19]. The intervention will focus on six HBM constructs: perceived susceptibility to undernutrition during pregnancy, perceived severity of undernutrition during pregnancy, perceived benefits of dietary diversity, perceived barriers to dietary diversity practice, self-efficacy, and cues to action. The study does not aim to test HBM itself but rather uses its foundational behavioral frameworks to design and deliver the educational content.

Nutrition Education Intervention

Pregnant women in the intervention arm received monthly nutrition education for three consecutive months. Educational resources such as manuals, leaflets, brochures, and counseling cards were developed based on the dietary and nutritional recommendations of the World Health Organization, the Food and Agriculture Organization [1], and the Ethiopian Ministry of Health [10]. The education module covered: risks of undernutrition in pregnancy, physiological needs of pregnancy, short- and long-term health, economic and social consequences of undernutrition for mothers and children, benefits of dietary diversity and pregnancy weight gain, food groups and their nutrient contents (emphasizing locally available foods), mixed dishes and serving sizes, and recommended eating patterns, food taboos and misconceptions, food hygiene and safety, and the benefits of iodized salt and iron-folic acid supplementation. Each education session

lasted three hours and was delivered in the local ("Nuer") language using interactive methods such as discussions, brainstorming, group learning, demonstrations, and role plays to enhance engagement and retention. The methodologies and structures followed the guidance in the Training of Trainers Manual for Counseling on Maternal, Infant, and Young Child Nutrition [23]. Two health professionals with bachelor's degrees and two with master's degrees were recruited as educators and supervisors based on their experience and proficiency in the local language. They received a five-day training on the intervention content and delivery methods. In addition, community health extension workers received a one-day training and conducted home-to-home visits every 15 days to provide individual nutrition counseling for 30–60 minutes per session. During these visits, they identified and discussed practical challenges to dietary diversity and provided tailored support to enhance self-efficacy. The intervention was delivered over three consecutive months, and endline data were collected one month after the final education session to assess sustained behavior change.

Intervention Fidelity

Fidelity of the intervention was ensured using the five best-practice elements defined by the National Institutes of Health Behavior Change Consortium [22]: (i) ensuring that the intervention dose was uniform across all participants by following a standardized education manual that outlined learning activities and time allocation; (ii) standardizing interventionist training through a structured manual that defined key elements and procedures; (iii) monitoring intervention delivery using a structured field supervision guide and session scripts; (iv) evaluating participants' understanding through pre- and post-tests in each session; and (v) ensuring participants use the skills taught through reinforcement during home visits. Interventionist fidelity was assessed using structured observation checklists completed by supervisors for 90% of education sessions (n = 54 of 60) and 85% of home visits (n = 102 of 120). Fidelity scores (percentage of checklist items completed as planned) averaged 87.3% (SD = 6.2) for education sessions and 85.6% (SD = 7.1) for home visits. Inter-educator agreement was assessed by having two supervisors independently rate 10% of sessions, yielding Cohen's $\kappa = 0.82$ (95% CI: 0.74–0.89), indicating high agreement.

Variables and Operational Definitions

Dietary Diversity Practice was assessed using the Minimum Dietary Diversity for Women (MDD-W) indicator, based on a 24-hour dietary recall. MDD-W is a food group diversity indicator used as a proxy for micronutrient adequacy of diets of women of reproductive age. It uses ten food groups namely (1) grains, white roots and tubers, and plantains, (2) pulses: beans, peas, and lentils, (3) nuts and seeds, (4) dairy: milk and milk products; (5) meat, poultry, and fish, (6) eggs, (7) dark green leafy vegetables, (8) vitamin A-rich fruits and vegetables, (9) other vegetables, and (10) other fruits. Participants recalled all foods (ingredients) they ate in the previous 24 hours. Each food group consumed was scored as 1, and scores were summed to obtain the Dietary Diversity Score (DDS), ranging from 0 to 10. A DDS of 5 or more indicates adequate dietary diversity, while a score below 5 indicates inadequate diversity. Consuming at least five of the ten food groups reflects higher nutrient intake than the average requirement for 11 micronutrients of public health relevance, such as calcium, folate, iron, zinc, vitamin A, thiamine, riboflavin, niacin, vitamin B6, vitamin B12, and vitamin C [24]. Only foods consumed in quantities of at least 15 grams ("one tablespoon") were counted in the food group indicator to avoid falsely inflating the dietary diversity score.

Health Belief Model Constructs were measured using 27-item Likert-scale questionnaire, adapted from validated instruments [25, 26], covering perceived susceptibility (4 items), perceived severity (4 items), perceived benefits (4 items), perceived barriers (5 items), self-efficacy (4 items), and cues to action (6 items). Responses were scored on a five-point scale (strongly disagree to strongly agree, very unlikely to very likely) to rate participants' perceptions and beliefs. Scores for each construct were summed and categorized into tertiles, with the highest tertile indicating a higher level for the construct. Higher perceived susceptibility, perceived severity, perceived benefits, self-efficacy, and cues to action are associated with a higher likelihood of participants engaging and achieving desired behavior outcomes ("adequate dietary diversity"), whereas higher perceived barriers are associated with a lower likelihood of adopting behavior and achieving outcomes [27].

Household Food Insecurity was assessed using the standard Household Food Insecurity Access Scale (HFIAS) [28], comprising nine occurrence questions and nine frequency questions. Occurrence questions are dichotomous (Yes/No) and ask whether a household experienced any food insecurity (access)- related conditions in the last four months. Each occurrence question specifies "lack of resource" as the reason for food insecurity to ensure the measure excludes food deprivation conditions associated with behaviors such as dieting to lose weight, fasting for religious reasons, or food shortages for any reason other than resource constraints. The occurrence or experience of a food insecurity (access) related condition is coded 1, and non-occurrence is coded 0. Households experiencing at least one food insecurity condition in the past four weeks were classified as food insecure.

Household Wealth Index was measured using an adapted version of the International Wealth Index (IWI), covering household assets, housing quality, water source, and sanitation facilities [29]. The IWI scale is an asset-based index used to measure households' long-term economic status and living standards in low-and middle-income countries [29]. A household owning more expensive consumer durables, a better-quality house, and having access to basic services has a higher level of material well-being [29]. The tool comprised 22 questions. 20 of these are dichotomous, asking whether a household owns defined assets or goods, such as consumer durables. Two questions assessed the quality of the household's water supply and toilet facility. Dichotomous questions are scored as 1 (yes) or 0 (no). The quality of the toilet facility is scored as low quality (1) for traditional pit latrines, hanging toilets, and no toilet facility; middle quality (2) for public toilets and improved pit latrines; and high quality (3) for private flush toilets. Household water supply quality was scored as low quality (1) for unprotected wells, boreholes, springs, and surface water sources; middle quality (2) for public taps, protected wells, and tanker trucks; and high quality (3) for bottled water or water piped into dwellings. Principal component analysis was used to derive weights, and scores were categorized into quintiles: first wealth quintile (poorest household), second quintile (poor household), third quintile (medium household), fourth quintile (wealthy household), and fifth wealth quintile (wealthiest household).

Nutrition Knowledge was measured using 11 dichotomous questions (yes/no), coded as 1 for a correct response and 0 for an incorrect response. Knowledge scores were converted into tertiles, with the highest tertiles indicating good nutrition knowledge, the middle tertiles indicating medium nutrition knowledge, and the lowest tertiles indicating poor nutrition knowledge.

Data Collection Instruments and Procedure

A pre-tested, structured interviewer-administered questionnaire adapted from the literature was used to collect data [30]. The questionnaire comprises nine sections covering demographic and socioeconomic characteristics, obstetric history, dietary diversity, HBM constructs, nutrition knowledge, eating habits, food taboos, household food insecurity, and wealth index. A 24-hour 'open' dietary recall was used to capture all foods consumed in meals and snacks over the previous day. Mixed dishes were disaggregated into their ingredient components, and only ingredients consumed in quantities ≥15 grams were counted in the MDD-W food groups. Four data collectors with bachelor's degrees in public health nutrition and two supervisors with master's degrees in the same field were recruited and trained. Data collection occurred in three phases: (1) a pre-study household survey to identify eligible participants and create the sampling frame, (2) baseline data collection, conducted immediately before the intervention, and (3) endline data collection, conducted one month after the final education session to assess outcome variables (DDS, MUAC, HBM constructs, nutrition knowledge, and eating habits).

Data Quality Assurance

Independent language experts translated the questionnaire into the local "Nuer" language and back-translated it into English to ensure conceptual equivalence. Data collectors and supervisors received five days of training on interviewing techniques, 24-hour dietary recall procedures, food group classification, operationalizing serving sizes, mixed dishes, and anthropometric measurements.

The questionnaire was pre-tested on 5% of the sample in a non-study district. Internal consistency was assessed using Cronbach's alpha, which ranged from 0.72 to 0.89 across the HBM subscales, exceeding the target threshold of 0.7. Content validity was assessed using Lawshe's Content Validity Ratio, with values ranging from 0.81 to 0.95 (target ≥ 0.78). Face validity was assessed using Cohen's Kappa, yielding values of 0.65 to 0.78 (target ≥ 0.60). Confirmatory factor analysis was performed to validate the HBM constructs, with goodness-of-fit indices ranging from 0.91 to 0.95 (target ≥ 0.9).

To prevent recall bias in the 24-hour dietary recall, a comfortable and neutral environment for the interview was ensured, rapport was established, and sufficient time was allowed for subjects to think without rushing to enhance their memory recall. During data collection, data collectors checked each questionnaire for completeness, and supervisors verified completeness and accuracy daily.

Statistical Analysis

Data were collected using an online Kobo Toolbox form on Android devices and exported to SPSS version 25.0 for analysis. Descriptive statistics (means, standard deviations, frequencies, percentages) were computed for all variables. Normality of continuous variables was assessed using the Kolmogorov-Smirnov test. Baseline comparability between intervention and control groups was assessed using chi-square tests (for categorical variables) and independent t-tests (for continuous variables). To assess the effect of the nutrition education intervention on dietary diversity over time, Generalized Estimating Equations (GEE) were used. This approach was chosen to account for the inherent correlation between the two repeated measurements (baseline and endline) taken from the same pregnant woman, while providing population-averaged estimates that are directly interpretable as the average intervention effect across the study sample. The primary outcome, Dietary Diversity Score (DDS), is a count variable representing the

number of food groups consumed out of the possible ten. Given its discrete, bounded nature and the likelihood of increasing variance with higher mean values, a distribution that correctly models the data-generating process was selected with due care.

To determine the most appropriate distribution for the count outcome, we initially fitted a Poisson GEE model and assessed the overdispersion parameter (calculated as the Pearson chi-square statistic divided by its degrees of freedom). This parameter indicated significant overdispersion (value = 1.47), meaning the variance in DDS substantially exceeded the mean, which is common in dietary data where some women consume very few foods while others consume many. Consequently, the Poisson distribution was rejected in favor of the Negative Binomial distribution, which includes an additional dispersion parameter to explicitly model this extra-variability and ensure correctly estimated standard errors. A log link function was employed, and the model was specified with an exchangeable working correlation matrix. This structure assumes a constant correlation between the two time points for each participant, which is a parsimonious and appropriate choice with only two repeated measures; moreover, the use of robust (sandwich) standard errors ensures that inference remains valid even if this correlation structure is slightly misspecified. The primary analytic model was adjusted for a set of pre-specified baseline covariates to control for potential confounding and to improve the precision of the intervention effect estimate. These covariates included maternal age, education level, household wealth index quintiles, family size, parity, and baseline DDS.

The primary parameter of interest was the interaction between Time and Group (Time × Group), which directly estimates the difference-in-differences (DiD) that is, the additional change in DDS from baseline to endline in the intervention group relative to the control group. A series of diagnostic checks was performed to validate the assumptions underlying the GEE model. The GEE model was specified with the 22 kebeles as the highest-level clustering variable to adjust for the intra-cluster correlation inherent in the study design, while the subject was defined as each participant's unique identifier to account for the correlation between repeated measurements. The mean-variance relationship was assessed by plotting standardized Pearson residuals against fitted values, which revealed no systematic patterns, confirming that the Negative Binomial variance function adequately captured the heteroscedasticity. Multicollinearity among continuous predictors was examined using Variance Inflation Factors (VIFs), all of which were below 2.0, indicating no problematic collinearity. Influential observations were screened using Cook's distance; no values exceeded the conventional threshold of 4/n, suggesting that individual participants did not disproportionately influence the overall estimates. Regarding missing data, fewer than 5% of observations were incomplete. Baseline characteristics between participants who completed follow-up and those lost to follow-up were compared; no statistically significant differences observed, supporting the assumption that missingness was unrelated to the outcome after accounting for observed covariates (missing at random).

Consequently, GEE provides valid estimates under these conditions. All coefficients from the Negative Binomial Model were exponentiated to present Incidence Rate Ratios (IRR), which represent the multiplicative change in the expected DDS count. Hypothesis testing was conducted using Wald chi-square tests with a two-sided significance level of $\alpha=0.05$. To aid interpretation, estimated marginal means (EMMeans) were computed on the response scale for each group at each time point, adjusted for all covariates, and within-group

changes over time were compared using pairwise contrasts with the Least Significant Difference (LSD) adjustment. All analyses were performed using IBM SPSS Statistics for Windows, Version 25 (IBM Corp., Armonk, NY, USA), using the Generalized Estimating Equations procedure (GENLIN) with a Negative Binomial distribution and a log link.

Results

Baseline Participants Characteristics and Comparability

The flowchart of study participants through the phases of intervention is illustrated in Figure 2. Of 328 pregnant women enrolled in the study (164 per arm), 321 (97.9%) completed follow-up (intervention 162, control 159); attrition was unrelated to baseline characteristics (all P > 0.05). Table 1 demonstrates complete baseline equivalence across all sociodemographic, socioeconomic, and nutritional variables (P values: 0.168–0.957), confirming successful randomization. The sample predominantly aged 25–34 years (~60%), with similar marital status and family size distribution across arms. Approximately 50% were food insecure, 72–76% had inadequate dietary diversity, and 72% had low-to-medium nutrition knowledge. The mean gestational age at baseline was comparable in intervention and control groups (13.76 vs 14.61 weeks, respectively). This homogeneity ensures that post-intervention differences are attributable to the intervention (Table 1).

Table 1. Baseline Sociodemographic and Economic Characteristics of Participants by Study Group in Nuer Zone, Gambella Region, Western Ethiopia, 2026

Characteristics	Category	Intervention	Control	P-value
		N (%)	N (%)	
Age (years)	≤24	43 (26.2)	46 (28.0)	0.487
	25–34	98 (59.8)	102 (62.2)	
	≥35	23 (14.0)	16 (9.80)	
Marital status	Married & live together	57 (34.8)	55 (33.5)	0.937
	Separated	56 (34.1)	55 (33.5)	
	Divorced	51 (31.1)	54 (32.9)	
Education of respondent	College and above	50 (30.5)	47 (28.7)	0.957
	Secondary (9–12)	36 (22.0)	38 (23.2)	
	Primary (1–8)	42 (25.6)	40 (24.4)	
	No formal education	36 (22.0)	39 (23.8)	
Occupation of respondent	Employee	39 (23.8)	44 (26.8)	0.254
	Merchant (trader)	41 (25.0)	36 (22.0)	
	Farmer	39 (23.8)	51 (31.1)	
	Daily laborer	45 (27.4)	33 (20.1)	
Education of husband	College and above	49 (29.9)	37 (22.6)	0.359
	Secondary (9–12)	37 (22.6)	37 (22.6)	
	Primary (1–8)	34 (20.7)	45 (27.4)	
	No formal education	44 (26.8)	45 (27.4)	
Occupation of husband	Employee	40 (24.4)	38 (23.2)	0.168
	Merchant (trader)	49 (29.9)	34 (20.7)	
	Farmer	37 (22.6)	40 (24.4)	
	Daily laborer	38 (23.2)	52 (31.7)	

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Family size	<5 (small)	74 (45.1)	71 (43.3)	0.739
	≥5 (large)	90 (54.9)	93 (56.7)	
Nutrition knowledge	Low	72 (43.9)	77 (47.0)	0.833
	Medium	47 (28.7)	46 (28.0)	
	High	45 (27.4)	41 (25.0)	
Household food security	Food secure	88 (53.7)	79 (48.2)	0.32
	Food insecure	76 (46.3)	85 (51.8)	
Dietary diversity	Inadequate	124 (75.9%)	120 (73.0)	0.542
	Adequate	40 (24.1%)	44 (27.0)	
Mean gestational age		13.76	14.61	0.10

Correlation of HBM Constructs with Dietary Diversity

Table 2 presents the independent t-test comparisons of Health Belief Model constructs between the intervention and control groups at baseline and endline. At baseline, no statistically significant difference was observed across any of the six HBM constructs (all $p > 0.05$), confirming complete randomization and group comparability before the intervention. At endline, however, the intervention group demonstrated significantly higher scores than the control group on perceived susceptibility ($p < 0.001$, Mean difference = +2.68, 95% CI: 2.29 -3.07), perceived severity ($p < 0.001$, Mean difference = +3.59, 95% CI: 3.20–3.98), perceived benefits ($p < 0.001$, Mean difference = +2.47, 95% CI: 2.06–2.88), self-efficacy ($p < 0.001$, Mean difference = +1.49, 95% CI: 1.04–1.94), and cues to action ($p < 0.001$, Mean difference = +3.56, 95% CI: 3.05–4.07). The largest intervention effect was observed on perceived severity, where the intervention group scored +3.59 points higher than the control group. Conversely, the intervention group reported significantly fewer perceived barriers to dietary diversity than the control group ($p < 0.001$, Mean difference = –4.58, 95% CI: –4.95 to –4.21) (Table 2).

Table 2. Baseline Comparability and Endline Intervention Effects on Health Belief Model Constructs by Study Group in Nuer Zone, Gambella Region, Western Ethiopia, 2026

Construct	Time	Intervention Mean (SD)	Control Mean (SD)	t	P-value	Mean Difference (95% CI)	Effect Size
Perceived Susceptibility	Baseline	11.38 (3.01)	11.48 (3.13)	0.41	0.68	–0.10 (–0.58, 0.38)	0.03
	End line	13.95 (3.05)	11.27 (1.92)	13.4	<0.001	2.68 (2.29, 3.07)	1.06
Perceived Severity	Baseline	13.04 (3.19)	12.83 (3.33)	0.82	0.414	0.21 (–0.29, 0.71)	0.06
	End line	16.82 (2.90)	13.23 (2.03)	18.2	<0.001	3.59 (3.20, 3.98)	1.45
Perceived Benefits	Baseline	11.35 (2.99)	11.48 (3.13)	0.54	0.592	–0.13 (–0.61, 0.35)	0.04
	End line	17.32 (2.99)	14.85 (2.22)	11.9	<0.001	2.47 (2.06, 2.88)	0.94
Perceived Barriers	Baseline	14.15 (3.11)	14.24 (2.98)	0.37	0.709	–0.09 (–0.56, 0.38)	0.03
	End line	9.36 (2.85)	13.94 (1.79)	24.4	<0.001	–4.58 (–4.95, –4.21)	1.94
Self-Efficacy	Baseline	10.39 (2.36)	10.16 (1.87)	1.37	0.172	0.23 (–0.10, 0.56)	0.11
	End line	12.79 (2.99)	11.30 (2.86)	6.45	<0.001	1.49 (1.04, 1.94)	0.51
Cues to Action	Baseline	11.97 (3.03)	12.03 (3.65)	0.23	0.821	–0.06 (–0.58, 0.46)	0.02
	End line	15.91 (3.73)	12.35 (2.75)	13.8	<0.001	3.56 (3.05, 4.07)	1.10

CI: Confidence Interval, SD: Standard Deviation

Effect of Nutrition Education Intervention on Dietary Diversity

Endline dietary diversity data showed a considerable between-group difference in outcomes. At baseline, intervention and control groups exhibited comparable proportions of inadequate dietary diversity (75.3% and 73.0%, respectively). By the endline assessment, the proportion of participants achieving adequate dietary diversity in the intervention group rose from 24.7% to 73.5%. Over the same interval, the control group declined in adequate dietary diversity, falling from 27.0% to 6.9%. This endline disparity, representing an absolute difference of 66.6 percentage points in favor of the intervention, suggests that the intervention was associated with improved dietary outcomes relative to baseline. Moreover, the concurrent deterioration observed in the control group, potentially attributable to external factors such as seasonal food scarcity, highlights a possible protective effect of the intervention against such contextual influences. The period from March to June (when this study was carried out) marks the transition from the post-harvest spring season to early summer before the main harvest, with a seasonal shortage of fresh produce and a hunger gap in the study setting. Collectively, these results indicate that the intervention is associated with a notable improvement in dietary diversity within this study population. These observations support consideration of this strategy for broader implementation, although further evaluation across varied contexts is prudent (Table 3).

Table 3. Dietary Diversity Practice of Pregnant Women Over the Follow-up Period in Nuer Zone, Gambella Region, Western Ethiopia, 2026

Variable	Study Period	Category	Intervention	Control
			N (%)	N (%)
DDS	Baseline	Inadequate dietary diversity	122 (75.3%)	116 (73.0%)
		Adequate dietary diversity	40 (24.7%)	43 (27.0%)
	End line	Inadequate dietary diversity	43 (26.5%)	148 (93.1%)
		Adequate dietary diversity	119 (73.5%)	11 (6.9%)

DDS: Dietary Diversity Score

Observing the group Dietary Diversity Scores (DDS), the intervention and control groups were statistically comparable at baseline: the intervention group recorded a mean DDS of 3.47 (SD = 1.093), while the control group recorded 3.57 (SD = 1.052); the between-group mean difference was –0.103 (SE = 0.120), and the corresponding t-test yielded a p-value of 0.390, confirming no statistically significant difference at the study's outset. At the endline, the mean DDS of the intervention group rose to 4.52 (SD = 0.879), whereas the control group's score declined to 3.06 (SD = 0.847), with a between-group mean difference of 1.456 (SE = 0.096), a t-value of 15.102, and a p-value < 0.01, representing a statistically significant difference in favor of the intervention group. Examining within-group changes from baseline to endline, the intervention group demonstrated a mean DDS increase of +1.05 points, while the control group exhibited a mean decrease of –0.51 points, yielding a Difference-in-Differences (DiD) estimate of 1.56, which was also statistically significant (p-value < 0.01). Collectively, these results suggest that the intervention was associated with a statistically significant net improvement in dietary diversity scores relative to the control group, and the concurrent decline in scores among the control group further supports the observed effect (Table 4).

Table 4. Differences in Mean Dietary Diversity Scores by Group Over the Study Period in Nuer Zone, Gambella Region, Western Ethiopia, 2026

Variable	Study Period	Intervention Mean ± SD	Control Mean ± SD	t-test	Mean Difference (Intervention – Control) ± SE	P-value
DDS	Baseline	3.47 ± 1.093	3.57 ± 1.052	–0.861	–0.103 ± 0.120	0.39
	End line	4.52 ± 0.879	3.06 ± 0.847	15.1	1.456 ± 0.096	<0.01
	Difference (EL – BL)	1.05	–0.51	–	1.56 (DiD)	< 0.01

BL: Baseline, DDS: Dietary Diversity Score, EL: End-line, SD: Standard Deviation, SE: Standard Error

Because DDS is a count variable and showed overdispersion (dispersion parameter = 1.47), we fitted the GEE model with a Negative Binomial distribution and a log link. The fully adjusted model revealed a significant main effect of Time (IRR = 0.738, 95% CI: 0.699–0.780) and Group (IRR = 0.735, 95% CI: 0.691–0.782), alongside a highly significant positive Time × Group interaction (IRR = 1.425, 95% CI: 1.322–1.535, $p < 0.001$). The intervention group experienced a 35.5% relative increase in DDS from baseline to endline, whereas the control group experienced a 4.9% relative decline. Consequently, the nutrition education intervention produced a 42.5% greater relative increase in dietary diversity than the control group. Among the covariates, baseline DDS exhibited a strong, graded regression-to-the-mean effect: women with DDS of 2, 3, 4, and 5 had significantly lower endline scores compared to those with baseline score of 6 (IRRs = 0.553, 0.688, 0.813, and 0.928, respectively, all $p < 0.01$). Good nutrition knowledge was independently associated with higher DDS (IRR = 1.065, 95% CI: 1.027–1.105, $p = 0.001$). Education was also significantly associated with DDS; women with primary (IRR = 0.943, $p = 0.004$) and secondary education (IRR = 0.953, $p = 0.040$) had lower DDS compared to those with tertiary education. Family size showed a marginal positive association that did not reach statistical significance (IRR = 1.025, 95% CI: 0.998–1.053, $p = 0.065$), while home garden availability was not significantly associated with DDS (IRR = 1.014, $p = 0.298$). None of the other sociodemographic factors, including age, household wealth, parity, food insecurity, or ANC attendance, was significantly associated with DDS (as all 95% confidence intervals crossed 1.00). Overall, these findings demonstrate that the intervention produced a robust and statistically significant improvement in dietary diversity, independent of baseline dietary status, food insecurity, and all measured socio-demographic characteristics. Identifying nutrition knowledge as a strong independent predictor, alongside the graded effect of baseline DDS, underscores the importance of targeted education and the need to account for regression to the mean in intervention studies (Table 5).

Table 5. Generalized Estimating Equation of the Intervention Effect on Dietary Diversity Practices of the Pregnant Women in Nuer Zone, Gambella Region, Western Ethiopia, 2026

Parameter	β	SE	IRR	95% CI
(Intercept)	1.841	0.043	6.305	(5.798, 6.855)
Time (End line vs Baseline [Ref])	–0.303	0.028	0.738	(0.699, 0.780)
Group (Intervention vs Control [Ref])	–0.308	0.032	0.735	(0.691, 0.782)
Time × Group	0.354	0.038	1.425	(1.322, 1.535)
Age category (Ref: ≥35 years)	–	–	1	–

15–24 years	0.011	0.024	1.011	(0.964, 1.060)
25–34 years	0.006	0.02	1.006	(0.968, 1.046)
Education (Ref: Tertiary)	–	–	1	–
No formal education	–0.036	0.024	0.964	(0.921, 1.010)
Primary	–0.059	0.021	0.943	(0.905, 0.982)
Secondary	–0.048	0.023	0.953	(0.911, 0.998)
Family size (Ref: large)	0.025	0.014	1.025	(0.998, 1.053)
Household wealth (Ref: Richest)	–	–	1	–
Poorest	–0.035	0.019	0.966	(0.929, 1.003)
Poorer	–0.037	0.02	0.964	(0.927, 1.002)
Middle	–0.039	0.022	0.962	(0.922, 1.004)
Richer	–0.031	0.019	0.97	(0.935, 1.006)
Parity (Ref: Grand multipara)	–	–	1	–
Nulipara	–0.002	0.026	0.998	(0.948, 1.050)
Multipara	0.018	0.02	1.018	(0.979, 1.059)
Household food insecurity (Food Insecure vs Secure [Ref])	–0.008	0.018	0.992	(0.958, 1.026)
ANC attendance (Ref: No)	–0.027	0.021	0.974	(0.935, 1.014)
Nutrition knowledge (Ref: Poor)	0.063	0.019	1.065	(1.027, 1.105)
Home garden available (Ref: No)	0.014	0.014	1.014	(0.988, 1.042)
Baseline DDS (Ref: Score = 6)	–	–	1	–
Score = 2	–0.593	0.031	0.553	(0.520, 0.587)
Score = 3	–0.375	0.027	0.688	(0.653, 0.725)
Score = 4	–0.207	0.03	0.813	(0.767, 0.861)
Score = 5	–0.075	0.027	0.928	(0.879, 0.979)

ANC: Antenatal Care, CI: Confidence Interval, DDS: Dietary Diversity Score, IRR: Incidence Rate Ratio, Ref: Reference Category, SE: Standard Error.

Mediation of HBM Pathways Influencing Dietary Diversity

To investigate the mechanisms through which the nutrition education intervention influenced dietary diversity, a parallel multiple mediation analysis was conducted using the product-of-coefficients method with 5,000 bootstrap resamples to estimate indirect effects (IE) and their 95% confidence intervals. The analysis tested whether changes in the six HBM constructs: perceived susceptibility, severity, benefits, barriers, self-efficacy, and cues to action mediated the intervention's effect on endline DDS, adjusting for baseline covariates. The total effect of the intervention on dietary diversity was 0.474 (95% CI: 0.312–0.636; $p < 0.001$). After controlling for all mediators simultaneously, the direct effect was reduced to 0.096 (95% CI: −0.028 to 0.220; $p = 0.128$), indicating full mediation. The total indirect effect through all mediators was 0.378 (95% CI: 0.251–0.505), accounting for 79.7% of the total effect. Self-efficacy was the strongest mediator, accounting for 38% of the total effect (IE = 0.180, 95% CI: 0.112–0.258). Perceived benefits (IE = 0.076, 95% CI: 0.032–0.124; 16%) and perceived barriers (IE = 0.077, 95% CI: 0.028–0.131; 16%) also emerged as significant mediators. Perceived susceptibility had a small but significant mediating effect (IE = 0.018, 95% CI: 0.005–0.035; 4%). In contrast, perceived severity (IE = 0.008, 95% CI: −0.002–0.020) and cues to action (IE = 0.019, 95% CI: -0.004–0.045)

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did not significantly mediate the intervention effect, as their confidence intervals included zero (Figure 3, Table 6).

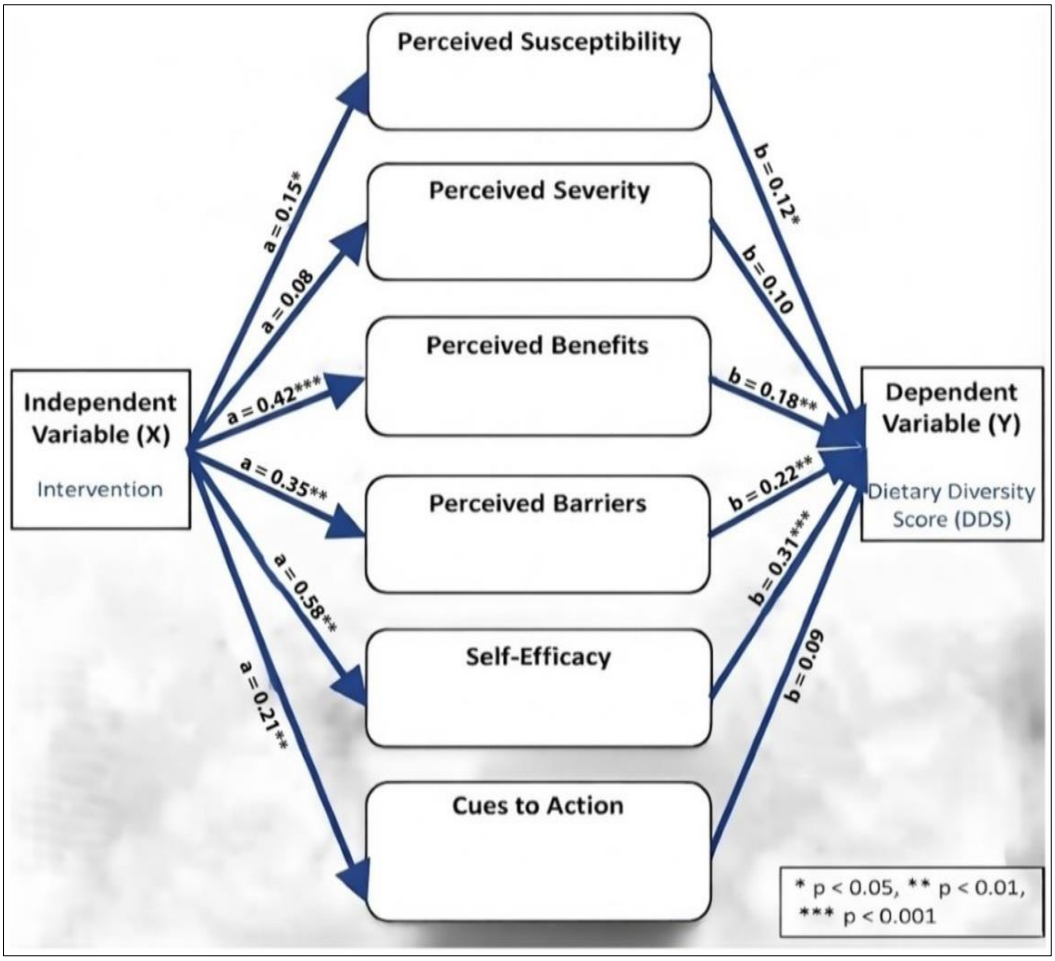


Figure 3. Parallel Multiple Mediation Models of Health Belief Model Constructs

Table 6. Mediation Analysis of Health Belief Model Pathways in a Nutrition Education Intervention to Improve Dietary Diversity among Pregnant Women in Nuer Zone, Gambella Region, Western Ethiopia, 2026

Mediator (M)	Path a (X→M)	Path b (M→Y)	Indirect Effect (a×b)	95% CI	Proportion Mediated
Perceived Susceptibility	0.15*	0.12*	0.018*	(0.005, 0.035)	4%
Perceived Severity	0.08	0.1	0.008	(-0.002, 0.020)	—
Perceived Benefits	0.42***	0.18**	0.076**	(0.032, 0.124)	16%
Perceived Barriers	–0.35***	–0.22**	0.077**	(0.028, 0.131)	16%
Self-Efficacy	0.58***	0.31***	0.180***	(0.112, 0.258)	38%
Cues to Action	0.21**	0.09	0.019	(-0.004, 0.045)	—

**p-value < 0.05, **p-value <0.01, ***p-value <0.001*

Per-Protocol Analysis of Intervention Effect on Dietary Diversity

To complement the primary intention-to-treat analysis, a per-protocol analysis was conducted among women who adhered to the intervention protocol (attended ≥ 50% of education sessions). Of the 164 women in the intervention group, 138 (84.1%) were adherent. In the per-protocol GEE model, the Time × Group interaction remained highly significant (IRR = 1.385, 95% CI: 1.274–1.507, p < 0.001). The intervention group experienced a 33.3% relative increase in DDS from baseline to endline, while the control group experienced a 3.8% relative decline. The net effect was a 38.5% greater relative increase in dietary diversity compared to the control group, slightly attenuated from the intention-to-treat (ITT) estimate of 42.5%. This consistency, observed in both analytical approaches, confirms the robustness of the intervention's impact. Among the covariates, the graded regression-to-the-mean effect persisted (p < 0.01 for all baseline DDS categories). Nutrition knowledge remained a strong independent predictor (IRR = 1.071, 95% CI: 1.029–1.115, p = 0.001). Family size was significantly associated with DDS; women from smaller households had 3.3% higher DDS compared to those from larger households (IRR = 1.033, p = 0.031), while education showed a borderline association (Primary vs. Tertiary: IRR = 0.954, 95% CI: 0.907–1.002, p = 0.060), likely due to the reduced sample size. None of the other covariates were significantly associated with DDS (all p > 0.05) (Table 7).

Table 7. Per-Protocol Analysis of the Intervention Effect on Dietary Diversity of Pregnant Women in Nuer Zone, Gambella Region, Western Ethiopia, 2026

Parameter	β	SE	IRR	95% CI	P-value
(Intercept)	1.809	0.045	6.104	(5.584, 6.672)	<0.001
Time (End line vs Baseline [Ref])	–0.288	0.03	0.75	(0.706, 0.795)	<0.001
Group (Intervention vs Control [Ref])	–0.283	0.036	0.753	(0.702, 0.808)	<0.001
Time × Group	0.326	0.043	1.385	(1.274, 1.507)	<0.001
Age category (Ref: ≥35 years)	–	–	1	–	–
15–24 years	0.007	0.028	1.007	(0.954, 1.063)	0.795
25–34 years	0.005	0.022	1.005	(0.962, 1.049)	0.833
Education (Ref: Tertiary)	–	–	1	–	–
No formal education	–0.042	0.028	0.959	(0.907, 1.013)	0.135
Primary	–0.048	0.025	0.954	(0.907, 1.002)	0.06
Secondary	–0.038	0.027	0.963	(0.913, 1.016)	0.17
Family size (Ref: Large)	0.032	0.015	1.033	(1.003, 1.064)	0.031
Household wealth (Ref: Richest)	–	–	1	–	–
Poorest	–0.024	0.022	0.976	(0.934, 1.019)	0.271
Poorer	–0.023	0.023	0.977	(0.934, 1.022)	0.306
Middle	–0.038	0.026	0.963	(0.915, 1.012)	0.137
Richer	–0.031	0.021	0.969	(0.930, 1.010)	0.135
Parity (Ref: Grand multipara)	–	–	1	–	–
Nulipara	0.006	0.029	1.006	(0.950, 1.065)	0.838
Multipara	0.015	0.022	1.016	(0.972, 1.061)	0.49
Household food insecurity (Ref: Food secure)	0.001	0.02	1.001	(0.963, 1.040)	0.972

ANC attendance (Ref: No)	–0.020	0.023	0.98	(0.936, 1.026)	0.389
Nutrition knowledge (Ref: Poor)	0.069	0.02	1.071	(1.029, 1.115)	0.001
Home garden available (Ref: No)	0.005	0.015	1.005	(0.976, 1.035)	0.742
Baseline DDS (Ref: Score = 6)	–	–	1	–	–
Score = 2	–0.609	0.03	0.544	(0.513, 0.577)	<0.001
Score = 3	–0.374	0.026	0.688	(0.654, 0.724)	<0.001
Score = 4	–0.204	0.03	0.816	(0.770, 0.865)	<0.001
Score = 5	–0.072	0.026	0.93	(0.883, 0.980)	0.006

ANC: Antenatal Care, CI: Confidence Interval, DDS: Dietary Diversity Score, IRR: Incidence Rate Ratio, Ref: Reference Category, SE: Standard Error

Subgroup Analysis by Household Food Security Status

A subgroup analysis was conducted to investigate whether the intervention effect varied by household food security status. Food security status was assessed using the Household Food Insecurity Access Scale (HFIAS) at baseline. The intervention effect was significant in both subgroups: Among food-secure women, the intervention led to a 48% greater relative increase in DDS (IRR = 1.480, 95% CI: 1.300–1.685, $p < 0.001$), while the effect was 56% greater relative increase among food-insecure women (IRR = 1.560, 95% CI: 1.401–1.738, $p < 0.001$). To test whether this difference was statistically significant, a three-way interaction term (Time × Group × HFIAS) was included in the GEE models. The three-way interaction was not statistically significant (IRR = 0.936, 95% CI: 0.856–1.023, $p = 0.145$), indicating that the intervention effect did not differ significantly by food security status after adjusting for other covariates: age, education, wealth, parity, family size, and baseline DDS. This suggests that the intervention was equally effective in improving dietary diversity among both food-secure and food-insecure women. Likewise, baseline DDS was significantly associated with endline DDS in both subgroups, consistent with regression to the mean. Among food-secure women, higher baseline DDS was associated with a 23.7% lower endline score (IRR = 0.763, 95% CI: 0.736–0.791, $p < 0.001$), and the effect was the same for the food-insecure subgroup (IRR = 0.761, 95% CI: 0.738–0.785, $p < 0.001$) (Table 8).

Table 8. Subgroup Analysis of Intervention Effect on Dietary Diversity by Food Security Status, Nuer Zone, Gambella Region, Western Ethiopia, 2026

Subgroup	Parameter	β	SE	IRR	95% CI	P value
Interaction Test	Three-Way Interaction (Time × Group × HFIAS)	–0.066	0.046	0.936	(0.856, 1.023)	0.145
Food-secure women	Time × Group	0.392	0.052	1.48	(1.300, 1.685)	<0.001
	Baseline DDS	–0.271	0.018	0.763	(0.736, 0.791)	<0.001
Food-insecure women	Time × Group	0.445	0.038	1.56	(1.401, 1.738)	<0.001
	Baseline DDS	–0.273	0.016	0.761	(0.738, 0.785)	<0.001

CI: Confidence Interval, IRR: Incidence Rate Ratio, SE: Standard Error

Sensitivity Analysis: Alternative Correlation Structure

To assess the robustness of the primary GEE results to the choice of correlation structure, a sensitivity analysis was conducted. The primary analysis assumed an exchangeable correlation structure. For the sensitivity analysis, the model was refitted using an autoregressive (AR-1) correlation structure, which assumes that measurements closer in time are more highly correlated than those further apart. The sensitivity analysis using an AR-1 correlation structure yielded results consistent with the primary analysis. The Time x Group interaction remained significant (IRR = 1.51, 95% CI: 1.40–1.63, $p < 0.001$), which was comparable to the primary estimate of IRR = 1.52 (95% CI: 1.41–1.65). The direction, magnitude, and statistical significance of the intervention effect did not change materially. This confirms that the primary findings are robust to the choice of correlation structure in the GEE model.

Discussion

This cluster-randomized controlled trial assessed the effect of a Health Belief Model (HBM)-based nutrition education intervention on dietary diversity practices among pregnant women in rural western Ethiopia. The intervention led to a statistically significant and clinically meaningful improvement in dietary diversity, with a 42.5% greater relative increase in the dietary diversity score in the intervention group compared to the control group. In descriptive analyses, the proportion of women achieving adequate dietary diversity rose from 24.7% to 73.5% in the intervention arm but declined from 27.0% to 6.9% in the control arm over the same period, consistent with the adjusted GEE model results. These findings provide robust evidence that theory-based nutrition education can substantially improve maternal dietary practices, even in remote, resource-limited settings. The observed effect size aligns closely with findings from similar trials in Ethiopia. A cluster-randomized controlled trial conducted in Southeast Ethiopia reported that pregnant women receiving HBM-based education were significantly more likely to achieve adequate dietary diversity compared to controls [31]. Another cluster-randomized controlled trial in Northeast Ethiopia revealed that providing nutrition education based on the Health Belief Model improved nutritional knowledge and dietary practices among pregnant women [9]. Similarly, a quasi-experimental study in rural Southwest Ethiopia found that theory-based nutrition education, combined with male involvement, improved dietary diversity scores among pregnant women [32].

A systematic review and meta-analysis of nutrition education interventions in Ethiopia reported that longer interventions of five or more months yield a larger effect [33]. While our intervention was delivered over three months shorter than the duration identified in that review, the magnitude of improvement observed in this study indicates that a moderate-duration, intensively delivered intervention (combining monthly group sessions with bi-weekly home visits) produces substantial behavioral change. This suggests that intervention intensity and reinforcement frequency may partially compensate for shorter overall duration, particularly when theoretical frameworks like the HBM address multiple cognitive and practical determinants of behavior simultaneously.

Beyond the overall effect size, it is important to distinguish the intervention's true impact from a statistical phenomenon known as regression to the mean (RTM). In this study, two patterns were observed. First, the intervention group demonstrated a substantial improvement in dietary diversity relative to the control group, indicating a genuine program effect. Second, an inverse relationship was observed between baseline and endline dietary diversity scores: women who started with

higher dietary diversity tended to have lower scores at follow-up. This is consistent with RTM, whereby extreme baseline values naturally move toward the average upon repeated measurement. A similar pattern emerged in a large cohort study of Japanese adults, where those with high baseline dietary diversity declined significantly at five-year follow-up, while those with low baseline scores remained stable or improved [34]. Importantly, the intervention effect in our study was independent of baseline dietary diversity, and the RTM pattern did not differ between the intervention and control groups. This strongly suggests that the program's impact is genuine and not an artefact of statistical regression. These findings highlight the importance of accounting for RTM in intervention research to avoid misinterpreting natural fluctuations as program effects.

The substantial decline in adequate dietary diversity in the control group (from 27.0% to 6.9%) is notable and likely reflects the seasonal food scarcity characteristic of the 'lean season' in rural Ethiopia [35]. The study period (March to June) encompasses a transition in the agricultural cycle from the post-harvest period to the pre-harvest 'hunger gap' when household food stores are depleted, and fresh produce is scarce. This seasonal pattern, driven by the interplay of agricultural production, market supply, and household economics, is a well-documented challenge in the region [35] and underscores the importance of seasonality in dietary assessments. The intervention group's ability to maintain and even improve dietary diversity during this period suggests the education may have helped women better use available resources, including stored foods, fishing, and livestock products, thereby protecting them from the typical seasonal decline.

Regarding the theoretical mechanisms of behaviour change, the intervention demonstrated significant improvements in most HBM constructs at endline compared to the control group. Self-efficacy was the strongest mediator of the intervention effect on dietary diversity practices. Perceived benefits and perceived barriers were also significant mediators. The significant improvement in perceived benefits indicates that women recognized the tangible advantages of diverse diets for fetal and maternal health, reinforcing their motivation to adopt the recommended practices. Perceived susceptibility demonstrated a statistically significant but relatively minor mediating role, suggesting that while the intervention may have increased women's awareness of their personal risk, this awareness alone was not the primary driver of behavioral change. In contrast, perceived severity and cues to action did not emerge as significant mediators.

These findings are consistent with prior HBM-based interventions in Ethiopia and elsewhere [9] and confirm that the educational content effectively modified both the cognitive appraisals of undernutrition risk and the practical facilitators of dietary behavior. The significant reduction in perceived barriers, particularly around cost, availability, and household food allocation, is conceptually central to the HBM and suggests that the intervention successfully translated abstract nutritional knowledge into actionable, context-specific solutions (e.g., identifying affordable local nutrient-dense foods, meal planning, and negotiating household food sharing). The substantial increases in women's self-efficacy (confidence) to improve dietary intake further support this interpretation; the between-group difference in self-efficacy was +1.49 points, with within-group changes of +2.40 in the intervention group versus +1.14 in controls, underscoring the intervention's impact.

Similar studies demonstrated significant improvements in HBM constructs. A quasi-experimental study on cardiovascular disease risk factors in Shiraz, Iran, significantly improved most HBM constructs, with effect sizes of +0.130 to +0.312 [36], showcasing the

model's validity in shaping health behaviours across different contexts, as observed in the complex dietary and behavioral modifications in this study. An intervention targeting violence-preventive behaviours among (rural) older women showed significant improvements in nutrition knowledge, attitude, and all HBM constructs [37]. These studies, alongside the current findings, reinforce the HBM's theoretical validity and practical utility in health promotion programmes across diverse health contexts.

This study has several notable strengths, including a cluster-randomized controlled trial design, a high retention rate (97.9%), comprehensive fidelity monitoring, rigorous statistical analysis using GEE with a Negative Binomial Distribution, and thorough instrument validation. Grounded in the Health Belief Model, the intervention enabled examination of theoretical mechanisms and was equally effective across all socioeconomic subgroups, supporting its equity-focused applicability. The marginal association between family size and dietary diversity ($p = 0.050$) warrants cautious interpretation; larger households may face greater food allocation challenges, though the intervention effect remained robust and consistent across all household sizes. However, some limitations must be acknowledged. Dietary diversity was assessed using a self-reported 24-hour recall, which is susceptible to recall and social desirability bias. The study was conducted in a single rural zone, limiting generalizability, and the short follow-up period precludes assessment of long-term sustainability. Seasonality was not objectively measured, and no biological markers were collected to validate dietary improvements. The intervention's resource-intensive nature raises questions about cost-effectiveness and scalability.

Clinical and Public Health Implications

This study's findings have important implications for maternal and child nutrition in Ethiopia and similar settings. Primarily, the marked increase in adequate dietary diversity prevalence within the intervention arm supports the idea that intensive nutrition education can elicit substantial behavioral improvements without requiring major economic investments, instead optimizing the use of existing household food resources. Moreover, the synergistic effectiveness of the dual-delivery model comprising group-based sessions for scalable knowledge transfer and peer reinforcement, coupled with individual home visits for personalized counseling and contextual barrier mitigation, supports its pragmatic feasibility for broader regional scale-up. Critically, the absence of significant covariate interactions confirms the intervention's uniform efficacy across all socioeconomic and demographic strata, thereby precluding the exacerbation of existing disparities and underscoring its strategic salience for equity-oriented nutrition programming.

Conclusions

An HBM-based nutrition education intervention significantly improved dietary diversity among pregnant women in rural western Ethiopia and demonstrated a protective effect against seasonal dietary decline. The intervention worked through multiple HBM pathways, most notably by reducing perceived barriers and enhancing self-efficacy. The magnitude of improvement observed (a mean increase of 1.05 food groups) carries important clinical implications, with the potential to reduce adverse pregnancy outcomes. The intervention's compatibility with Ethiopia's existing Health Extension Program infrastructure suggests strong potential for sustainable integration into routine antenatal care, though it will require

careful attention to training, supervision, and resource allocation. While this trial did not include male involvement, future adaptations could explore its potential benefits. These findings provide evidence that behaviourally informed nutrition education can enhance maternal dietary practices in resource-limited settings. However, further implementation research is warranted to evaluate the long-term sustainability, scalability, feasibility, and cost-effectiveness of integrating HBM-based nutrition education into routine antenatal care services.

Data Sharing

Data are available on reasonable request from the corresponding author.

Conflict of Interest

The authors declare no competing interests.

Ethical Approval and Consent

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki [38] and the Ethiopian National Research Ethics Review Guidelines of 2014 [39]. The Institutional Review Board of the Gambella Peoples National Regional State Health Bureau granted ethical approval. Permission was secured from the Nuer Zone Health Office and district health authorities. All participants received detailed information about the study objectives, procedures, potential risks, and benefits, and provided written informed consent before enrollment. For those who could not read and write, an impartial witness was present during the consent process. Participants were assured that their participation was voluntary and that they could withdraw at any time without affecting their healthcare. We anonymised data using unique identification codes, and stored all information securely on password-protected computers. Pregnant women identified with undernutrition (MUAC < 23 cm) or other health conditions were referred to the nearest health facility for appropriate care. To ensure beneficence, the control group received the educational materials and a condensed version of the intervention after endline data collection. Findings will be disseminated to the community, district health authorities, and the regional health bureau to inform policy and practice.

Authors' Contribution

The corresponding author contributed to all phases of the research project, from Conception and Design, Execution (Data Acquisition), Data Analysis and Interpretation, and Manuscript Preparation (Drafting and Finalization), while the other authors contributed to Conception and Design, Interpretation, and Manuscript Revision and agreed to publication in this journal.

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Factors Associated with Incomplete Childhood Immunization among Children Aged 12–36 Months in Burkina Faso

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Abstract *Childhood immunization remains one of the most effective public health interventions to prevent vaccine-preventable diseases. In Burkina Faso, incomplete immunization schedules remain a challenge amid insecurity, population displacement, and health system disruptions. This study aimed to identify factors associated with incomplete immunization and the vaccination dropout rate in children aged 12 to 36 months. A secondary analysis of the 2021 Burkina Faso Demographic and Health Survey (2021-DHS-BF) data was performed. Incomplete immunization was defined as a child not receiving all recommended routine vaccine doses by 15 months of age. Factors associated with incomplete immunization were identified using modified Poisson regression with generalized estimating equations; adjusted prevalence ratios (aPR) with 95% confidence intervals were reported at a 5% significance threshold. Among the 2,375 children who met the eligibility criteria in the 2021-DHS-BF dataset, 1,482 (66.0%) had not completed their immunization schedule. The dropout rate between the first and third doses of the pentavalent vaccine was 11.0%. Maternal occupation (Saler: aPR = 0.89, 95% CI: 0.80–0.98 and farmer/self-employed: aPR = 0.93; 0.85, 95% CI: 0.78–0.94) and being treated with respect "sometimes" at health facilities (aPR = 1.14, 95% CI: 1.02–1.27) were associated with an incomplete immunization schedule. Strengthening person-centered care, improving post-first-dose follow-up, and expanding community-based outreach strategies could improve immunization schedule completion.*

Keywords *Burkina Faso, Children, Factors Associated, Immunization, Vaccine.*

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Introduction

Immunization of children starting at birth is universally recognized as one of the most effective and cost-effective public health strategies for reducing morbidity and mortality from vaccine-preventable diseases [1]. The World Health Organization (WHO) estimates that vaccination prevents 2 to 3 million deaths annually, a figure that could increase by an additional 1.5 million with improved global coverage. However, achieving this collective effectiveness relies on maintaining high and equitable vaccination coverage across populations [2]. Despite global progress in childhood immunization, major challenges persist. In 2021, nearly 25 million children were under-immunized. Furthermore, the number of "zero-dose children"–defined as those who have not received any doses of the pentavalent vaccine, serving as a key indicator of poor of access to health services–increased from 13.6 million in 2019 to 18.2 million in 2021 [3].

In West Africa in 2015, 24,551 children were incompletely vaccinated in six countries, including 55.2% in Mali, 69.8% in Liberia, 26.2% in Ghana, 21.6% in Burkina Faso, 48.9% in Côte d'Ivoire, and 63.1% in Guinea [4].

In Burkina Faso, the Ministry of Health has made efforts that have led to major public health achievements, such as eliminating maternal and neonatal tetanus and eradicating wild poliovirus. Consequently, the percentage of fully vaccinated children in their first year of life reached 96.20% according to the 2020 vaccination coverage survey report [5]. Service delivery is supported by routine immunization in both public and private health facilities, where vaccines and healthcare supplies are provided free of charge [6].

However, vaccine-preventable diseases remain a complex challenge. The continued deterioration of the security situation since 2016 has led to mass population displacement, leaving many individuals without reliable access to immunization services and creating a pool of children who have not completed their vaccination schedule. In addition, despite free access to vaccines, disparities persist: certain populations live far from health facilities, while others are disproportionately affected by insecurity. Missed opportunities for vaccination remain high [6] with various barriers, including insecurity, poverty, population displacement, and poor service quality, hindering adherence to the immunization schedule [7]. Beyond initial access to immunization, schedule completeness is a critical indicator of immunization program performance. Because receiving initial doses does not guarantee the completion of the recommended immunization schedule, dropouts between scheduled visits weaken individual child protection and compromise the herd immunity necessary for the sustainable control of vaccine-preventable diseases [8].

Burkina Faso's National Immunization Strategy 2022-2026 aims to achieve at least 95% coverage for all routine antigens nationally and to reduce the number of zero-dose children by 50% by 2026 [9]. To achieve these ambitious goals and mitigate emerging threats from vaccine-preventable infectious diseases, understanding the specific factors underlying non-adherence to immunization is imperative.

This study aimed to identify the factors associated with incomplete immunization among children aged 12 to 36 months and evaluate vaccination dropout rates in Burkina Faso using data from the 2021 Demographic and Health Survey (2021 DHS-BF).

Methods

Design Study and Period

This was a secondary analysis of nationally representative data from the 2021 Burkina Faso Demographic and Health Survey [10]. Data were collected between July and November 2021 [11].

Study Site

In 2021, Burkina Faso had an estimated population of 21,510,181, with a slight female (51.79%) and predominantly young demographic, of whom 45.29% were under 15 years of age [12]. The annual population growth rate was 2.9% in 2019. The population remains largely rural (73.7% in 2019) with low literacy levels, as only 23% of women and 38% of men considered literate. The total fertility rate declined from 6.2 children per woman in 2003 to 5.4 in 2019 [12].

The health system is organized according to a three-tiered pyramidal structure. Healthcare services are structured across three levels: the first level comprises Health and Social Promotion Centers, Medical Centers and Medical Centers with Surgical facilities; the second level consists of Regional Hospital Centers and Regional University Teaching Hospitals; and the third level includes National University Teaching Hospitals. In addition to the public sector, the country has an extensive network of private healthcare facilities, pharmacies, drug dispensaries, as well as a community-based health network operated by Community-Based Health Workers (CBHWs), at a rate of two agents per village. Immunization is central to national health policy due to its crucial role in reducing infant and child morbidity and mortality [13]. In 2020, zero-dose cases accounted for 3.5% of children aged 0-11 months [7].

Study Population

The target population for this study comprised all children aged 12 to 36 months residing in Burkina Faso at the time of the 2021 DHS-BF survey.

Inclusion and Exclusion Criteria

Children alive and aged 12 to 36 months at the time of the 2021 DHS-BF survey were included in the study. Children with incomplete or missing key information regarding vaccination status or study variables was excluded.

Variables

Dependent Variable

The dependent variable was incomplete immunization schedule among children aged 12 to 36. A child was classified as having an incomplete immunization schedule (coded 1) if he or she has not received all the recommended routine vaccines doses by the age of 15 months. Conversely, a child who received all required doses by 15 months of age was classified as having a complete immunization schedule (coded 0).

Independent Variables

Independent variables were selected based on sociodemographic, contextual and individual determinants of immunization schedule completeness (Table 1).

Table 1. Independent Variables

Variables	Categories
Mother/Caregiver	
Age in years	<20, 20–29, 30–39, ≥40
Marital status	Single/Divorced/Widowed, Married/Cohabiting
Level of education	No Education, Primary, Secondary, Tertiary
Occupation	Unemployed, Professional/Technical/Manager, Sales, Farmer/Self-employed, Manual worker
Wealth Index	Poorest, Poorer, Middle, Richer, Richest
Distance a big problem	No, yes
Treated with respect at facility	All the time, sometimes, no at all

Place of residence	Rural, Urban
Region of residence	Boucle du Mouhoun
	Cascades
	Centre
	Centre Est
	Centre Nord
	Centre Ouest
	Centre Sud
	Est
	Hauts-bassins
	Nord
	Plateau central
	Sahel
	Sud-Ouest
Husband/Partner	
Gender of household head	Men, Women
Husband/Partner's education level	No education, Primary, Secondary, Tertiary
Husband/Partner occupation	Unemployed, Professional/Technical/Manager, Saler, Farmer/Self-employed, Manual worker
Child	
Age in months	12-23 months, 24-36 months
Gender	Male, Female
Twin	No, yes

Data Source

The data were from the 2021 Burkina Faso Demographic and Health Survey (Phase VI of the DHS program). Information was primarily extracted from the Individual Questionnaire for Women [14].

Sampling

The 2021 DHS-BF used a two-stage stratified cluster sampling design to ensure representative results at the national, regional, and urban/rural levels. The sampling was conducted across consecutive stages [11].

The first step involved stratifying the population to ensure adequate representation across the country's different subpopulations. Stratification was based on Burkina Faso's 13 administrative regions and place of residence, distinguishing between urban and rural areas. This stratification improved estimate precision and ensured reliable comparisons across regions and places of residence.

In the first stage, enumeration areas (EAs) were selected within each defined stratum. EAs are geographical units delineated during the 2019 General Population and Housing Census [15], each consisting of a defined number of households.

EAs were selected using systematic sampling with probability proportional to size, where size was defined as the number of households enumerated in each EA during the census. This sampling strategy ensured that more populated areas had a higher probability of selection, while maintaining overall randomness. At the end of this stage, a final list of selected EAs was generated for each stratum.

In the second stage, ordinary households were selected within each sampled EA. Prior to selection, a complete household listing was conducted in each selected EA to update the sampling frame. A fixed number of households was then selected from this updated list using equal probability systematic sampling.

All households within the same cluster had an equal probability of selection, thereby minimizing selection bias.

In each sampled household, the survey included all individuals meeting the eligibility criteria defined by standard DHS protocols. These included all women aged 15 to 49 who were usual resident in the household, as well as children under 5 years of age (for whom data were collected via maternal reports). Additionally, all men aged 15 to 59 were interviewed in a designated subsample of households.

Finally, sampling weights were applied to the data to adjust for unequal selection probabilities across households and individuals, complex survey stratification and clustering, and potential non-response.

Applying these weights ensured that the resulting estimates were nationally, regionally, and environmentally (urban/rural) representative.

Sample Size

A total of 2,375 children aged 12-36 months were extracted from the 2021 DHS-BF survey dataset and included in the analysis.

Statistical Analyses

Statistical analyses were performed using Stata version 15.0 (StataCorp, College Station, TX, USA). We first described the sociodemographic characteristics of the children and their parents/caregivers, as well as the clinical characteristics of children who had information on their immunization status, along with specific vaccines received by the children. Pearson's chi-square test was used to compare the proportion of reported health events (fever, cough, diarrhea and anemia) during the two weeks preceding the survey between children with complete and incomplete immunization schedules. All descriptive analyses incorporated sampling weighted, stratification, and clustering to account for the complex survey design, in accordance with DHS program guidelines [11]. To identify independent factors associated with incomplete immunization schedule in children aged 12 to 36 months, we used a modified Poisson regression model with generalized estimating equations (GEE) with a robust variance estimator in an adjusted model. Variables associated with incomplete immunization schedule at p-value <0.20 in the unadjusted model were included in the adjusted model. Adjusted prevalence ratios (aPR) and their corresponding 95% confidence intervals (CI) were estimated. Statistical significance was set at a two-sided p-value < 0.05.

Ethical Considerations

The 2021 DHS-BF protocol received ethical approval from the Health Research Ethics Committee (CERS) of Burkina Faso. All participants provided informed consent prior to data collection. For minors, informed consent was obtained from parents or legal guardians, alongside participant assent where applicable. The dataset used in this study was anonymized and publicly available with formal authorization from the DHS Program [11].

Results

The 2021 DHS-BF dataset involved 5,907 children with recoded age data. Among these, 2,375 were aged 12 to 36 months and met the inclusion criteria for this study. Within this target population, 66% had an incomplete immunization schedule (Figure 1).

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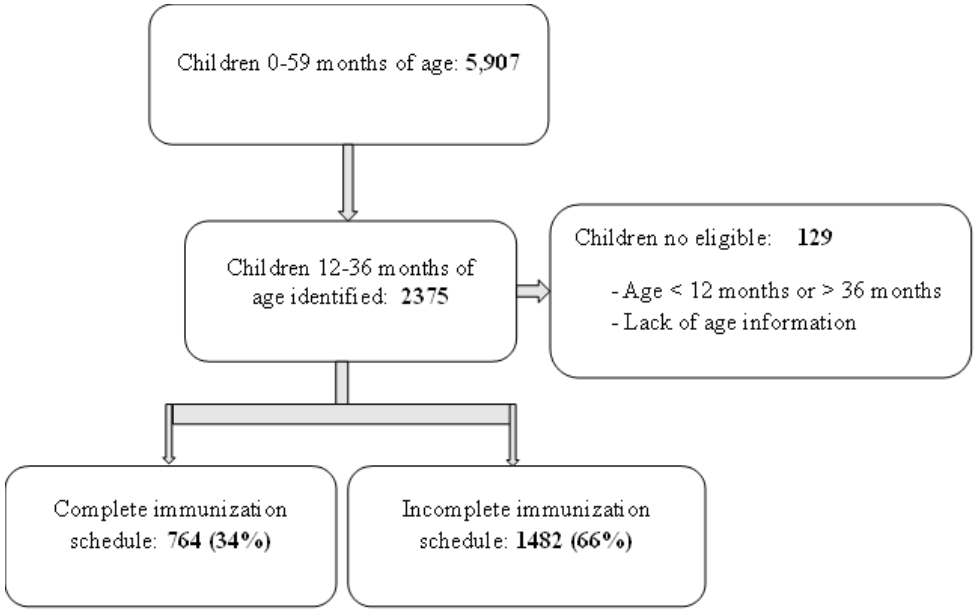


Figure 1. Flow Diagram for the Selection of the Study Population

The majority of mothers/caregivers were aged 20 and 29, and more than 95% were married or cohabiting. More than two-thirds had no formal education and resided in rural areas. The distribution of maternal/caregiver occupations was comparable between children with incomplete and complete immunization schedules, with unemployed mothers/caregivers accounting for 36% and farmer/self-employed accounting for 45% of participants. More than 85% of mothers/caregivers reported being treated with respect at health facilities. Among partners, over 68% had no formal education and were predominantly farmer/self-employed. The mean age of children was similar between those with incomplete (1.49 years; SD = 0.5) and complete immunization schedules (1.43 years; SD = 0.5) (Table 2).

Table 2. Sociodemographic Characteristics of Children Aged 12 to 36 Months and their Parents in Burkina Faso in 2021

Characteristics	**Incomplete Immunization Schedule**	**Complete Immunization Schedule**	**Total**
Mother	**n (%)**	**n (%)**	
Age in years (meaning, SD)	28.95 (6.95)	28.72 (6.78)	
<20	91 (6.44)	49 (6.86)	140
20–29	727 (48.87)	377 (51.02)	1104
30–39	536 (36.35)	281 (35.17)	817
≥40	128 (8.34)	57 (6.95)	185
Marital status			
Single/divorced/widowed	72 (4.34)	26 (2.95)	98
Married/cohabiting	1410 (95.66)	738 (97.05)	2148
Education			
No education	1017 (68.76)	528 (69.44)	1545
Primary	198 (13.31)	95 (12.34)	293
Secondary	253 (16.58)	130 (16.04)	383

Higher	14 (1.36)	11 (2.18)	25
Place of residence			
Rural	1037 (73.50)	577 (79.08)	1614
Urban	445 (26.50)	187 (20.92)	632
Region of residence			
Boucle du Mouhoun	85 (6.33)	89 (14.87)	174
Cascades	57 (2.31)	55 (4.04)	112
Centre	146 (15.60)	58 (12.63)	204
Centre Est	138 (10.25)	89 (13.42)	227
Centre Nord	110 (10.03)	43 (8.15)	153
Centre Ouest	132 (11.02)	61 (9.03)	193
Centre Sud	113 (5.14)	28 (2.61)	141
Est	98 (8.75)	53 (9.01)	151
Hauts-Bassins	184 (11.81)	41 (4.89)	225
Nord	115 (5.88)	74 (7.19)	189
Plateau central	110 (5.31)	95 (9.44)	205
Sahel	83 (3.91)	11 (1.10)	94
South-Ouest	111 (3.66)	67 (3.62)	178
Occupation			
Unemployed	524 (36.24)	194 (27.74)	718
Professional/Technical/Managerial	55 (3.77)	26 (3.61)	81
Sales	295 (18.78)	151 (18.27)	446
Farmer/self-employed	512 (33.95)	349 (45.27)	861
Manual Laborer	94 (7.26)	41 (5.10)	135
Wealth Index			
The poorest	299 (22.07)	148 (21.40)	447
Poorer	291 (20.98)	154 (19.97)	445
Midfield	320 (19.85)	199 (25.36)	519
Richer	320 (19.29)	157 (18.53)	477
The richest	352 (17.80)	106 (14.74)	458
Distance is a big problem			
No	901 (58.92)	455 (60.67)	1356
Yes	541 (41.08)	309 (39.33)	850
Treated with respect at facility			
All the time	1069 (85.24)	617 (88.51)	1686
Sometimes	116 (9.98)	49 (7.79)	165
No at all	62 (4.78)	27 (3.70)	89
Husband/Partner			
Head of household Sex			
Male	1319 (88.64)	693 (90.56)	2012
Female	163 (11.36)	71 (9.44)	234
Education			
No education	1017 (68.76)	528(69.44)	1545
Primary	198 (13.31)	95 (12.34)	293

Secondary	253 (16.58)	130 (16.04)	383
Higher	14 (1.36)	11 (2.18)	25
Profession			
Unemployed	166 (13.05)	45 (7.42)	211
Professional/Technical/Managerial	102 (7.64)	63 (9.93)	165
Saler	194 (14.21)	105 (14.20)	299
Farmer/self-employed	597 (41.81)	359 (48.61)	956
Manual laborer	319 (23.29)	157 (19.83)	476
Children			
Age in months (sort of, SD)	1.49 (0.50)	1.43 (0.50)	
12–23	965 (49.59)	223 (46.31)	1188
24–36	942 (50.41)	245 (53.69)	1187
Gender			
Male	771 (50.76)	384 (52.12)	1155
Female	711 (49.24)	380 (47.88)	1091
Twins			
No	1437 (97.30)	729 (95.17)	2166
Yes	45 (2.70)	35 (4.83)	80

Across the 19 routine vaccine doses scheduled between 0 and 23 months, coverage patterns among children aged 12 to 36 months varied substantially. Over 90% of children received five vaccines (BCG, OPV0, OPV1, Pentavalent 1 and 2), over 80% received ten vaccines and fewer than 80% received four vaccines (IPV, Rotavirus 3, Measles 2 and Meningitis) (Table 3).

Table 3. Vaccination Coverage Among Children Aged 12 to 36 Months in Burkina Faso in 2021

Vaccines	**n (%)**
BCG (Bacillus Calmette–Guérin)	
No	70 (3.14)
Yes	2159 (96.86)
Oral polio vaccine (OPV) 0	
No	138 (6.20)
Yes	2090 (93.8)
OPV 1	
No	152 (6.81)
Yes	2076 (93.19)
OPV 2	
No	224 (10.06)
Yes	2004 (89.94)
OPV 3	
No	445 (19.99)
Yes	1782 (80.01)
Inactivated Poliovirus Vaccine (IPV)	
No	946 (42.91)
Yes	1258 (57.09)

Pentavalent 1	
No	120 (5.39)
Yes	2103 (94.61)
Pentavalent 2	
No	167 (7.52)
Yes	2055 (92.48)
Pentavalent 3	
No	230 (10.36)
Yes	1992 (89.64)
Pneumococcal 1	
No	269 (12.10)
Yes	1954 (87.90)
Pneumococcal 2	
No	326 (14.66)
Yes	1897 (85.34)
Pneumococcal 3	
No	324 (16.87)
Yes	1598 (83.13)
Rotavirus 1	
No	310 (13.99)
Yes	1909 (86.01)
Rotavirus 2	
No	369 (16.61)
Yes	1851 (83.39)
Rotavirus 3	
No	468 (21.09)
Yes	1752 (78.91)
Measles 1	
No	286 (12.91)
Yes	1929 (87.09)
Measles 2	
No	716 (37.33)
Yes	1201 (62.67)
Meningitis	
No	719 (37.67)
Yes	1191 (62.33)
Yellow fever	
No	396 (17.91)
Yes	1815 (82.09)

Among children aged 12 to 36 months, the prevalence of health conditions reported in the two weeks preceding the survey was similar regardless of the immunization completion status. Fever was reported in 28.80% of children with an incomplete immunization schedule compared to 29.73% of those with a complete immunization schedule. Similarly, comparable distributions were observed between the two groups for cough (12.87% vs.

11.73%), diarrhea (21.89% vs. 21.22%) and moderate anemia (49.76% vs. 51.92%) (Table 4).

Table 4. Prevalence of Reported Childhood Health Conditions During the Two Weeks Preceding the Survey, by Immunization Status in Burkina Faso in 2021

Health Conditions	Incomplete Immunization Schedule	Complete Immunization Schedule	P-Value
Fever in the last two weeks prior to the survey			0.68
No	1063 (71.20)	538 (70.27)	
Yes	417 (28.80)	225 (29.73)	
Cough these last two weeks before the investigation			0.51
No	1298 (87.13)	672 (88.27)	
Yes	182 (12.87)	92 (11.73)	
Diarrhea in the last two weeks prior to the survey			0.74
No	1165 (78.11)	610 (78.78)	
Yes	315 (21.89)	154 (21.22)	
Anemia			0.60
Severe	51 (3.60)	21 (2.57)	
Moderate	706 (49.76)	388 (51.92)	
Mild	389 (26.32)	202 (25.58)	
No anemia	305 (20.33)	145 (19.93)	

After adjusting for potential confounders, maternal occupation/caregiver (Saler: aPR = 0.89, 95% CI: 0.80–0.98 and farmer/self-employed: aPR = 0.93; 0.85, 95% CI: 0.78–0.94) and reporting treatment sometimes with respect at health facilities (aPR = 1.14, 95% CI: 1.02–1.27) remained significantly associated with incomplete immunization schedules in children aged 12 to 36 months (Table 5).

Table 5. Factors Associated with Incomplete Immunization Schedule Among Children Aged 12 to 36 Months in Burkina Faso: Evidence from the 2021 Demographic and Health Survey.

Factors	Unadjusted			Adjusted		
	PR*	95% CI	p-value	PR	95% CI	p-value
Mothers						
Age in years			0.54			
<20	1					
20 - 29	1.01	[0.90 – 1.13]				
30 - 39	1.01	[0.90 – 1.13]				
≥40	1.08	[0.94 – 1.23]				
Marital status			0.09			
Single/divorced/widowed	1					
Married/living with partner	0.90	[0.79 – 1.01]				
Education			0.95			
No education	1					
Primary	1.00	[0.91 – 1.10]				
Secondary	0.98	0.90 – 1.07]				

Higher	0.92	[0.66 – 1.29]				
Place of residence			0.05			0.18
Rural	1			1		
Urban	0.92	[0.85 – 1.00]		0.93	[0.85 – 1.03]	
Occupation			<0.001			0.01
unemployed	1			1		
Professional/Technical/Managerial	0.93	[0.80 – 1.09]		0.91	[0.75 – 1.10]	
Saler	0.90	[0.83 – 0.98]		0.89	[0.80 – 0.98]	
Farmer/self-employed	0.84	[0.77 – 0.90]		0.85	[0.78 – 0.94]	
Manual Laborer	0.91	[0.79 – 1.04]		0.92	[0.79 – 1.07]	
Wealth Index			0.74			
The poorest	1					
Poorer	0.98	[0.90 – 1.08]				
Midfield	0.95	[0.86 – 1.05]				
Richer	0.99	[0.90 – 1.09]				
The richest	1.02	[0.62 – 0.72]				
Distance is a big problem			0.63			
No	1					
Yes	1.01	[0.94 – 1.09]				
Treated with respect at facility			0.02			0.04
All the time	1			1		
Sometimes	1.14	[1.03 – 1.27]		1.14	[1.02 – 1.27]	
No at all	1.09	[0.94 – 1.25]		1.07	[0.93 – 1.25]	
Husband/Partner						
Head of household Sex			0.51			
Male	1					
Female	1.03	[0.93 – 1.14]				
Education			0.95			
No education	1					
Primary	1.00	[0.91 – 1.10]				
Secondary	0.98	[0.90 – 1.07]				
Higher	0.92	[0.66 – 1.29]				
Occupation			<0.01			0.08
unemployed	1			1		
Professional/Technical/Managerial	0.83	[0.72 – 0.95]		0.88	[0.75 – 1.03]	
Saler	0.83	[0.74 – 0.93]		0.85	[0.74 – 0.97]	
Farmer/self-employed	0.84	[0.77 – 0.93]		0.94	[0.83 – 1.05]	
Manual laborer	0.88	[0.80 – 0.97]		0.94	[0.83 – 1.06]	
Age in months			0.01			0.05
12–23	1			1		
24–36	1.09	[1.01 – 1.14]		1.07	[0.99 – 1.15]	
Gender			0.72			
Male	1					
Female	0.98	[0.93 – 1.04]				

Fever in the last two weeks prior to the survey			0.44			
No	1					
Yes	0.97	[0.91 – 1.04]				
cough these last two weeks before the investigation			0.80			
No	1					
Yes	1.01	[0.92 – 1.10]				
Diarrhea in the last two weeks prior to the survey			0.71			
No	1					
Yes	1.01	[0.94 – 1.08]				
Anemia			0.46			
No anemia	1					
Severe	1.04	[0.88 – 1.22]				
Moderate	0.96	[0.89 – 1.04]				
Mild	1.01	[0.93 – 1.09]				

**PR: prevalence Ratio*

Vaccine Dropout Rate

Using the pentavalent vaccine as a proxy for program retention, 11.02% of children aged 12 to 36 months dropped out between the first and third doses (Pentavalent 1 to 3). The overall dropout rate across the complete immunization schedule was 5.19% (Figure 2).

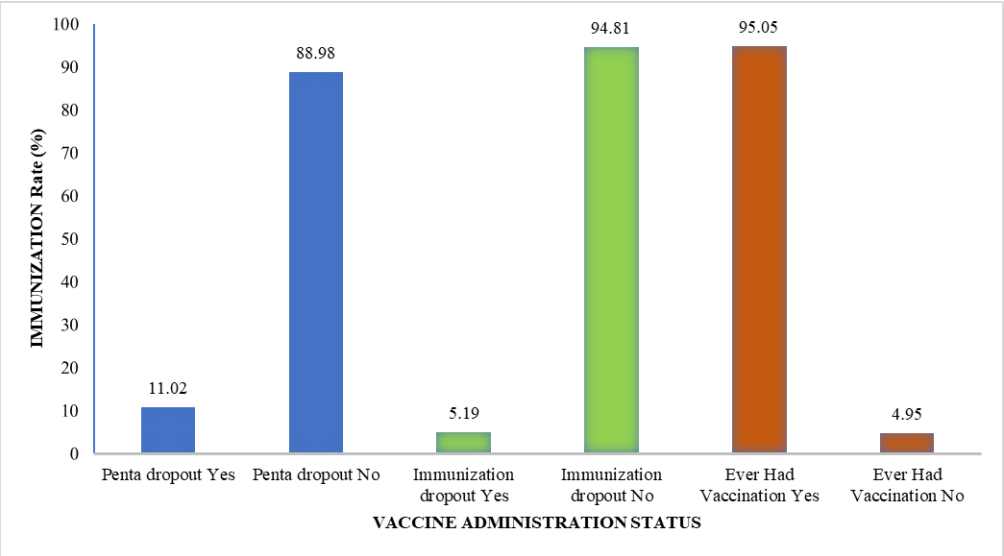


Figure 2. Pentavalent and overall Vaccination Dropout Rates Children Aged 12 to 36 Months in Burkina Faso in 2021

Discussion

Our study highlights that immunization completeness remains insufficient among Burkinabè children aged 12 to 36 months, driven by dropouts after the second doses of the measles-rubella, meningitis, and inactivated poliomyelitis vaccines. Key factors independently associated with an incomplete immunization schedule included maternal occupation (salaried and farmers/self-employed) and inconsistent (sometimes) respectful treatment at the facility.

This study highlights a high prevalence of incomplete immunization schedules among children aged 12 to 36 months in Burkina Faso. The prevalence of incomplete immunization schedules in our study is higher than rates

reported in several sub-Saharan African countries, such as Ghana and Nigeria, where incomplete immunization estimates generally range between 25% and 50% [17, 18]. This difference could be explained by the specific context in Burkina Faso, which has been marked by persistent insecurity challenges, internal population displacements, disruptions in healthcare delivery, and the lingering effect of the COVID-19 pandemic—all of which hinder adherence to the immunization schedule and compromise healthcare continuity [16].

Our results show that vaccination coverage remains high for the initial doses administered during the first year of life, reflecting strong initial adherence to EPI services. However, this performance gradually wanes as children age, with a marked decline in coverage for vaccines scheduled during the second year of life, particularly the second dose of measles-rubella vaccine and meningitis [17]. This gap poses a major challenge for the Expanded Programmed on Immunization (EPI), as it reflects a breakdown in service continuity despite high coverage for vaccines administered in early infancy. This progressive drop suggests that the main challenge for the EPI in Burkina Faso has shifted from initial access to ensuring service continuity and retaining children in the health system through completion of the schedule. Strengthening community health worker networks for active tracking and home-based follow-up could offer an effective strategy to reduce incomplete immunization schedules. A similar progressive decline in immunization completeness has also been reported in several countries in sub-Saharan Africa, where they decrease with the number of visits [18, 19].

This study also highlights a substantial dropout rate between the first and third doses of the pentavalent vaccine, alongside a notable dropout rate across the complete immunization schedule. These results indicate that, despite generally satisfactory performance by the EPI, a significant proportion of children discontinue their vaccination series before receiving all recommended doses [19]. The observed dropouts predominantly affect vaccines scheduled late in the immunization timeline, confirming that service continuity remains a major challenge to overcome and achieve full protection for children [20]. To address this challenge, expanding outreach and mobile strategy in hard-to-reach areas, alongside routine catch-up campaigns for children who have missed one or more doses, is essential. These programmatic needs align with findings from similar settings across West Africa [19, 21, 22].

Two factors were independently associated with incomplete immunization schedules. The first was the inconsistent (sometimes) respectful treatment at health facilities. Mothers who reported being treated with respect only occasionally (sometimes) at health facilities were at significantly higher risk of having children with incomplete immunization schedules. This was also reported by Esako et al. in Morrocco [22]. These findings underscore that immunization retention relies heavily on positive interpersonal interactions between caregivers and healthcare providers [23]. This aligns with evidence from Togo and Nigeria, where supportive health worker attitudes, respectful engagement, and reduced waiting times were key determinants of sustained caregiver adherence to vaccination schedules [18, 24].

Additionally, children whose mothers/caregivers were Salers or farmers/self-employed had a significantly lower risk of incomplete immunization schedules compared with those whose mothers/caregivers were unemployed. This association may be explained by the greater financial autonomy of working mothers, which enables them to better absorb indirect immunization costs, such as transportation expenses and opportunity costs from clinic waiting times. Furthermore, women engaged in in commercial or agricultural activities frequently participate in community networks or occupational groups, which serve

as crucial conduits for health information. These results align with those of several studies conducted in sub-Saharan Africa. A meta-analysis by Bangura et al. demonstrated that low household socio-economic status is associated with lower uptake of routine pediatric immunization services [24]. Similarly, Sambala et al. highlighted women's economic empowerment as a key driver of completion of the childhood immunization schedule [25].

This study has several limitations to consider when interpreting the findings. First, because the 2021 DHS-BF is cross-sectional, causal inferences cannot be established. Second, immunization status was determined in part through maternal recall when vaccination cards were unavailable, introducing potential recall bias. Finally, several key structural and behavioral determinants—such as health facility stockouts of vaccines and related consumables, local staffing levels, geopolitical insecurity, and parental vaccine hesitancy—are not captured in DHS datasets and could not be controlled for in our models [10]. Despite these limitations, this study has notable strengths. It utilizes a nationally representative sample and applies appropriate analytical methods that account for the complex DHS sampling design and clustering, thereby enhancing the precision and external validity of our findings.

Conclusion

This study reveals a high prevalence of incomplete immunization among children aged 12–36 months in Burkina Faso. Although initial coverage was high for vaccines administered early in infancy, marked coverage drops and high dropout rates were observed for subsequent doses scheduled in the second year of life. Incomplete immunization was associated with maternal/caregiver occupation (Salers and farmers/self-employed) and the perceived quality of interpersonal interactions at health facilities, specifically inconsistent (sometimes) respectful treatment. Strengthening child tracking systems following immunization initiation, fostering respectful, person-centered care, and institutionalizing targeted catch-up strategies for children who miss scheduled may contribute to improving immunization completion.

Conflict of Interest

The authors declare no competing interests.

Data Availability

The dataset analyzed in this study is publicly available upon request from the Demographic and Health Surveys (DHS) Program repository (https://dhsprogram.com).

Author Contributions

L.C.B. conceptualized the study. J.D.B. accessed and extracted the datasets from the DHS program website and analyzed the data.

L.C.B. and J.D.B. wrote the initial manuscript with contributions from M.D.

The I.T.T. supervised the work. All co-authors reviewed and consent to publication.

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Community Health Worker Integration into Formal Health Systems in Rural Sub-Saharan Africa: Models, Facilitators, Barriers, and Training Needs from a Systematic Review

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Abstract *Sub-Saharan Africa (SSA) faces persistent shortages of skilled health workers, weak rural health infrastructure, limited access to care, and fragmented Community Health Worker (CHW) programmes. The contribution of CHWs to primary health care (PHC) depends less on their presence in communities than on the extent to which they are integrated into formal health systems. The aim is to synthesise evidence on the integration models, facilitators, barriers, and capacity-building requirements that shape the integration of CHW programmes into formal health systems in rural SSA. A PRISMA 2020, guided the systematic review of secondary data. Seven databases (PubMed/MEDLINE, Scopus, Web of Science, EMBASE, CINAHL, African Index Medicus, AJOL) and grey literature from WHO, UNICEF, the World Bank, USAID, and Ministry of Health repositories were searched for English-language publications from January 2010 to December 2025. Of 444 records, 42 met the inclusion criteria. Quality was appraised using AMSTAR 2, and evidence was combined through thematic and framework synthesis mapped onto the WHO Health System Building Blocks. Three integration models were identified: government-led (strongest institutionalisation), NGO-led (partial, project-bound), and hybrid (most common). Integration was strongest in service delivery, governance, and workforce support, and weakest in financing, health information systems, and supply chains. The leading facilitators were political commitment and policy recognition, supportive supervision, and sustainable financing; the critical barriers were governance fragmentation, supply chain stock-outs, and weak supervision. Ten competency domains were required for integration, six of them essential: clinical service delivery, referral management, health information systems, supply chain management, community engagement, and supportive supervision. Consistent with WHO guidance, integration is a health system strengthening process rather than a workforce intervention. Rural SSA programmes are institutionalised operationally but remain structurally unsupported, and training alone did not sustain performance where governance, financing, supervision, information, and supply systems were weak. The review introduces the CHW Integration Capability Framework, a three-tier model linking foundational competencies, system interface capabilities, and sustained performance. Sustainable integration requires simultaneous investment across all six building blocks, prioritising domestic financing, harmonised information systems, and public supply chains, together with explicit transition pathways from partner-dependent to nationally owned CHW programmes.*

Keywords *Community Health Workers, Health System Building Blocks, Integration, Primary Health Care, Sub-Saharan Africa.*

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Introduction

Sub-Saharan Africa (SSA) continues to face persistent shortages of skilled health workers, inadequate infrastructure, geographic barriers to access, and a high burden of communicable and non-communicable disease. WHO projects a substantial health workforce deficit in the African Region by 2030, threatening progress towards Universal Health Coverage (UHC) and the Sustainable Development Goals [1, 2]. These constraints are most acute in rural and underserved communities, where Community Health Workers (CHWs) have become a critical, cost-effective component of primary health care (PHC), extending services to populations beyond the reach of formal facilities [3, 4].

CHWs are trained, community-based workers who deliver promotive, preventive, referral, and selected curative services while linking communities to formal health systems. Across SSA, they have contributed to improvements in maternal and child health, immunisation coverage, infectious disease control, treatment adherence, and community surveillance [4, 5]. Ethiopia, Rwanda, and Malawi report improved PHC access through institutionalised CHW programmes embedded within national health systems [7-9], and CHWs were central to community-level responses during the COVID-19 pandemic [1, 10].

However, the effectiveness and sustainability of CHW programmes depend not on the presence of CHWs in communities, but on the extent to which they are integrated into formal health systems. Integration refers to the degree to which CHW programmes are embedded within routine health system functions: leadership and governance, financing, workforce management, service delivery, health information systems, and access to medicines and technologies [3, 11, 12]. CHWs achieve the greatest impact where governance is coherent, financing is predictable, supervision is reliable, referral pathways function, information systems are integrated, and supply chains are dependable [1, 13, 14]. Conversely, fragmented implementation, donor-dependent financing, parallel reporting systems, weak supervision, and recurrent stock-outs continue to undermine programme performance [15-17].

Capacity-building needs are therefore best understood not as isolated training topics but as a structured set of integration capabilities [4, 5, 18]. Many integration failures occur at the interface between CHWs and the formal health system, where workers hold basic clinical competencies but lack the supervisory structures, referral linkages, and institutional recognition required to engage effectively with health system functions [3, 5, 11, 18].

Models of CHW Integration in Sub-Saharan Africa

CHW programmes in SSA have evolved through three dominant integration models: government-led (institutionally embedded within the national health system and regulated by the Ministry of Health, as in Ethiopia and Malawi), NGO-led (initiated, financed, and managed by non-governmental or development partners), and hybrid models that combine state stewardship with partner-supported implementation (as in Kenya, Uganda, and Sierra Leone) [3-5]. Deeper integration across governance, financing, human resources, supply chains, information systems, and service delivery is consistently associated with greater sustainability, better quality of care, and stronger contributions to UHC [3, 15].

The WHO Health System Building Blocks Framework

This review is anchored on the WHO Health System Building Blocks Framework, which comprises service delivery, health workforce, health information systems, access to essential medicines and technologies, health financing, and leadership and governance. The framework

holds that health outcomes depend not only on how well each block performs, but on how coherently the blocks function together, and it therefore allows the strengths and weaknesses of CHW integration to be analysed systematically [1, 12]. The framework is summarised in Figure 1.

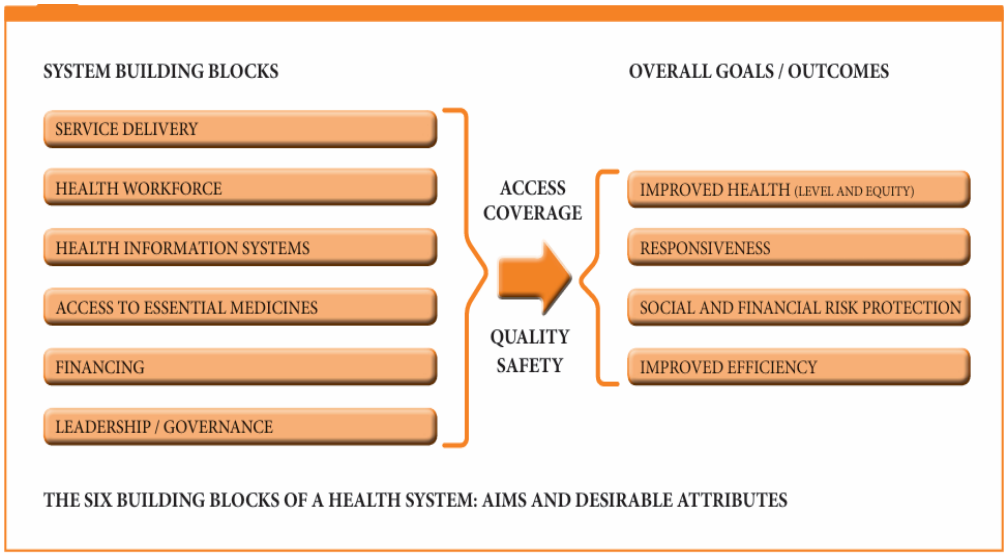


Figure 1. The WHO, Health Systems Framework

Source: *[12]*

Applied to CHWs, the framework shows that integration is typically strongest in service delivery and community outreach, while substantial weaknesses persist in financing, governance, supply chains, and information systems, particularly in rural settings where health systems are already fragile [1, 19].

Research Gap, Study Novelty, and Contribution

Previous reviews have examined CHW performance, supervision, motivation, and disease-specific outcomes [5, 18, 20], and a recent scoping review has mapped CHW programme components to the health system building blocks [19]. The evidence nevertheless remains fragmented: no synthesis has simultaneously examined the facilitators, barriers, integration models, and training requirements for CHW integration across all six WHO Health System Building Blocks in rural SSA or explained why competency-based training frequently fails to translate into sustained performance. This review addresses this gap.

The review makes three contributions. First, it synthesises facilitators, barriers, and training needs for CHW integration across all six building blocks in rural SSA, and prioritises them by frequency, consistency, and reported impact. Second, it compares government-led, NGO-led, and hybrid models and identifies common and context-specific determinants of integration. Third, it introduces the CHW Integration Capability Framework, a novel three-tier model linking foundational competencies, system interface capabilities, and sustained performance, offering a practical tool for workforce development, programme design, and policy planning.

Aim of the Study

This study systematically reviews and synthesises evidence on the facilitators, barriers, integration models, and capacity-building requirements influencing the integration of Community Health Worker programmes into formal health systems in rural Sub-Saharan Africa.

Research Questions

1. What facilitators and barriers influence the integration of CHW programmes into formal health systems in rural Sub-Saharan Africa?
2. What models have been used to integrate Community Health Worker programmes into formal health systems in rural Sub-Saharan African settings?
3. What training and capacity-building requirements are necessary for effective CHW integration?

Materials and Methods

Study Design

This study employed a systematic review design using secondary data to synthesise evidence on the facilitators, barriers, integration models, and capacity-building requirements influencing the integration of Community Health Worker (CHW) programmes into formal health systems in rural Sub-Saharan Africa. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses [21] guidelines to ensure transparency, reproducibility, and rigorous reporting of the review process.

Review Framework and Analytical Domains

The review question was structured using the Population, Intervention, Comparison, Outcome (PICO) framework: Population - CHWs and equivalent community-based cadres in rural SSA; Intervention - integration of CHW programmes into formal health systems; Comparison - integration models (government-led, NGO-led, hybrid) and country contexts; Outcomes - facilitators, barriers, integration maturity, and training requirements. Evidence synthesis was guided by the WHO Health System Building Blocks Framework (leadership and governance, financing, health workforce, service delivery, health information systems, and medical products and technologies) [12, 25]. These blocks were adopted as the analytical domains for three reasons. First, they are the internationally accepted architecture for health system analysis and are used in WHO CHW guidance, which makes the findings directly comparable with global policy recommendations [3, 12]. Second, the recurrent determinants reported in the CHW literature - governance and policy recognition, financing and remuneration, supervision and workforce management, digital and information systems, supplies, and referral or service delivery - map cleanly onto these six blocks rather than onto disease- or programme-specific categories [11, 19]. Third, using the blocks prevented the analysis from privileging any single model or country and allowed integration to be compared consistently across heterogeneous settings.

Search Strategy

A comprehensive search was conducted across seven electronic databases: PubMed/MEDLINE, Scopus, Web of Science, EMBASE, CINAHL, African Index Medicus, and African Journals Online (AJOL). Grey literature was sourced from WHO, UNICEF, World Bank, USAID, and national Ministry of Health repositories, and the reference lists of included studies were hand-searched. The search period covered publications from 1 January 2010 to 31 December 2025, and the final search was run in December 2025. Only English-language publications were retrieved. Search terms combined three concept blocks using Boolean operators, adapted to the controlled vocabulary of each database: (i) cadre - "community health worker*" OR "village health worker*" OR "health extension worker*" OR "health surveillance assistant*" OR "lay health worker*" OR "community health volunteer*"; (ii) focus - integrat* OR institutionalis* OR "health system*" OR governance OR financing OR supervision OR "supply chain" OR "information system*" OR referral OR training OR "capacity building" OR competenc* OR facilitator* OR barrier*; and

(iii) setting - "sub-Saharan Africa" OR Africa OR rural OR the names of individual SSA countries. The three blocks were combined with AND (for example, in PubMed: ("community health worker*"[tiab] AND (integrat*[tiab] OR "health system*"[tiab]) AND ("sub-Saharan Africa"[tiab] OR rural[tiab])).

Eligibility Criteria

Studies were eligible if they focused on CHWs or equivalent community-based cadres operating in rural or underserved SSA settings and reported evidence on integration, facilitators, barriers, training needs, or integration outcomes. Reviews, empirical evaluations, policy documents, and country case studies were all eligible. Studies were excluded if they were conducted outside SSA, addressed exclusively urban or facility-based cadres, or reported no health system or integration outcomes.

Quality Assessment

The AMSTAR 2 tool was applied to critically appraise the methodological quality of included systematic reviews. AMSTAR 2 examined 16 domains covering key features such as review questions and eligibility criteria, literature search comprehensiveness, study selection and data extraction, risk of bias assessment, synthesis methods, publication bias, conflicts of interest, and overall confidence in review findings. This structured quality assessment process enhanced the credibility of the synthesis and strengthened the validity of policy and programme implications [22, 25].

Data Synthesis and Analysis

Evidence synthesis employed a combination of thematic synthesis and framework synthesis. Thematic synthesis followed three stages: (1) line-by-line coding of extracted findings, (2) development of descriptive themes, and (3) generation of higher-order analytical themes. Framework synthesis mapped findings against the WHO Health System Building Blocks (service delivery, health workforce, health information systems, access to essential medicines and technologies, health financing, and leadership/governance) to enable systematic comparison across studies and countries. [12, 23, 24].

To enable comparison across heterogeneous studies, a structured rating system was developed to classify the relative importance of facilitators, barriers, and training needs. Each item was rated on three criteria: frequency of reporting across the included studies, consistency of findings across countries and programme models, and the reported strength of influence on integration outcomes. Frequency thresholds were applied consistently (facilitators and training: reported in 10 or more studies = high importance or essential; 5-9 studies = moderate importance or important; 4 or fewer = low importance. Barriers: 10 or more studies = critical; 4-9 = high; 1-3 = moderate). This allowed the findings to be prioritised rather than simply listed, and the ratings are reported in Tables 2, 5, 6, and 7.

Results

Included Studies and Characteristics

A total of 444 records were identified through database and grey literature searching. Forty duplicates were removed, and 362 records were excluded at title and abstract screening because they did not address CHW integration into health systems or CHW capacity and training needs. Forty-two (42) studies were retained for synthesis. Figure 2 presents the selection process, adapted from PRISMA 2020 [21].

The included studies provided a heterogeneous body of evidence comprising policy documents, empirical programme evaluations, systematic reviews, and country case studies, reflecting both conceptual and implementation-oriented perspectives.

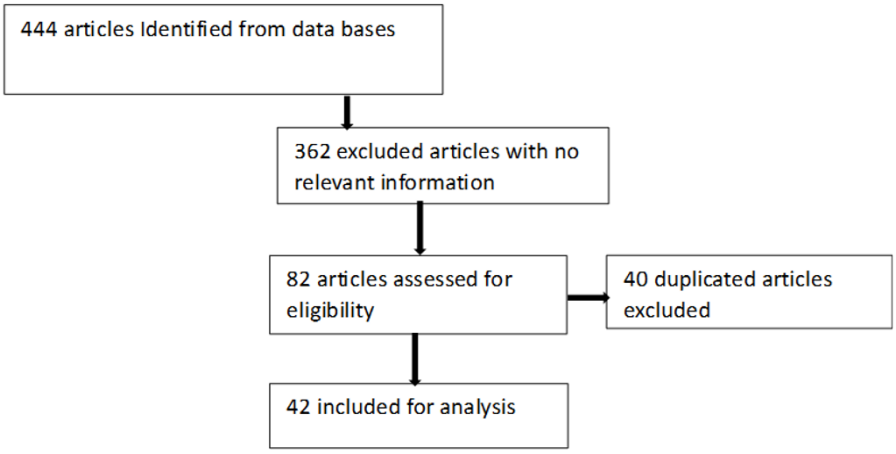


Figure 2. Illustrates, The Selection Process of Articles

Source: *Adapted from the PRISMA guidelines [21]*

Geographical Distribution of Evidence and Country Integration Maturity

The evidence base was concentrated in countries with established national CHW programmes, particularly Ethiopia, Rwanda, Kenya, Malawi, Uganda, Ghana, and South Africa, while Central African countries remained underrepresented (Table 1). East Africa showed both the strongest evidence base and the highest integration maturity, reflecting long-standing government-led programmes such as Ethiopia's Health Extension Programme and Rwanda's Community Health Programme [7, 8]. Southern Africa showed relatively mature integration, particularly in service delivery and workforce, although financing constraints continue to affect sustainability [3, 34]. West Africa (Ghana, Nigeria, Liberia, Sierra Leone) showed moderate integration with substantial cross-country variation, Ghana being the exception with relatively mature integration through CHPS. Central Africa showed the weakest evidence base and the lowest integration maturity, reflecting fragile health systems and limited institutionalisation.

Table 1. Geographic Distribution of Evidence

Region	Evidence Strength	Rationale	Representative Countries	Integration Maturity	Rationale
East Africa	Very High	Largest volume of CHW literature; extensive evidence from Ethiopia, Rwanda, Kenya, Uganda, and Tanzania; multiple systematic reviews and programme evaluations	Ethiopia, Rwanda, Kenya, Uganda, Tanzania	High	Strong national CHW programmes, policy recognition, structured supervision, established referral systems, and formal workforce integration

Southern Africa	High	Strong evidence base from South Africa, Malawi, Zambia, Zimbabwe, and Mozambique	South Africa, Malawi, Zambia, Zimbabwe	Moderate–High	Well-established CHW programmes with strong service delivery, but challenges remain in financing and workforce sustainability
West Africa	Moderate	Moderate evidence from Nigeria, Liberia, Sierra Leone, and Senegal; more programme variability. Ghana could be an exception.	Ghana, Nigeria, Liberia, Sierra Leone	Moderate	Mixed integration models; stronger service delivery integration than financing, HMIS, or governance integration
Central Africa	Low	Few studies and limited programme evaluations; underrepresented in the literature	DRC, Central African Republic, Cameroon, Chad	Low	Weak institutionalisation, fragile health systems, donor dependency, and limited CHW system integration

Source: *Author's synthesis from included studies*

Interpretation of classification: *Evidence strength was assessed based on the volume, diversity, consistency, and depth of evidence available from each region. Integration maturity was assessed according to the degree of institutionalisation of CHW programmes across the WHO Health System Building Blocks, including governance, financing, workforce, service delivery, health information systems, and supply chains.*

Integration Across the WHO Health System Building Blocks

Integration was strongest in operational functions (service delivery, governance, and workforce support) and weakest in institutional support functions (financing, health information systems, and supply chains) (Table 2). Many programmes have therefore expanded community-level service delivery without achieving integration into the systems required for sustainability, accountability, and resilience, indicating that financing, information systems, and supply chain infrastructure should be prioritised [3, 26].

Table 2. Traffic Light Framework for CHW Integration Across WHO Health System Building Blocks

Health System Building Block	Status	Interpretation
Service Delivery		Strongly integrated and routinely embedded
Leadership & Governance		Well integrated with minor implementation gaps
Health Workforce		Generally integrated through training and supervision structures
Health Financing		Partially integrated with donor dependence and funding instability

Health Information Systems		Weakly integrated with reporting and data-use challenges
Supply Chain		Poorly integrated with frequent stock-outs and logistics constraints

Source: *Author's synthesis from included studies*

Traffic Light Key

Green = Strong (Score ≥10 studies)
Yellow = Partial (Score 6 – 9 studies)
Orange = Weak - moderate integration (Score 2 – 5 studies)
Red = Poorly integrated (≤2 studies)

The Traffic Light Framework (Table 2) summarises the relative strength of CHW integration across the six building blocks, based on the frequency, consistency, and depth of integration reported in the included studies.

Comparison of Integration Models by Frequency, Sustainability, and Integration Level

Government-led models achieved the highest frequency, sustainability, and integration scores, indicating the strongest alignment with formal health system structures (Figure 3). Hybrid models also performed well, reflecting their relevance where government stewardship is complemented by NGO or donor support. NGO-led models showed only partial integration, often operating through parallel systems that support short-term delivery but limit sustainability, while disease-specific or vertical programmes scored lowest. The gradient is consistent: the more a model is led, financed, supervised, and institutionalised by government, the higher its integration and sustainability, confirming that integration is a matter of embedding CHWs within the health system architecture rather than simply deploying community-based workers [3, 19, 26].

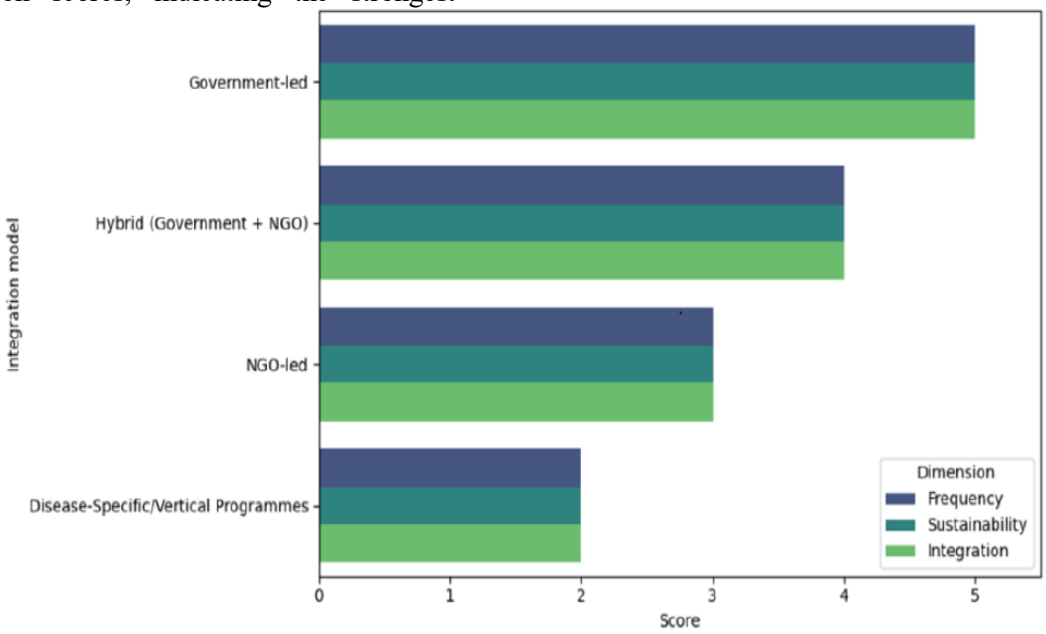


Figure 3. Grouped Horizontal Bar Chart Comparing CHW Integration Models by Frequency, Sustainability, and Integration Level

Source: *Author's synthesis of included studies [3, 19, 26]*

Interpretation of ratings: *5.0 - High (well institutionalised, consistently functional); 4.0 - Moderate–High (generally integrated with minor gaps); 3.0 - Moderate (partially integrated); 2.0 - Low (limited integration with major weaknesses); 1.0 - Very Low (minimal integration and weak institutional embedding).*

Comparison of Integration Models Across Core Health System Building Blocks

Table 3 compares the three models across the core building blocks. Integration is a progressive process of institutional alignment rather than a single event, forming a continuum from government-led (strongest institutionalisation, with CHWs embedded in national policy, government financing, Ministry of Health accountability, standardised training, district supervision, national information systems, and public supply chains), through hybrid (transitional), to NGO-led (partial and project-based). NGO-led models may strengthen short-term implementation through intensive training, dedicated supervision, parallel digital tools, and NGO-managed last-mile logistics, but reliance on project funding limits sustainability beyond funding cycles. Hybrid models are particularly relevant in resource-constrained settings but require explicit transition mechanisms to avoid permanent dependence on external actors.

Table 3. Comparison of CHW Integration Models Across Core Health System Building Blocks

Characteristic	Government-Led	NGO-Led	Hybrid
Policy basis	National CHW policy, legal mandate	MOU / project agreement	Shared national framework + operational MOU
Governance	Ministry of Health accountability	NGO operational control	Joint steering committee; progressive handover
Financing source	Domestic government budget	Donor/NGO project funding	Mixed: government core + partner supplemental
CHW status	Civil servant or salaried staff	Community volunteer or project employee	Variable: transitioning toward formalisation
Training	National standardised curriculum	NGO-specific, often more intensive	National curriculum + partner quality assurance
Supervision	District/facility-embedded	Dedicated, lower ratio, partner-funded	Government-led, partner-supported
HMIS integration	Integrated into national DHIS2	Often parallel digital tools	Pilot integration, transitioning to national
Supply chain	National logistics system	NGO-managed last-mile	Government backbone + partner gap-filling
Sustainability	Strongest institutionalisation	Fragile beyond project cycles	Pragmatic; risk of permanent hybridity

Source: *Author's synthesis of included studies [3-5, 10, 18, 19, 28]*

Note: *The categories reflect the predominant characteristics of health system building blocks reported in the reviewed studies and may vary across individual programmes and country contexts.*

Country-Level Integration Models

The classification in Table 4 is an analytical typology rather than a rigid country label, since many CHW systems are evolving and combine government policy leadership with NGO or donor implementation support [19]. It reflects evidence that CHW programmes in Ethiopia, Ghana, Malawi, Nigeria, Rwanda, and Zambia are formally linked to national health systems, although integration varies across financing, supervision, information systems, and supplies.

https://doi.org/10.21522/TIJPH.2013.14.03.Art035

Table 4. Country-Level CHW Integration Model Table

Country	Main CHW Cadre/Programme	Dominant Model	Integration Level	Sustainability Outlook
Ethiopia	Health Extension Workers	Government-led	High	High, if financing and supplies remain stable
Rwanda	Binômes and Agents de Santé Maternelle	Hybrid with strong government stewardship	High	Moderate-high, dependent on continued partner-aligned financing
Kenya	Community Health Promoters/Volunteers and Community Health Assistants/Officers	Hybrid	Moderate-high	Moderate, with county financing and coverage constraints
Uganda	Village Health Teams	Hybrid / NGO-supported	Moderate	Moderate-low unless financing and supervision are strengthened
Tanzania	Community Health Workers under community-based health programme	Hybrid transitioning towards government-led	Moderate-high	Moderate, dependent on formalisation and scale-up financing
South Africa	Ward-Based Primary Health Care Outreach Teams	Government-led with hybrid legacy	Moderate-high	Moderate, affected by supervision, employment, and resource challenges
Malawi	Health Surveillance Assistants	Government-led	High	Moderate-high, dependent on workload management and public financing
Zambia	Community Health Assistants	Government-led	High	Moderate-high, dependent on payroll absorption and scale-up
Zimbabwe	Village Health Workers	Hybrid	Moderate	Moderate-low, dependent on allowances, supervision, and supply continuity
Ghana	Community Health Officers/Nurses and Community Health Volunteers under CHPS	Government-led	High	High for salaried CHOs/CHNs, lower for volunteer component
Nigeria	Community Health Extension Workers (CHEWs), Junior Community Health Extension Workers (JCHEWs), and	Hybrid	Moderate	Moderate, with state-level variation and partner dependence

	Community Health Officers (CHOs) and community health influencers/promoters			
Liberia	Community Health Assistants and Community Health Service Supervisors	Hybrid with strong government leadership	Moderate-high	Moderate, with strong policy architecture but donor financing dependence
Sierra Leone	Community Health Workers and peer supervisors	Hybrid	Moderate-high	Moderate, dependent on professionalisation, financing, and transition from partner support

Source: *Author's synthesis of included studies [3-7, 18, 28, 31-33]*

Interpretation of integration level: High: *fully institutionalised within national health systems;* ***Moderate high:*** *strongly integrated with some partner-support functions;* ***Moderate:*** *partially integrated with notable implementation gap;*

Interpretation of the Table

Government-led models are strongest where CHWs are formally embedded in national workforce structures, as with Ethiopia's Health Extension Workers, Malawi's Health Surveillance Assistants, Zambia's Community Health Assistants, and Ghana's CHPS-linked Community Health Officers; in these settings CHWs are connected to national policy, public supervision, government financing, information systems, and supply chains, although integration still differs across recruitment, training, remuneration, supervision, and supplies [3, 5, 18, 28].

Hybrid arrangements are the most common, occurring where government provides policy direction but implementation depends substantially on partners, as in Kenya, Uganda, Tanzania, Zimbabwe, Nigeria, Liberia, and Sierra Leone. Partner support can strengthen training, supervision, logistics, data systems, and service delivery, but sustainability depends on whether these functions are progressively absorbed into national systems; Liberia illustrates a national programme that emerged from partner-supported post-Ebola reforms into a formal, standardised, compensated cadre.

NGO-led systems rarely function as the dominant national model, although donor support remains highly influential in implementation. The key implication is that integration should be assessed not by the existence of a national policy alone, but by whether financing, supervision, data reporting, commodities, and referral systems are actually embedded in the public health system, consistent with WHO warnings against fragmented workforce planning [3].

Facilitators of CHW Integration

The synthesis identified eleven key facilitators that influenced the successful integration of Community Health Worker (CHW) programmes into formal health systems across rural Sub-Saharan Africa. They were ranked according to frequency and reported impact.

1. Analysis suggests that System-level factors were more influential than programme-specific interventions. The highest-ranked facilitators were political commitment and national policy recognition, supportive supervision, and sustainable financing, followed by competency-based training. Countries with clear national CHW policies, formal governance structures, and government ownership showed more consistent integration,

stronger accountability, and greater sustainability [3, 4, 28]. Supportive supervision was the critical operational facilitator because it reinforced competencies, improved service quality, strengthened referrals, and improved motivation and retention [3, 18, 40], while competency-based training was consistently associated with improved performance [3, 5, 27] and predictable remuneration with workforce stability and reduced attrition [3].

2. At the system level, reliable supply chains, integrated health information systems, functional referral mechanisms, and partner coordination sustained continuity of care and strengthened community-facility linkages [3, 36], while community ownership and trust increased service uptake, acceptability, and accountability [3, 39].

Overall, integration is most successful where investment is coordinated across governance, workforce development, financing, supervision, information systems, and logistics. Isolated interventions such as training alone are insufficient; integration is achieved through the combined functioning of multiple building blocks [3, 35].

Table 5. Priority Facilitators of CHW Integration into Health Systems

Rank	Facilitator	Importance
1	Political commitment & policy recognition	High importance
2	Supportive supervision	High importance
3	Sustainable financing	High importance
4	Competency-based training	Moderate importance
5	Reliable supply chains	Moderate importance
6	Community ownership	Moderate importance
7	Partner coordination	Moderate importance
8	HMIS integration	Low importance
9	Referral systems	Low importance
10	Career pathways	Low importance
11	Digital health support	Low importance

Source: *Author's synthesis from included studies [3-5,18, 27, 28, 36, 39, 40]*

Importance ratings were derived using the frequency, consistency, and impact criteria and thresholds defined in Section ("Data Synthesis and Analysis").

Barriers to CHW Integration

Ten recurrent barriers were identified and these are linked with the health system building blocks. CHW integration barriers were primarily systemic and institutional, indicating that programme effectiveness is constrained more by health system weaknesses than by individual CHW capacity. These are synthesised using the health system building blocks.

Governance and Financing: Governance fragmentation and unstable financing were the most critical barriers, resulting in poor coordination, weak accountability, inconsistent implementation, and limited programme sustainability [3, 10, 18, 34].

Health Workforce: Weak supervision, limited career progression, high workloads, and poor collaboration with facility staff undermined CHW motivation, retention, and performance [3, 5, 18, 29].

Health Information Systems: Fragmented reporting systems, poor data quality, and limited integration of CHW data into routine HMIS reduced the effectiveness of community-

level information for decision-making and planning [3, 5, 37].

Service Delivery and Supply Chains: Frequent commodity stock-outs, weak referral systems, transport constraints, and inadequate facility readiness disrupted service continuity and reduced community trust in CHW programmes [3, 5, 36].

Generally, the findings show that sustainable CHW integration requires coordinated strengthening of governance, financing, supervision, information systems, and supply chains, as isolated interventions are unlikely to address interconnected system barriers.

Table 6. Priority Barriers to CHW Integration in Health Systems

Rank	Health System Building Blocks	Barrier	Severity
1	Leadership and governance	Governance fragmentation	Critical
2	Medical product, vaccines and technology	Supply chain stockouts	Critical
3	Health workforce	Weak supervision infrastructure	Critical
4	Health financing	Financing instability	High
5	Service delivery	Community trust and stigma issues	High
6	Health workforce	Training inadequacies	High
7	Service delivery	Weak referral systems	High
8	Leadership and governance	Partner coordination failures	Moderate
9	Health information system	HMIS disconnection	Moderate
10	Health workforce	Role overload	Moderate

Source: *Author's synthesis from included studies [3, 5, 10, 18, 29, 30, 34, 36, 37]*

Severity ratings follow the thresholds defined in Section ("Data Synthesis and Analysis") (critical: reported in ≥10 studies; high: 4–9; moderate: 1–3).

Training Needs for Effective CHW Integration

The synthesis identified ten core competency domains required for effective CHW integration (Table 7). These domains were not predetermined; they emerged inductively through thematic synthesis of training-related findings and were subsequently aligned with the WHO Health System Building Blocks Framework and WHO CHW guideline recommendations [3, 27].

Effective integration required competencies extending well beyond technical clinical skills. While clinical and preventive service delivery competencies remained foundational, the studies consistently emphasised referral management, health information systems, supply chain management, community engagement, supportive supervision, digital literacy, professional ethics, emergency preparedness, and work planning [3, 27, 35, 38], reflecting the complex role of CHWs as system actors at the interface between communities and formal services. Training alone was insufficient: competencies translated into performance only where supported by ongoing supervision, refresher training, mentoring, and continuous learning [3, 5, 27, 35].

Table 7. Priority Training Building Blocks

Competency Area	Priority
Clinical & Service Delivery	Essential
Referral Management	Essential
Health Information Systems	Essential
Supply Chain Management	Essential
Communication & Community Engagement	Essential
Supportive Supervision	Essential
Digital Literacy	Important
Professional Ethics	Important
Emergency Preparedness	Important
Work Planning	Important

Source: *Author's synthesis from included studies [3, 5, 27, 35, 38]*

Priority ratings follow the thresholds defined in Section ("Data Synthesis and Analysis") (essential: reported in ≥10 studies; important: 1–9).

CHW Integration Capability Framework

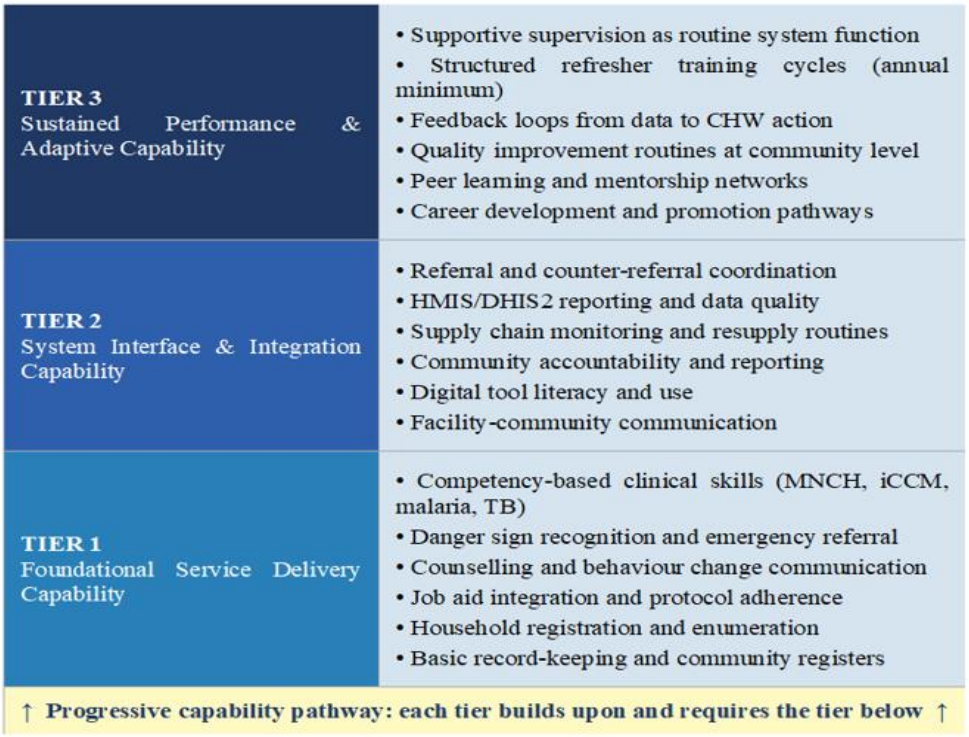
The synthesis of facilitators, barriers, and training requirements gave rise to the CHW Integration Capability Framework, the study's central conceptual contribution. It proposes that effective integration is neither a single event nor a binary outcome, but a progression across three interdependent tiers (Figure 4).

Tier 1 (Foundational Competencies) represents the essential knowledge and skills required for basic CHW practice, including clinical and service delivery competencies, communication skills, professional ethics, and community engagement. These competencies provide the foundation for all other integration capabilities and were consistently identified across the literature as prerequisites for effective CHW performance.

Tier 2 (System Interface and Integration Capabilities) reflects CHWs' ability to operate effectively within the broader health system. This includes competencies related to referral and counter-referral processes, health information systems, documentation and reporting, supply chain management, coordination with health facilities, and participation in supervisory structures. The synthesis demonstrated that many integration failures occur at this interface, where CHWs possess basic clinical skills but lack the capabilities or institutional support needed to interact effectively with health system structures.

Tier 3 (Sustained Performance and Adaptive Capability) is the highest level, encompassing continuous learning, supportive supervision, mentoring, problem-solving, emergency preparedness, and adaptive decision-making. Sustained effectiveness was achieved only where Tier 1 and Tier 2 capabilities were reinforced by ongoing support, learning opportunities, and responsive health system structures [4, 5, 18].

CHW effectiveness is therefore a progressive capability pathway rather than a static workforce attribute. The framework explains why training alone often fails to improve long-term outcomes where governance, supervision, financing, information systems, and supply chains remain weak (Figure 4).



***MNCH** = Maternal, Newborn, and Child Health; **iCCM** = Integrated Community Case Management; **HMIS** = Health Management Information System; **DHIS2** = District Health Information Software 2. **TB** = Tuberculosis.*

Figure 4. CHW Integration Capability Framework - Three-Tier Model

***Source:** Author's conceptualisation based on study findings and literature review.*

Discussion

Integration Across the Health System Building Blocks

CHW integration in SSA is substantial but uneven across the WHO building blocks: strongest in service delivery, workforce support, and basic information functions, and weakest in financing, governance, and supply chains. Programmes are thus integrated at the operational level of primary health care while remaining insufficiently embedded in the structural functions that sustain performance, so CHWs are expected to improve access, referrals, and uptake despite persistent weaknesses in financing, logistics, supervision, and governance. Effective integration should therefore be understood not as service delivery expansion but as the extent to which CHWs are supported across all six building blocks.

Integration Models and Their Implications for Health System Strengthening

Government-led integration showed the strongest alignment with formal health systems, embedding CHWs within national governance, financing, supervision, information, and supply-chain structures, and thereby strengthening accountability, sustainability, and state ownership. NGO-led models achieved only partial integration through parallel systems that may improve short-term delivery while weakening long-term sustainability. Hybrid models were the most common and mirror the realities of resource-constrained, donor-dependent settings.

These results confirm that CHW integration is essentially a health system strengthening process rather than a stand-alone programme. Incomplete integration reflects structural weaknesses in the health system itself and is

consistent with evidence that both the "hardware" (resources, infrastructure) and the "software" (governance, trust, social capital) of health systems determine programme performance. CHWs amplify the system: they extend the reach of health services while also exposing existing system weaknesses. Investment in a well-organised CHW subsystem embedded within primary health care can reduce maternal, newborn, and child morbidity, improve access to essential services, and strengthen community-level outbreak detection and response [4, 39].

Facilitators and Barriers, and Their Implications for Health System Strengthening

The facilitators and barriers identified confirm that CHW integration is fundamentally a health system strengthening process rather than a narrow workforce intervention, depending on the coordinated functioning of governance, financing, workforce development, information systems, supply chains, referral mechanisms, and service delivery platforms. Political commitment confers the policy legitimacy needed to embed CHWs in formal systems; sustainable domestic financing stabilises the workforce and reduces exposure to donor cycles; and standardised training with supportive supervision builds both clinical competence and system-interface capability, including reporting, referral, commodity use, and community engagement [3, 26, 35].

Conversely, the barriers reveal persistent weaknesses in the wider system. Governance fragmentation remains a major constraint where partner-managed programmes operate parallel training, supervision, reporting, financing, or logistics systems [3, 28, 35]; such arrangements may improve short-term implementation but weaken stewardship, duplicate reporting, and limit sustainability. Partner support strengthens the health system only when aligned with national policy and accompanied by explicit transition pathways to domestic ownership. Supply chain stock-outs directly undermine CHW credibility, service continuity, and community trust: even recognised, trained, and supervised CHWs are ineffective without commodities [3, 18], which illustrates the distinction between nominal and functional integration.

Weak supervision, fragmented information systems, inadequate referral pathways, unstable financing, and role overload further demonstrate that CHW performance is shaped by the systems within which CHWs operate [3, 18].

Training Needs for Effective CHW Integration

Effective integration required competencies extend beyond clinical service delivery to referral management, health information systems, supply chain coordination, community engagement, digital literacy, professional ethics, and work planning, reflecting the evolving role of CHWs as actors linking communities with formal health systems.

These competency requirements align closely with WHO guidance, which recommends competency-based training, supportive supervision, and continuous professional development as determinants of CHW programme effectiveness [3, 27]. Importantly, training alone did not achieve sustained integration; competencies were translated into practice only where reinforced by supervision, mentoring, refresher training, and continuous learning [5, 11, 18].

The CHW Integration Capability Framework: Interpretation and Implications

The CHW Capability Framework treats integration as a progressive, three-tier capability pathway rather than a collection of independent competencies. Unlike conventional capacity-building approaches, which concentrate on training inputs, it

specifies how competencies are converted into effective health system engagement and, ultimately, into sustained performance. The synthesis indicated that most integration failures occur at the second tier, where CHWs hold basic competencies but lack the institutional support and operational capacity to function within formal health systems.

The framework's key contribution is its recognition that integration capabilities are sequential and interdependent: higher-level integration functions depend on foundational competencies, and sustained performance depends on effective system engagement and continuous institutional support. This exposes the limits of isolated interventions, such as training without supervision or supervision without competency development, and explains why coordinated investment across the capability pathway is required. By linking workforce development to integration outcomes, the framework complements the WHO Health System Building Blocks Framework and provides a practical tool for programme design, workforce development, monitoring, and policy planning, although further empirical validation is required.

Comparison with Global Evidence and WHO Recommendations

The findings largely align with global CHW and health system frameworks, which hold that effective integration depends on coordinated governance, financing, supervision, information systems, and supply chains rather than workforce deployment alone [3-5, 18]. They are consistent with the WHO CHW guideline recommendations on competency-based training, supportive supervision, remuneration, and career pathways [3], and with prior reviews reporting that supervision and remuneration drive CHW performance [18, 20] and that CHW programme components map unevenly onto the building blocks [19]. The present review extends these findings by showing that, in rural SSA, integration is systematically stronger in service delivery and governance than in financing, information systems, and supply chains, and that this asymmetry, rather than any deficit of CHW competence, explains much of the observed variation in programme sustainability.

The review also underscores the depth of donor and partner dependence. Global evidence recognises the catalytic role of external support but cautions that fragmented financing undermines national ownership [3, 4, 15]. In rural SSA, donor-driven implementation frequently fragments training, supervision, reporting, remuneration, and supply systems, producing uneven integration across settings and over time [5, 28]. The findings therefore do not challenge global CHW integration theory; they demonstrate how difficult integration is to sustain where enabling system conditions, remoteness, and resource constraints interact [3-5, 39].

Future Research

1. Future research should validate the CHW Integration Capability Framework across diverse contexts and identify the combinations of governance, financing, supervision, training, HMIS, supply chain, and referral interventions that most effectively support integration.
2. Longitudinal and mixed-methods studies to determine whether improved CHW integration leads to better retention, service quality, community trust, primary health care outcomes, and long-term programme sustainability.

Limitations of the Study

1. Variability in the quality of the included evidence. Although we appraised quality, the reviewed studies differed considerably in methodological design, analytical rigor, and reporting standards.

2. Regional heterogeneity represents an important limitation of this review. The included studies spanned multiple countries with differing policy environments, health system capacities, CHW models, and implementation contexts.
3. Potential publication bias; Evidence on CHW integration is derived primarily from published studies, which may disproportionately report successful programmes, positive outcomes, and innovative interventions. As a result, unsuccessful integration programmes, may be underrepresented.
4. The proposed CHW Integration Capability Framework has not yet been empirically validated. Its validation is identified as a priority for future research.

Despite these limitations, the consistency of findings across multiple contexts and study designs strengthens confidence in the conclusions and their applicability to CHW integration policy and practice in rural Sub-Saharan Africa.

Conclusion

This review synthesised evidence from 42 studies on the models, facilitators, barriers, and competency requirements shaping the integration of Community Health Workers into formal health systems in rural Sub-Saharan Africa. Integration is uneven across the health system building blocks: CHWs are increasingly embedded in service delivery, governance, and workforce structures, but financing, health information systems, and supply chains remain weak, limiting sustainability and institutionalisation. Of the three dominant models, government-led arrangements showed the strongest institutionalisation and accountability, NGO-led models achieved short-term delivery gains through parallel systems that were fragile beyond project cycles, and hybrid models were the most common and pragmatic but require deliberate transition towards national ownership.

Integration is therefore a health system strengthening process rather than a workforce intervention. It is enabled by political commitment, sustainable domestic financing, supportive supervision, competency-based training, reliable supply chains, integrated information systems, and functional referral pathways, and it is constrained by governance fragmentation, financing instability, weak supervision, stock-outs, and disconnected data systems. The review further identifies ten competency domains required for integration and proposes the CHW Integration Capability Framework, a three-tier model in which foundational competencies, system interface capabilities, and sustained performance are sequentially linked and mutually reinforcing. The framework explains that training alone does not deliver sustained results and offer a practical tool for workforce planning, programme design, and implementation monitoring, although it requires empirical validation.

Sustainable CHW integration requires coordinated investment across all six WHO health system building blocks, with particular attention to governance, financing, information systems, workforce, and supply chains. Governments, policymakers, and development partners should move beyond fragmented, disease-specific, and externally driven approaches towards institutionalised, system-wide strategies that recognise CHWs as an essential and supported component of the primary health care workforce.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

This study is a systematic review of secondary data from publicly available published sources. No primary data collection

involving human participants was conducted. Formal ethical approval was therefore not required. All included studies were accurately represented, appropriately cited, and reported in compliance with PRISMA 2020 standards.

Author Contributions

Sowo Anita Lebbie conceptualised the study, and co-authors contributed to writing and approval of the final manuscript.

Data Availability

The data supporting the findings of this study are derived from publicly available published literature. All included studies are cited in the reference list. The corresponding author can provide full data extraction records upon reasonable request.

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Cost of Quality-Applicability in Clinical Laboratories, Particularly in Resource-Limited Countries: A Survey of the Literature

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Abstract *Healthcare providers rely on laboratory results to make medical decisions daily. Laboratories must adhere to specified requirements to ensure that the service provided is reliable and safe. The service provided to patients and clinicians should therefore be customer-focused. Discussions on expenditure on continuous quality improvement activities have grown as more laboratories develop quality management systems. This discussion is even more relevant as laboratory managers try to balance their organization's productivity by reducing waste and unnecessary expenditure. Quality cost is the total cost of activities that prevent or mitigate errors in laboratory processes (cost of good quality), and failure cost is the cost resulting from flawed laboratory processes (cost of poor quality). There is extensive evidence on the application of CoQ in manufacturing and other non-health service industries, however there is limited information about its applicability in clinical laboratories. Furthermore, laboratories located in countries with scarce resources may face unique challenges in assessing quality costs, including the ease of data collection for cost inputs. This article examines the information presented in the literature on quality-related costs in clinical laboratories. Secondly, it provides a summary of various cost models. Finally, it explores the application of quality cost in clinical laboratories, particularly in resource-limited countries, and outlines the benefits and challenges.*

Keywords *Clinical Laboratory, Cost of Quality, Quality Management Systems, Resource-Limited Countries.*

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Introduction

The emphasis on quality management systems (QMS) has grown immensely popular in low- and middle-income countries. The implementation of such systems often requires laboratory managers to assess the balance between operating costs associated with implementing good clinical practices and the need to earn a profit. The principle of quality management centers on providing reliable, standardized service that meets users' needs. Managers must therefore consider delivering a high standard of service at the lowest possible cost. To quantify expenses for quality activities and those related to waste and retesting, laboratory staff need to understand the core principles of quality costs. These principles appear seemingly complex to laboratorians, as much of the literature focuses on the application of cost of quality (CoQ) to manufacturing and non-health service industries [1-5].

The CoQ is described as the sum of the cost incurred from preventing or mitigating laboratory errors (sum of conformances) and the cost associated with service failures or errors (sum of non-conformances) [6, 7]. A practical framework is important to guide managers on measuring quality-related expenses. Philip Crosby emphasized that organizations should measure quality cost to determine when they have achieved zero defects. He thought that the absence of defects or errors would eliminate the need for rework or repairs and consequently result in lower production cost [8]. The prevention-appraisal-failure model is commonly used in many industries, including clinical laboratories.

A CoQ approach considers designing continuous improvement activities, which lowers the overall cost and fulfils customer requirements. Expenses on quality assurance activities are viewed as wise investment, which later yields a return in reduced failures. Managers, therefore, have to create a balance in expenses on such activities and their benefits to the organization. As knowledge of quality management increases among laboratorians, managers continue to seek appropriate quality tools to improve laboratory processes and reduce errors. Although the literature offers extensive evidence on the application of CoQ in manufacturing and other service industries, there is little information on the use of these models in clinical laboratories. Furthermore, laboratories in resource-limited countries may face unique challenges in measuring or reporting quality costs due to several factors, such as ease of data collection for cost inputs. This article examines the information presented in the literature on quality-related costs clinical laboratories. Secondly, it provides a summary of various cost models. Finally, it explores the application of quality cost in clinical laboratories, particularly in resource-limited countries, and outlines the benefits and challenges of its application.

Demystifying Quality Costs

Quality costs are expenses incurred by a product or service in meeting a set of standards. These standards are outlined in terms of agreements with a company and its customers [10]. Quality cost has been classified into four distinct categories: prevention, appraisal, internal failure, and external failure costs (Table 1). Prevention and appraisal costs are associated with ‘good quality’. These expenses are related to activities that reduce laboratory errors. Prevention costs are allocated to exercises that avoid errors. Appraisal costs are associated with evaluating, assessing, or auditing products to ensure that they conform to specific requirements [6, 7, 11, 12].

Internal and External costs, ‘bad quality, are related to failures which occurs in a system. Internal failures are costs incurred to resolve errors which are detected by the laboratory before it gets to the physician. On the other hand, external failure costs consider expenses to correct errors which are identified outside the laboratory’s control [6, 7, 11, 12]. Zahar and his

colleagues argued that some failure costs are hidden, this is likened to the 'submerged section of an iceberg' [11]. Managers therefore need to appreciate the interconnections among systems within their processes to recognize hidden costs and account for their contributions to cost models.

Table 1. Summary of Quality Cost Types & Cost Elements

Type of Cost	Examples of Cost Elements
Prevention	Development of Quality management system
	Continuous quality improvement activities
	Preventive maintenance & establishing service contracts
	Quality education
	Verification of laboratory processes before implementation
	Initial staff competency assessments
Appraisal	Monitoring quality indicators
	Ongoing staff competency assessments
	Instrument calibration
	Internal audit programs and external accreditation
	Sample & reagent inspections
Internal Failure	Errors occurring in the pre-examination phase such as mislabeled, insufficient or flawed samples, data entry errors, sample and reagent transport failures.
	Errors occurring in the examination phase such as calibration and quality control failures, invalid instrument runs, expired reagents, instrument downtime, retesting.
External Failure	Patient misdiagnosis
	Customer complaints
	Revised and recall reports
	Damage reputation and loss revenue
	Litigation

Cost of Quality Models

There is an extensive body of literature on cost of quality models, including various reviews that provide a comprehensive analysis on the subject. Cost models are frequently divided into four groups: the prevention-appraisal-failure (PAF) model, or Crosby model; opportunity cost models; process cost models; and activity-based (ABC) models [4, 13]. In addition to these frameworks, the Six Sigma approach was also another option for managing quality costs [14].

The most recent review of the subject matter by Foulad and colleagues [9] provided a comprehensive overview of cost models, including newer models which address gaps in earlier work. These frameworks include tangible and intangible costs, opportunity costs, hidden costs, poor-quality costs and the Kélada model. The literature review in this section provides a description of both early and newer models.

The PAF model, which was developed by Feigebaum [15] is perhaps the most widely used across various organizations. In this structure quality related costs are divided into (i) expenditure on activities which promotes adherence to product standard (control) and

(ii) cost associated with defects (failure). Expenses related to controlling product standards are further subdivided into two groups: expenses to prevent nonconformances (prevention cost) and expenses for activities that maintain product standards. Failure outlays are also divided into two categories. These are (i) outlays related to failures which occur within the organization (such as spoilage or scrap) and (ii) outlays related to failures which take place when the product leaves the organization (such as customer complaints and product issues). It is the view that as prevention-related expenses increase within an organization, the costs allocated to failures and appraisal will ultimately decrease [15].

Crosby's description of cost categories closely mirrors Feigenbaum's, which is why authors refer to it as the PAF model [4]. Quality-related outlays can be quantified as total conformance and nonconformance expenses. Conformance outlays consist of activities that ensure things are done correctly the first time. These expenses include activities that hinder the production of defects (e.g preventive maintenance) and activities which prioritize the assessment of the quality of a product (e.g inspections). Expenses related to non-conformance are referred to as failure cost and include rework, redesign, or corrective actions after failure to conform to product requirements.

Industry leaders also frequently use the process cost model. The model considers continuous improvement in key processes, reflecting Kaizen & Deming's plan-do-study-act (PDSA) cycle [13]. Cost items are viewed as steps within a process than costs incurred in producing a product or service. The total quality cost is measured by allocating expenditure to activities which promotes (conformance) or deviates (nonconformance) from set standards at each stage of the process.

The Six Sigma methodology is similar to the use of continuous improvement activities in the process cost model. Six sigma is a data-driven approach that seeks to eliminate defects or failures in business processes. The method uses a five-step project management technique: define, measure, analyze, improve and control (DMAIC). These steps are repeated in cycles and allow for continuous improvements in work processes. The method is largely supported by the lean approach, which emphasizes eliminating waste and inefficiencies [14].

Scholars proposed the Activity-Based Cost (ABC) method to address gaps identified in the earlier models. The method assigns costs to each activity, which allows accounting teams to collate cost elements, including overhead costs. This information is thought to help managers make strategic decisions [9, 13].

After developing the PAF model, scholars proposed CoQ frameworks to address its limitations. This has resulted in several variations of intangible and opportunity cost models. The intangible models emphasize the importance of hidden cost in assessing the true cost of quality. Juran argued that there were two groups of cost categories; costs that can be quantified (tangible factory costs and intangible sales costs) and those that are difficult to quantify directly (intangible cost) [16, 17]. Taguchi's hidden cost model also emphasizes the difficulties in quantifying intangible costs [14]. The cost framework is similar to the ideas presented It was the view that the quality of a product is a 'loss' which is transferred to the clients [14]. Kelada's model builds on the ideas of Taguchi. In his framework cost categories are divided into five groups- direct, indirect, tangible, calculatable and intangible costs. While the four prior categories can be measured directly, intangible cost has to be estimated [9]. Sandoval-Chávez and Beruvides developed the opportunity cost model [18]. The framework accounts for potential losses in maximizing profits, such as underutilization of capacity, inadequate material handling, and poor delivery service [18].

Harrington had a different approach to defining the cost of quality. He proposed that

quality cost should be seen in terms of poor quality. This approach may have been intended to change managers' perception that producing quality products means higher costs. There are two main categories in this model, (i) Direct cost which includes categories prevention, appraisal, internal and external costs. These costs can be controlled by organizations (ii) Indirect cost- these costs are not measurable and include customer dissatisfaction, loss of reputation and lost opportunities [9].

Despite the extensive body of knowledge on CoQ frameworks, its application is limited across industries. Managers may have increased awareness that improving the quality of a service or product increases market competitiveness, however, there seems to be a lack of commitment to putting these tools in practice [4].

Application of Cost of Quality in Clinical Laboratories

Four articles were identified from the literature that demonstrated the use of CoQ models in clinical laboratories. Two articles used the principles of the PAF model. The third article was based on the process cost model, and the final article applied the six sigma and the lean concepts. The elements within the cost categories were largely consistent across laboratories, with deviations reflecting unique situations in each laboratory.

Menichino [19] was the first to explore the application of CoQ in a laboratory setting. The study applied the process cost model and classified cost categories as conformance or non-conformance within each process. Conformance costs included quality-related salaries, QC and calibration, normal specimen collection, testing, and results reporting. Cost of non-conformity included retesting, corrective action costs, instrument downtime, and associated repairs. The model enabled the laboratory to quickly identify areas of poor quality and excessive spending and subsequently target improvement activities (Table 2).

Elbireer and his colleagues [9] analyzed cost data using the classical PAF model in a clinical laboratory located in a resource-limited country. In their study, prevention costs represent the cost of good quality, including personnel salaries related to quality assurance (QA), preventive maintenance programs, quality-related supplies, continuing education activities, and the laboratory information system (LIS). Appraisal costs elements included the External Quality Assessment (EQA) program for proficiency testing, quality control program, and process validation (i.e., method comparison). Cost of poor quality: internal failures were poor inventory practices, data entry errors, rework costs, quality control (QC) failures, calibration failures, retesting, and deviations from standard operating procedures. External failures included pre-analytical, analytical, and post-analytical errors. Similarly, Zahar and his companions [11] used the PAF model to determine CoQ. The authors also included the revised Juran's model to expand cost classifications. Similar cost elements were noted, with variations in internal and external failure costs, such as loss of results and aspiration failures (Table 2).

In the study [20], six sigma and lean approaches were used to quantify failure costs in a clinical laboratory. The authors evaluated quality costs using a series of calculations that accounted for defect costs throughout the test process. The authors divided cost categories into prevention, appraisal, internal failure, and external failure. Supplies and labor costs constituted prevention and appraisal costs, while internal and failure costs included the cost to correct the number of non-conformances recorded within one month (Table 2).

Similarities were observed in the base calculations for three articles, which were used to assign quality-related manpower hours, reagent wastage, and the retesting of controls or calibrators across the two articles where data were available. [7, 19]. Personnel salaries for

quality-related activities were calculated as the time per activity multiplied by the average personnel cost per hour. The cost of calibrators, QC testing, and rework was calculated based on usage and the price per test. In contrast, Carlson and his colleagues [20] use the cost per defect as the base calculation to quantify quality cost.

The laboratories reported variations in cost-of-quality data, even when the base calculations were similar. Data from a laboratory in Uganda showed that 94% of quality costs were attributed to good quality (24% spent on prevention activities and 70% on appraisal activities). Poor quality accounted for the remaining 6% of the cost (4% on internal quality costs and 2% on external quality costs) [7]. In contrast, quality costs in a hospital laboratory in the United States represented 35% of operating expenses (10% for good quality and 25% for poor quality [19]). Meanwhile, in a clinical laboratory in Morocco, good-quality costs accounted for 83% of the total quality cost (prevention and appraisal costs were shared equally). The cost of poor quality was reported as 17% (11% for internal failure and 6% external failure) [11]. In a study using sigma and lean approaches, good-quality costs accounted for 93% of quality costs (3% on prevention costs and 90% on appraisal costs). Bad quality costs accounted for 7% of the total quality cost (with all 7% spent on internal failure cost) [20]. These deviations were not uncommon and were also observed among organizations in the electronics or manufacturing industries [4].

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Table 2. Summary of Articles Demonstrating Application of CoQ Models

Country	Model	Cost Elements	Results	Publication
United States	Process Cost Model	Cost of Conformance salaries, QA activities, QC materials, activities related to normal specimen collection, testing and reporting	Cost of quality-35% of operating expense Cost of conformance-10% of operating expenses	Menichino T. 1992

		Cost of Nonconformance retesting, cost of corrections when things go wrong i.e. instrument down-time and repair cost (including manpower), delayed response, increase hospital length of stay	Cost of nonconformance- 25% of operating cost Impact- reduction of the cost of non-conformance decreased by 83% over 9 months due to continuous improvement	
Uganda	PAF	Prevention Cost personnel salaries QA related activities), preventive maintenance program, office supply quality-related cost, competence training and CE program, LIS	Good Quality Prevention cost-24% of total quality cost Appraisal cost- 70% of total quality cost	Elbireer A., et. al. 2010
		Appraisal Cost QC and calibration, annual accreditation and inspection, EQA PT, other process improvement activities, process validation (i.e external method comparison testing)		
		Internal Failure Cost poor inventory management (wasted reagents), QC and calibration failures/retesting, data entry errors and rework, processing and accessioning errors and rework, SOP violations/corrections/rework cost.	Poor Quality Internal failure cost- 4% of total quality cost External cost- 2% of total quality cost	
		External Failure Cost Total testing process Pre-analytical - delay specimen processing, data entry errors, specimen processing error, rejected sample not reported, other Analytical- wrong test performed, result error, test not performed, other Post-analytical - extended turnaround time, transcription error, storage status error, data download error, lab requisition form missing, other		

Morocco	PAF+ Revised Juran Model	Prevention Cost personnel salaries (QA related activities), preventive maintenance program, office supply quality-related costs, competence training, and CE program, LIS	Good Quality Prevention cost-41% of total quality cost Appraisal cost- 90 % of total quality cost	Zahar M., et. al. 2015
		Appraisal Cost QC & Calibration, annual accreditation and inspection, EQA PT, other process improvements and quality activities, process validation (i.e external method comparison testing)		
		Internal Failure Cost poor inventory management (wasted reagents), QC and calibration failures/retesting, data entry errors and rework, processing and accessioning errors and rework, SOP violations/corrections/rework cost.	Bad Quality Internal failure cost-11% of total quality cost External cost- 6% of total quality cost	
		External Failure Cost Total testing process Pre-analytical - inappropriate sample, wrong anticoagulant, improper conservation method, inappropriate patient preparation, error in patient identification Analytical- expired reagents, control & calibrators, failure in aspiration system Post-analytical- mismatch sample and lab files, wrong result from analyzer sent to lab report, extended turnaround time, loss of result		
Not specified	Six Sigma Lean	Prevention cost supplies & labour	Good quality Prevention cost-3% of total quality cost Appraisal cost- 90 % of total quality cost	Carlson O.R., et. al. 2012
		Appraisal cost: supplies and labour		
		Internal Failure Cost - Cost to correct 45 internal errors	Poor Quality Internal failure cost- 7% of total	

		External Failure Cost - Cost to correct o external failures	quality cost External cost- 0% of total quality cost	

Discussion

The literature search confirmed that laboratorians do not widely use the cost of quality as a quality tool. Laboratory Managers cannot effectively plan or improve processes without measuring the cost of poor quality. The studies presented data that emphasized the value of CoQ as a quality management tool. Menichino [19] identified several areas of waste within laboratory processes that increased poor-quality costs. One such issue was the receipt of unnecessary phone inquiries, which accounted for 6.6% of productive hours and 30% of the cost of all non-conformances. The installation of an automated phone distribution system reduced disruptions by two-thirds in the year. Similarly, the implementation of corrective actions led to a reduction in the number of canceled tobramycin tests. The corrective action reduced poor-quality costs by 83% within 8 months, resulting in savings of $7,470 per year. These examples demonstrate that quality improvement efforts can lead to cost-reduction opportunities. The ultimate goal is to reduce failure cost to zero by continuously evaluating prevention efforts to achieve further improvements [10].

Similarly, Carlson and his colleagues [20] demonstrated the usefulness of the sigma and lean approaches for identifying and preventing defects and failures in patient and clinician services. During this process, the laboratory eliminated testing waste, thereby reducing the cost of a good unit (service).

The studies among the laboratories demonstrated variations in quality costs. Comparisons among organizations may not yield valuable insights, as cost categories or denominators used in the base calculation, and the period of data collection for quality costs, may vary. The cost of poor quality in a clinical laboratory in the United States was reported as 25% of operating expenditure [7], whereas in a clinical laboratory in Uganda, it was 6% of total quality expenditure [19]. Furthermore, costs within each category may differ based on the size and complexity of the organization, or on whether the organization is located in a resource-limited country. For example, the prevention cost for a clinical laboratory in Morocco was 41% of the cost of good quality. Equipment maintenance accounted for the largest share of prevention costs [11]. In contrast, prevention costs for a laboratory in Uganda were 24% of the cost of good quality. The largest share of this cost was salaries [19]. This variation was also observed in the two laboratories' cost allocations for appraisal. Appraisal cost in the former laboratory accounted for 42% of the total cost of good quality, with QC and calibration accounting for 50% of this expenditure. In contrast, in the laboratory in Uganda, appraisal costs represented 70% of the cost of good quality, with QC and calibrators comprising 89% of the category’s total cost [11, 19].

The cost of good quality represented the largest allocation of the total quality cost [7, 11, 20]. Quality pioneers generally view investment in prevention costs as reducing failure costs. A reduction in failure costs will eventually justify fewer inspections, consequently reducing appraisal costs. Elbireer [7] argued that, from the perspective of patient care, it would be more prudent to invest in prevention and appraisal costs to reduce the likelihood of poor patient outcomes. An opposing perspective is that appraisal tools detect only a portion of existing failures, and resources must be allocated to their correction. As a result, appraisal activities will eventually increase quality costs. Appraisal activities must

therefore focus on the highest-risk areas [20].

Cost of quality models possesses several challenges [7, 9]. It may be difficult to collect or measure direct labor costs, particularly when staff are involved in diverse activities. Oftentimes, this cost category is not analyzed or underestimated due to a lack of data on how the time is allocated among diverse activities [21]. The accuracy of data collection is dependent on the quality of the preliminary data field. The classical PAF model relies on accounting systems to collect cost data, which may not always capture relevant or accurate data within cost categories. Furthermore, it is the practice that quality data includes the department name from which they originate. This poses the potential for under-reporting of quality failures and, in turn, the cost of poor quality. Additionally, the hidden costs of poor quality are often difficult to measure, such as loss of customer confidence and damage to reputation. It is, however, the view of Crosby that while attempts should be made to measure quality cost, they should not be treated as a performance measurement but as an indication of where corrective action will be profitable [8].

Foulad and colleagues [9] argued that CoQ models are designed primarily to reduce costs and maximize profits. He thought that existing models did not consider all stakeholders' interests, particularly environmental concerns and customers' losses. He proposed a ‘paradigm shift’ to integrate the needs of stakeholders into quality interests. There may be relevance to his ideas in the current challenges posed by climate change and environmental concerns about the disposal of laboratory waste.

Conclusion

Little literature exists on applying CoQ models in the clinical laboratory, particularly in resource-limited settings. Existing publications demonstrated the value of these tools in identifying failures, preventing severe patient outcomes, and reducing costs. Tools such as the process model, six sigma, and the lean approach support continuous improvement in processes and the elimination of waste, which affect post-quality costs. Further research is, however, required to apply these models in resource-limited countries, where diverse challenges may arise. Additionally, consideration must be given to developing new models that capture the needs of all stakeholders.

Conflict of Interest

The author has no potential conflicts in the publication of this article.

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Ethical Approval

No ethical approval was required for this study. No data were collected from patients or the general public for this publication.

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors’ Contributions

DSW conceptualized the project ideas, drafted, and revised the manuscript.

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Adolescent Nutrition Surveillance in Africa: Addressing the Triple Burden of Malnutrition Through Stronger Health Information Systems

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Abstract *Adolescence represents a critical stage of human development characterized by rapid physical growth and increased nutritional requirements. However, adolescents remain underrepresented in nutrition surveillance systems, particularly in low- and middle-income countries where the burden of malnutrition remains high. This study aimed to examine the current state of adolescent nutrition surveillance and identify key gaps in existing data systems that limit evidence-based policy and programming. We conducted a narrative literature review and policy analysis using scientific publications and authoritative institutional reports published between 2000 and 2025. Data sources included peer-reviewed journals and reports from major global health organizations. The analysis focused on measuring adolescent nutritional indicators and integrating these indicators into national health information systems. The findings reveal that current surveillance systems largely prioritize children under five years of age and women of reproductive age, leaving adolescents underrepresented in routine monitoring systems. Existing data sources, including household surveys and school-based health surveys, provide only partial and irregular information on adolescent nutritional status. Furthermore, adolescents are increasingly affected by the triple burden of malnutrition, including undernutrition, overweight and obesity, and micronutrient deficiencies such as anaemia. Strengthening adolescent nutrition surveillance by integrating standardized indicators into national health information systems is essential to support evidence-based decision-making, guide targeted interventions, and improve long-term health outcomes for adolescents.*

Keywords *Adolescent Nutrition, Anaemia, Malnutrition, Nutrition Surveillance, Overweight, Thinness.*

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Introduction

Adolescence, defined as the period between 10 and 19 years of age, represents a critical stage of growth and development characterized by rapid physical, cognitive, and psychosocial changes. Nutritional requirements increase substantially during this period, making adolescents particularly vulnerable to poor dietary practices and nutritional deficiencies. Investments in adolescent nutrition can generate long-term benefits for health, educational attainment, and economic productivity across the life course. Recent global health research highlights adolescence as a unique opportunity to improve health trajectories and break intergenerational cycles of malnutrition [1].

Globally, adolescents face a triple burden of malnutrition encompassing undernutrition, overweight and obesity, and micronutrient deficiencies such as anaemia. These forms of malnutrition increasingly coexist within the same populations due to complex interactions between food insecurity, nutrition transition, urbanization, and socio-economic inequalities. While undernutrition and micronutrient deficiencies remain highly prevalent in many low- and middle-income countries, overweight and obesity among adolescents have increased considerably over recent decades [2, 3]. This evolving nutritional landscape requires stronger surveillance systems capable of monitoring diverse dimensions of adolescent nutritional status.

Sub-Saharan Africa hosts the world's fastest-growing adolescent population, and projections from the United Nations Population Fund (UNFPA) indicate that adolescent populations in the region could increase by more than 60% by 2050 [4]. This demographic transition presents major opportunities and challenges for health systems, particularly in relation to nutrition. Despite growing global recognition of adolescent health, many African countries still lack comprehensive systems to monitor adolescent nutritional status and generate routine data to guide policy and programming.

In Senegal, a 2025 national assessment conducted within the Global Action for Measurement of Adolescent Health (GAMA) framework highlighted substantial gaps in adolescent nutrition surveillance systems. Although multiple national data sources exist, including DHIS2 routine data, demographic surveys, and nutrition assessments, major limitations persist regarding the availability, standardization, and age disaggregation of adolescent nutrition indicators, particularly among adolescents aged 10–14 years. The assessment also reported an anaemia prevalence of 29.1% among adolescents, with higher prevalence among adolescents aged 15–19 years (38.9%) compared with those aged 10–14 years (23.3%). Thinness was more prevalent among younger adolescents, while overweight and obesity were more frequently reported among older adolescents. These findings illustrate broader challenges faced across many African countries in strengthening adolescent nutrition surveillance systems and integrating adolescent-specific indicators into routine health information systems.

Although adolescents represent a large proportion of the African population, nutrition surveillance systems continue to prioritize children under five years of age and women of reproductive age, leaving adolescents underrepresented in many national health information systems. Existing data sources, including Demographic and Health Surveys (DHS) and school-based health surveys, often provide fragmented and incomplete information on adolescent nutrition. At the same time, Africa continues to face a persistent burden of undernutrition, micronutrient deficiencies, and increasing overweight and obesity among adolescents. Globally, more than 390 million children and adolescents aged 5–19 years were overweight in 2022, including approximately 160 million living with obesity [5]. These trends underscore the urgent need for

stronger adolescent nutrition surveillance systems and standardized indicators to support evidence-based public health action.

Global frameworks increasingly emphasize strengthening adolescent health measurement systems. The Global Accelerated Action for the Health of Adolescents (AA-HA!) framework [6] and the Global Action for Measurement of Adolescent Health (GAMA) initiative [7] both call for improved monitoring systems and standardized indicators to support evidence-based adolescent health policies and programmes. GAMA specifically identifies key nutrition indicators, including the prevalence of overweight and obesity, thinness, and anaemia among adolescents. Integrating these indicators into national health information systems, including digital platforms such as DHIS2, offers an important opportunity to strengthen adolescent nutrition surveillance and improve decision-making.

However, significant gaps persist in the availability, standardization, and use of adolescent nutrition data within many African health systems. Unlike previous reviews that primarily focused on global adolescent nutrition trends, this study emphasizes the African context and examines adolescent nutrition surveillance from a health information systems perspective. By integrating evidence from global frameworks together with emerging national experiences from Senegal, the review highlights operational gaps related to adolescent nutrition indicators, age disaggregation, and the integration of adolescent nutrition data into routine health information systems. This review therefore contributes to the limited literature examining adolescent nutrition surveillance in African settings and explores opportunities to strengthen data systems for improved policy and programmatic decision-making.

Materials and Methods

This study used a narrative literature review combined with a policy analysis approach to examine the current status of adolescent nutrition surveillance and identify key gaps in existing measurement systems. The review focused on global and regional evidence related to adolescent nutrition, particularly the triple burden of malnutrition, which includes undernutrition, overweight and obesity, and micronutrient deficiencies such as anaemia. The study primarily examined how global health frameworks and national health information systems measure and monitor adolescent nutrition.

Figure 1 presents the conceptual framework illustrating the relationship between adolescent malnutrition and surveillance systems.

The literature search used combinations of keywords related to adolescent nutrition, nutrition surveillance, health information systems, DHIS2, Africa, and Senegal.

The analysis was conducted as a global review of scientific literature and policy documents with particular relevance to low- and middle-income countries, where the burden of adolescent malnutrition remains substantial and adolescents continue to face major nutrition vulnerabilities [8]. The analysis considered global frameworks guiding adolescent health measurement, including the Global Accelerated Action for the Health of Adolescents (AA-HA!) framework, the Global Action for Measurement of Adolescent Health (GAMA) initiative, and monitoring indicators linked to the Sustainable Development Goals (SDGs). These frameworks provide important guidance for strengthening adolescent health measurement and integrating adolescent nutrition indicators into national health information systems.

Because the study relied entirely on secondary data sources, no laboratory experiments or biological measurements were conducted as part of this research. Instead, the analysis focused on synthesizing existing evidence regarding adolescent nutritional indicators, data collection methods, and surveillance frameworks reported in the literature. Particular attention was given to

commonly used indicators such as body mass index, dietary patterns, anaemia prevalence, and other micronutrient deficiencies reported in national and global surveys.

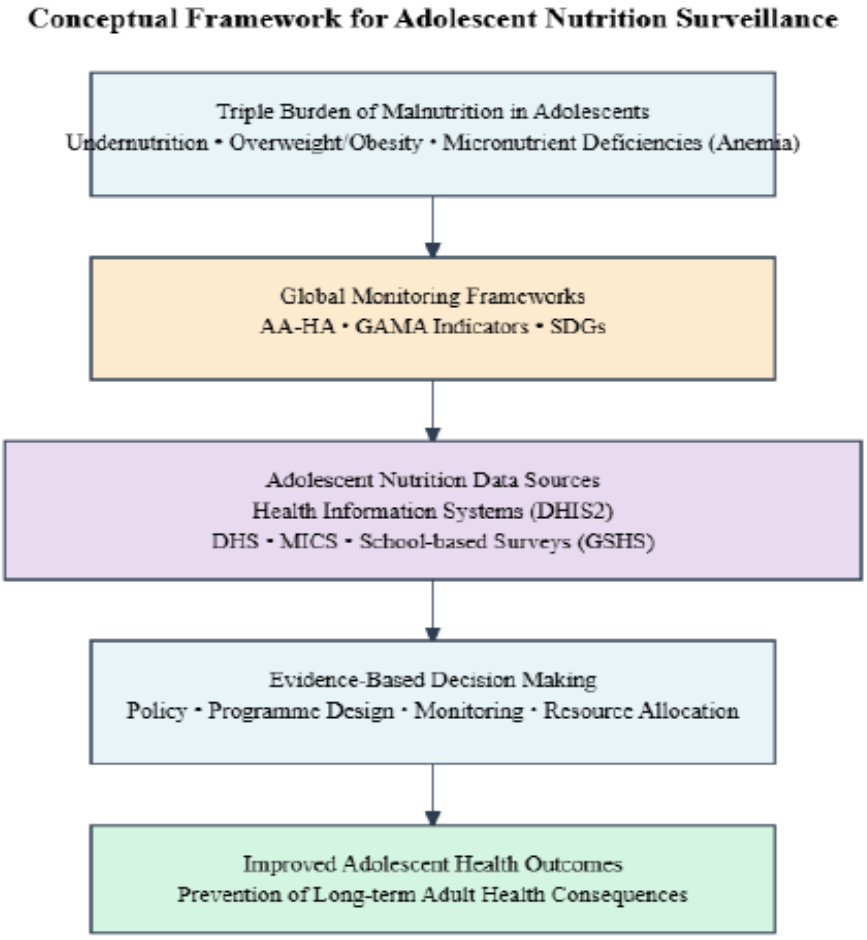


Figure 1. Conceptual Framework Illustrating the Relationship Between the Triple Burden of Malnutrition Among Adolescents, Global Monitoring Frameworks, Nutrition Surveillance Systems, and Evidence-Based Policy Responses

Inclusion and exclusion criteria were defined to ensure the relevance and quality of the selected documents. Included documents comprised peer-reviewed scientific articles, institutional reports, policy documents, and global health publications focusing on adolescent nutrition, adolescent health surveillance, nutrition indicators, or health information systems published between 2000 and 2025. Priority was given to documents addressing low- and middle-income countries, particularly African settings.

Documents were excluded if they focused exclusively on children under five years of age or adults without specific adolescent data, lacked sufficient methodological information, or were not directly related to adolescent nutrition surveillance or health information systems.

The search initially identified 88 documents, of which 19 were finally retained after screening and eligibility assessment. This confirms that while broader literature on adolescent health and nutrition exists, evidence specifically addressing adolescent nutrition surveillance and integration into health information systems in African contexts remains limited. Table 1 summarizes the literature search and document selection process.

Table 1. Summary of Literature Search and Document Selection Process for the Review of Adolescent Nutrition Surveillance Systems

Step of Review Process	Description	Number of Documents
Records identified	Documents identified through PubMed, Scopus, Google Scholar, Web of Science and institutional sources	88
Records screened	Documents screened after removal of duplicates and irrelevant titles	72
Records excluded	Documents excluded because they were not focused on adolescents, nutrition, surveillance, Africa, Senegal or HIS/DHIS2	38
Full-text documents assessed	Full-text articles, reports and policy documents assessed for eligibility	34
Full-text documents excluded	Documents excluded due to limited relevance, absence of adolescent-specific indicators, or insufficient focus on surveillance systems	14
Final documents included	Documents retained for analysis	19

The collected literature was analyzed using a thematic analytical approach to identify common patterns and gaps in adolescent nutrition surveillance. Selected documents were systematically reviewed and categorized by key analytical themes, including existing adolescent nutrition indicators, data collection sources, integration of adolescent indicators within health information systems, and implications for policy and program decision-making. This analytical approach identified major limitations in current surveillance systems and highlighted opportunities to strengthen adolescent nutrition data systems to better inform health policies and interventions.

Results

Table 2 summarizes the main documents and reports included in the review.

Table 2. Summary of Key Documents Included in the Review of Adolescent Nutrition Surveillance Systems

Author/Organization	Year	Type of Document/Study	Geographic Focus	Main Contribution to Adolescent Nutrition Surveillance
Sawyer S.M. et al.	2018	Review article	Global	Defined adolescence as a critical developmental stage requiring targeted nutrition and health interventions
Christian P. & Smith E.R.	2018	Review article	Global	Examined the burden and physiological determinants of

				adolescent undernutrition
Salam R.A. et al.	2016	Systematic review	LMICs	Reviewed interventions to improve adolescent nutrition outcomes
Ross D.A. et al.	2020	Framework article	Global	Proposed standardized adolescent health indicators under the GAMA initiative
Popkin B.M. et al.	2020	Review article	Global	Described the dynamics of the double burden of malnutrition and nutrition transition
Akseer N. et al.	2020	Review article	Global	Examined adolescent non-communicable diseases, determinants, interventions and policies
Norris S.A. et al.	2022	Lancet Series article	Global	Highlighted the role of nutrition in adolescent growth and development
Patton G.C. et al.	2022	Lancet commentary	Global	Emphasized the urgency of investing in adolescent nutrition globally
Azzopardi P.S. et al.	2019	Multi-country analysis	Global	Assessed progress in adolescent health and wellbeing indicators across countries
Ng M. et al.	2014	Global epidemiological analysis	Global	Reported trends in overweight and obesity among children and adolescents
Sy M. et al.	2025	Cross-sectional study	Senegal	Reported nutritional status and associated factors among adolescents in Senegal
Ndovie P. et al.	2025	Systematic review	Malawi and Ghana	Examined adolescent dietary diversity and micronutrient deficiencies
UNICEF	2021	Institutional review report	LMICs	Highlighted gaps in adolescent nutrition

				monitoring and data availability
WHO	2017	Global policy framework	Global	Introduced the Global Accelerated Action for the Health of Adolescents (AA-HA!) framework for adolescent health action
WHO / GAMA Initiative	2021	Global framework report	Global	Identified priority indicators and measurement gaps for adolescent health and nutrition
Global Nutrition Report	2023	Global nutrition report	Global	Reported trends in the triple burden of malnutrition
World Bank	2020	Technical report	Global	Reviewed nutrition and health data systems for adolescents
WHO	2020	Survey framework	Global	Provided guidance on the Global School-based Student Health Survey (GSHS)
Senegal GAMA Workshop Report	2025	National assessment report	Senegal	Identified gaps in adolescent nutrition indicators, DHIS2 integration and age disaggregation
DHS Senegal	2023	National household survey	Senegal	Provided adolescent nutrition and anaemia-related data for Senegal

The review of scientific literature and global health reports revealed several key insights regarding the current status of adolescent nutrition surveillance. Overall, the findings indicate that although global awareness of adolescent health has increased in recent years, the measurement and monitoring of adolescent nutrition remain fragmented and insufficiently integrated into routine health information systems.

A key finding of the review is that most existing nutrition data systems focus primarily on children under five years of age and women of reproductive age, with limited attention to adolescents. Large-scale household surveys such as Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) provide some information on adolescent nutrition, particularly among adolescent girls. However, these surveys are conducted only periodically and therefore cannot support continuous monitoring of adolescent nutritional trends. In addition, many national health information systems do not systematically include adolescent-specific nutrition indicators, which limits the

availability of routine data for policy and program planning [3].

The review also identified several global and national data sources that provide partial information on adolescent nutritional status. School-based surveys, including the Global School-based Student Health Survey (GSHS), collect data on dietary behaviors, physical activity, and body mass index among adolescents. Similarly, some national nutrition surveys include anthropometric measurements that can be used to assess undernutrition or overweight among adolescents. However, these data sources are often implemented irregularly and are not always harmonized across countries, making cross-country comparisons difficult [9].

Another key finding concerns the types of indicators currently used to monitor adolescent nutrition. The literature indicates that the most commonly reported indicators include body mass index for age, prevalence of overweight and obesity, dietary diversity, and anaemia prevalence among adolescent girls. While these indicators provide valuable information, they often fail to capture the full complexity of adolescent nutritional status. For example, micronutrient deficiencies other than anaemia are rarely measured in routine surveillance systems, and indicators related to dietary quality and food environments remain limited [2].

The review further highlights the growing concern regarding the triple burden of malnutrition affecting adolescents globally. In many low- and middle-income countries, undernutrition and micronutrient deficiencies remain widespread, particularly among adolescents living in rural and low-income settings. At the same time, overweight and obesity among adolescents have increased significantly in both urban and rural areas, reflecting global dietary transitions and increased exposure to energy-dense processed foods. Recent global estimates suggest that overweight and obesity among adolescents have risen dramatically over the past decades, creating new public health challenges for health systems [10, 11].

The provisional report of the Global Action for Measurement of Adolescent Health (GAMA) assessment conducted in Senegal further illustrates the growing triple burden of malnutrition among adolescents. The report documented an anaemia prevalence of 29.1% among adolescents, with higher prevalence among adolescents aged 15–19 years (38.9%) compared with adolescents aged 10–14 years (23.3%). Thinness was more prevalent among younger adolescents aged 10–14 years (24.5%), while overweight and obesity were more frequently reported among older adolescents aged 15–19 years. These findings highlight substantial nutritional vulnerabilities among adolescents and emphasize the importance of age-disaggregated nutrition surveillance systems.

Another key observation in the literature is the fragmentation of adolescent nutrition data sources. Data relevant to adolescent nutrition are often collected across multiple sectors, including health, education, and social protection systems. However, these data are rarely integrated into a unified surveillance system that can provide a comprehensive picture of adolescent nutritional status. As a result, policymakers often face challenges in accessing reliable and timely information needed to design targeted interventions and monitor program performance [12].

The main sources of data used to monitor adolescent nutrition are summarized in Figure 2.

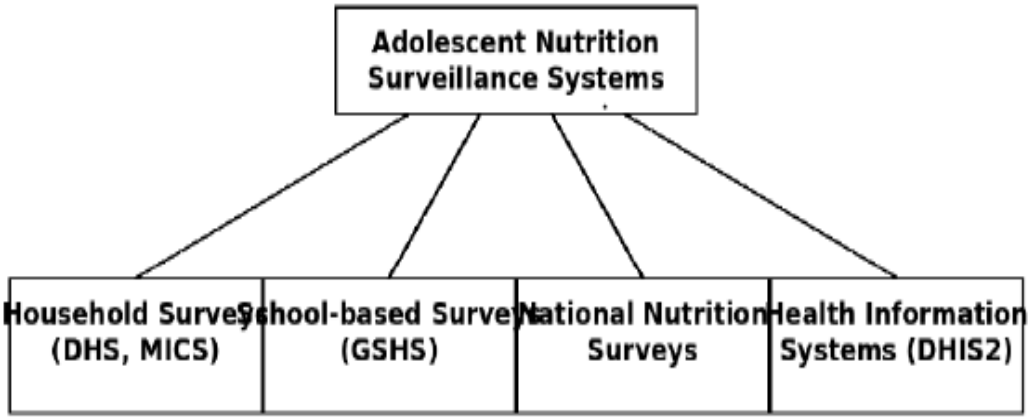


Figure 2. Major Data Sources Contributing to Adolescent Nutrition Monitoring, Including Household Surveys (DHS, MICS), School-Based Surveys (GSHS), National Nutrition Surveys, and Routine Health Information Systems such as DHIS2

Finally, the review indicates that despite growing recognition of the importance of adolescent health, major gaps remain in the availability, quality, and use of adolescent nutrition data. The limited integration of adolescent health indicators into national health information systems, and irregular data collection mechanisms contribute to significant knowledge gaps. Strengthening adolescent nutrition surveillance systems is therefore essential to support evidence-based policymaking and to ensure that adolescent nutrition receives adequate attention within national and global health agendas.

Discussion

The findings of this review highlight persistent gaps in the measurement and monitoring of adolescent nutrition despite increasing global recognition of the importance of adolescent health. While international initiatives and global health frameworks have emphasized the need to address adolescent health and nutrition, the results indicate that adolescents remain underrepresented in nutrition surveillance systems. Existing monitoring structures continue to prioritize children under five years of age and women of reproductive age, leaving a significant gap in the routine collection of data on adolescent nutritional status.

This pattern is consistent with previous research highlighting the historical neglect of adolescent nutrition within global health systems. Ross et al. [13] emphasized the need for a shared conceptual framework and multidimensional indicators to strengthen the measurement of adolescent well-being across settings. Similarly, studies examining adolescent nutrition have emphasized that the lack of standardized measurement tools and surveillance frameworks limits the ability of policymakers to accurately assess adolescent nutritional needs and monitor progress over time [14].

The results of this study also confirm the complexity of adolescent nutrition, characterized by the coexistence of undernutrition, overweight and obesity, and micronutrient deficiencies. This triple burden of malnutrition reflects broader global nutrition transitions and changing food environments affecting adolescents worldwide. Evidence suggests that many low- and middle-income countries are simultaneously facing persistent micronutrient deficiencies and rising rates of overweight and obesity among adolescents. According to global analyses, the increasing availability of energy-dense foods and the rapid

urbanization observed in many regions have significantly influenced dietary patterns and lifestyle behaviours among adolescents [15].

Another significant issue highlighted in this study is the fragmentation of existing adolescent nutrition data systems. Information on adolescent nutritional status is often dispersed across different sectors such as health, education, and nutrition programs, with limited coordination or integration between these systems. As a result, decision-makers often lack access to comprehensive and timely data needed to inform policies and interventions targeting adolescent populations. Previous studies have emphasized that strengthening health information systems and integrating adolescent health indicators into routine data systems are essential steps toward improving evidence-based decision-making [16].

Experiences from Senegal further illustrate the operational challenges faced by many African countries in integrating adolescent nutrition indicators into routine health information systems. These challenges include fragmented data sources, limited age disaggregation between younger and older adolescents, and insufficient harmonization of adolescent nutrition indicators within national DHIS2 platforms.

From an operational perspective, integrating adolescent nutrition indicators into national DHIS2 platforms requires harmonization with existing reporting tools, standardization of indicators, and capacity building for health workers and data managers to improve the routine collection, analysis, and utilization of adolescent nutrition data within national health information systems, in addition to validation within national health information system governance frameworks. Experiences from Senegal further demonstrate that fragmented data sources and the absence of adolescent-specific nutrition indicators within routine reporting systems remain major barriers to effective monitoring and evidence-based policymaking.

Furthermore, global initiatives such as the Global Action for Measurement of Adolescent Health (GAMA) have highlighted the urgent need for standardized indicators and improved measurement approaches to ensure that adolescents are adequately represented within health data systems. Integrating adolescent nutrition indicators into national health information systems could significantly improve governments' and development partners' capacity to monitor trends, identify priority populations, and design targeted interventions.

From a policy perspective, strengthening adolescent nutrition surveillance requires coordinated efforts across sectors, including health [17], education, and social protection systems to improve data integration and support coordinated policy responses. Governments and development partners should prioritize the integration of adolescent nutrition indicators into routine health information systems and national monitoring frameworks. Such efforts would also contribute to the achievement of the Sustainable Development Goals and strengthen national capacities for monitoring adolescent health and nutrition outcomes [18]. Investments in digital health platforms such as DHIS2 can further support the routine collection and analysis of adolescent health data, thereby improving the capacity of countries to monitor nutrition trends and design targeted interventions for adolescents. Strengthening adolescent data systems and improving the availability of routine nutrition information have also been identified as critical priorities for evidence-based decision-making in low- and middle-income countries [19].

A conceptual model illustrating how adolescent nutrition surveillance systems could be strengthened through the integration of standardized indicators into national health information systems is presented in Figure 3.

https://doi.org/10.21522/TIJPH.2013.14.03.Art037

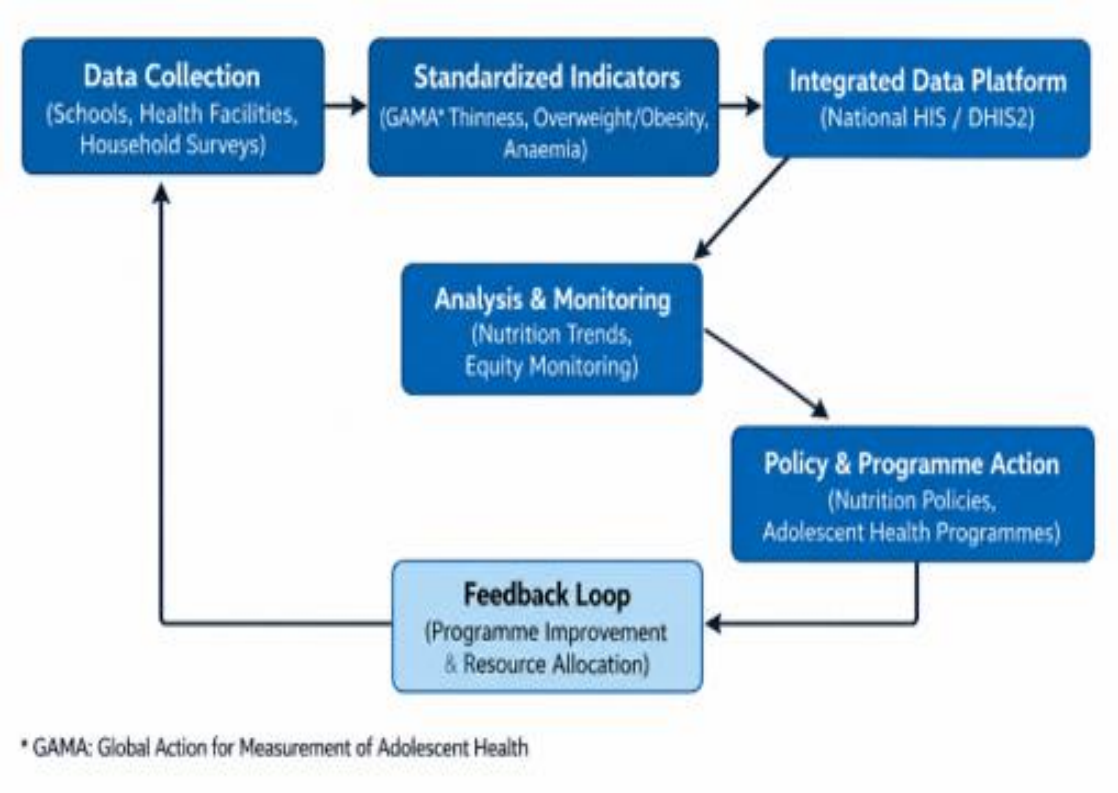


Figure 3. Recommended Adolescent Nutrition Surveillance System Illustrating the Flow from Data Collection Through Standardized Indicators and Integrated Health Information Systems to Analysis, Policy Action and Programme Feedback Mechanisms

Despite the valuable insights provided by this review, several limitations should be acknowledged. First, the study relied primarily on secondary data from published literature and institutional reports, which may not fully capture country-specific experiences or recent developments in adolescent nutrition surveillance. Second, the narrative review methodology does not allow for quantitative synthesis of findings or direct measurement of the magnitude of surveillance gaps across different settings. Additionally, variations in study designs and measurement approaches across the reviewed literature may limit the comparability of findings.

These limitations highlight the need for more context-specific and empirical research to better understand how adolescent nutrition surveillance systems can be strengthened at national and subnational levels. In this regard, the present study provides an essential conceptual and analytical foundation for further research. Building on these findings, the author will conduct more in-depth investigations as part of their doctoral research, which aims to explore the feasibility, challenges, and opportunities for strengthening adolescent nutrition surveillance systems within national health information systems. This research will generate context-specific evidence to support integrating adolescent nutrition indicators into routine monitoring systems and to inform evidence-based policy and programming.

The Global Action for Measurement of Adolescent Health (GAMA) initiative identifies key indicators for monitoring adolescent nutrition, including the prevalence of overweight and obesity among adolescents, prevalence of thinness among adolescents, and prevalence of anaemia among adolescents (Table 3).

Table 3. Key Indicators for Monitoring Adolescent Nutrition Based on the Global Action for Measurement of Adolescent Health (GAMA) Framework

GAMA Indicators	Description	Potential Data Sources	Relevance for Nutrition Surveillance
Prevalence of overweight and obesity among adolescents	Proportion of adolescents aged 10–19 years with body mass index above WHO reference thresholds for overweight or obesity	School-based surveys (GSHS), national nutrition surveys, health examinations	Captures the growing burden of overweight and obesity associated with nutrition transition and increased risk of non-communicable diseases
Prevalence of thinness among adolescents	Proportion of adolescents aged 10–19 years with body mass index-for-age below WHO reference thresholds	Household surveys (DHS, MICS), national nutrition surveys	Indicates undernutrition and chronic energy deficiency among adolescents
Prevalence of anaemia among adolescents	Percentage of adolescents aged 10–19 years with haemoglobin levels below WHO thresholds for anaemia	DHS surveys, school health programmes, micronutrient surveys	Reflects micronutrient deficiencies and nutritional vulnerability, particularly among adolescent girls

Conclusion

This study highlights persistent gaps in adolescent nutrition surveillance and monitoring, despite growing global recognition of the importance of adolescent health. Adolescence represents a critical period of growth and development during which nutritional status can significantly influence health outcomes across the life course. However, most nutrition surveillance systems continue to prioritize younger children and women of reproductive age, leaving adolescents underrepresented in routine health information systems.

The findings of this review emphasize that adolescents are increasingly affected by the triple burden of malnutrition, including undernutrition, overweight and obesity, and micronutrient deficiencies such as anaemia. Without adequate monitoring systems, these conditions may remain undetected and untreated, potentially leading to long-term health consequences in adulthood, including increased risks of non-communicable diseases, poor reproductive health outcomes, reduced productivity, and the intergenerational transmission of malnutrition.

Global measurement initiatives such as the Global Action for Measurement of Adolescent Health (GAMA) have identified key indicators to improve the monitoring of adolescent nutrition. These include indicators related to adolescent overweight and obesity, undernutrition, and anaemia prevalence among adolescents. Systematic measurement of these indicators is essential to capture evolving nutritional challenges affecting adolescents and inform evidence-based policies and interventions.

Strengthening adolescent nutrition surveillance therefore requires supporting countries in integrating these priority indicators into national health information systems and routine monitoring platforms. Such efforts will enhance the availability of reliable and timely data needed to guide policy decisions, design targeted nutrition interventions, and ultimately improve the health and well-being of adolescents while contributing to the

achievement of global nutrition and health targets.

Improving adolescent nutrition surveillance today represents a strategic investment in the health, productivity, and well-being of future generations.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article. The research was conducted independently, and no financial, institutional, or personal relationships influenced the design, analysis, or interpretation of the findings.

Author Contributions

Elodia Cheutou Siewoue: Conceptualization of the study, literature review, data analysis, and Manuscript drafting.

Fousséni Dao: Supervision, data curation, Formal analysis, review & editing.

Ousmane Dieng: Data curation, review & editing.

Abou Ba: Data curation, review & editing.

Sebit Mustafa: Supervision, review &editing.

Ethical Approval

Ethical approval was not required for this study because the research was based exclusively on secondary data obtained from published scientific literature and publicly available institutional reports. No human participants, personal data, or biological samples were involved in the conduct of this study.

Data Availability

All data used in this study are derived from publicly available sources cited in the reference list. No new datasets were generated or analysed during the current study.

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Unpacking Zimbabwe's Sub-national Health Systems Governance Dynamics in the 21st Century: A Scoping Review

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Abstract *Health system governance is growing in prominence globally, with increasing recognition of it's role in health system performance, particularly in low- and middle-income countries. Zimbabwe's Ministry of Health and Child Care (MOHCC) emphasizes the criticality of effective health governance for equitable and universal health coverage. However, despite the efforts, governance challenges persist, and the subject remains under-explored in Zimbabwe. This scoping review systematically maps and synthesizes evidence on subnational health system governance in Zimbabwe in the 21st century. Databases searched include PubMed Central, Science Direct, Springer Nature Link, ProQuest, Google Scholar, and grey literature. Based on the employed search criteria, ten studies were identified and included in the review. The review found persistent governance challenges across governance domains, across governance levels and throughout the period under review. Poor accountability, weak leadership capacity, inadequate decision-space, undervalued community governance structures were frequently cited. Few studies demonstrated potential for enhancing health governance through deliberate efforts to capacitate governance structures and systematically institutionalize governance in the wider health functions. The review found that evidence on subnational health governance in Zimbabwe was scant. Strengthening the evidence base on subnational health governance through empirical research will be essential for informing future health sector reforms that strengthen governance at the subnational level.*

Keywords *Decision-Space, Governance Domains, Health Governance, Leadership, Subnational.*

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Introduction

Governance has emerged as a central theme in public health discourse and is increasingly recognized as a key driver for sustainable public health. The World Health Organization (WHO) defines health systems governance as processes that involve setting strategic direction, formulating policy, enforcing accountability, and overseeing system performance [1]. In decentralized systems, governance functions are distributed across multiple levels, making subnational governance particularly influential in shaping service delivery outcomes because it is responsible for frontline service provision. Understanding the governance dynamics at subnational levels is therefore essential for identifying pathways for health governance reform.

Zimbabwe's health system evolved through early post-independence expansion and decentralization. However, reform efforts have been affected by challenges including recurring public health emergencies, economic decline, socio-political challenges, and staff attrition, among others [2].

This scoping review maps and synthesizes existing evidence on sub-national health systems governance in Zimbabwe in the 21st century. Specifically, it examines how governance is structured, how it functions, how external factors influence it, and its role in shaping health sector performance.

Literature Review

Conceptual Foundations of Health System Governance

The WHO identifies health system governance as one of the six health systems building blocks, alongside service delivery, health workforce, information systems, medical products, and financing. Different health system governance dimensions or domains have been proposed, including leadership and stewardship; accountability, transparency; participation, inclusiveness, and equity; decentralization and decision space; coordination; and information and learning [3]. Effectively applying these governance dimensions in the health system is critical to achieving a nation's health goals. The realization of these health goals, especially across low- and middle-income countries (LMIC), is often undermined by persistent systemic challenges that constrain not only health service delivery, but also health governance itself.

Health Governance Dynamics: Global and Regional Perspective

Global efforts toward Universal Health Coverage emphasize equity and accountability. Developed countries have all-encompassing, higher-performing multi-level governance frameworks [4], while LMICs continue to face systemic governance challenges, including uneven decentralization, opaque resource allocation, and fragmented accountability [5]. In Africa, for example, the role of strong health governance in enhancing equitable access to health is documented [6], with regional bodies such as the African Union (AU) increasingly emphasizing the importance of governance in health, in particular multi-level and subnational governance as instrumental to ensure effective implementation of national and continental health strategies [7].

Lessons from LMIC countries show that strong, broad vision; clear strategic direction; local leadership capacity; clear mandates; and adequate resources are essential to effective health governance [8]. The implementation of different strategies to strengthen local governance through decentralized decision making, community participation, performance monitoring and financial governance have shown promising results across different African countries, although more sustained efforts will be needed to ensure these strategies are implemented at scale for long-term system-wide impact [9].

Health Governance Dynamics: Zimbabwe's Perspective

Zimbabwe has a multi-level health system governance structure managed from the national level by the Ministry of Health and Child Care (MOHCC), to the provincial health executives (PHEs), district health executives (DHEs), and facility-level health centre committees (HCCs). These structures are mandated to coordinate policy and planning, resource mobilization, accountability, service delivery among others. The MOHCC's National Health Strategy of 2021–2025, prioritizes effective governance among other strategies to realize its goals towards health for all [10]. However, MOHCC's governance efforts have been constrained across levels by challenges such as inadequate decentralization, weak regulatory frameworks, inadequate staffing, weak leadership capacity, and limited resources [11].

Evidence suggests that Zimbabwe continues to reform its health governance structures, however, sub-national health governance dynamics remain underexplored. Most studies focus on financing, human resources, or national-level reforms, with limited attention to how provincial, district, and facility-level governance structures function and interact. This scoping review addresses this gap by mapping and synthesizing evidence on governance dynamics at sub-national levels, highlighting successes, challenges and opportunities.

Methodology

Study Design

This study utilised a scoping review design, a suitable choice of study design considering the subject covered by the research topic is not well developed, still emerging and is underexplored in Zimbabwe. This is unlike systematic literature reviews which provide a narrowly focused synthesis from a well-developed topic [12]. The scoping review design follows a systematic approach for identifying and analyzing existing evidence on sub-national health system governance dynamics in Zimbabwe.

This scoping review was conducted following the recommended 5 stages of scoping review from identifying to summarizing and reporting the results [13]. The PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) checklist was also utilised to systematically document the search and screening process, and consistent with scoping review methodology, it focused on mapping available evidence without assessing study quality [14].

Research Questions

What evidence exists on health governance dynamics within sub-national health systems in Zimbabwe within the 21st century?

Sub-questions included:

1. What are the structures and mechanisms of health governance at subnational level?
2. What is the performance of the subnational governance across governance domains?
3. What are the enablers and barriers to health governance at subnational level?

Search Strategy

A comprehensive search strategy was developed to capture peer-reviewed articles, policy documents, and grey literature published between 2000 and 2026. The systematic literature search was conducted by MC (author) and EN as second reviewer (duly acknowledged in acknowledgements section) to minimise bias.

Databases

The databases searched include PubMed Central, Science Direct, Springer Nature Link, ProQuest, Google Scholar, and grey literature was sourced from Government Website, (mainly the MOHCC) and International Organizations' websites (WHO, UNICEF, World Bank).

Search Guide and Keywords

The search strategy used for articles is shown in Table 1, and key words were applied using different combinations across all databases.

Table 1. Database Search Guide

	Governance Focus	**Geography**
"Health" OR	"governance" OR	"Zimbabwe" OR
"Health System" OR	"Stewardship" OR	"sub-national" OR
"Health Sector"	"system governance" OR	"provinc*" OR
	"system stewardship" OR	"district" OR
	"decentraliz*" OR	"facility" OR
AND	"devolution"; OR	"hospital" OR
	"accountability" OR	"clinic" OR
	"transparency" OR	"health centre"
	"function*" OR	
	"perform*"	
	AND	

Inclusion Criteria

This scoping review included the studies which focused on Zimbabwe's health system governance at sub-national levels and addressed governance structures, their function and performance across different health governance domains and factors determining their performance. The studies included were primarily peer-reviewed articles but also included credible grey literature. All literature would have been published from 2000 to 2026.

Exclusion Criteria

The scoping review excluded studies which did not analyze governance issues, even though they may have mentioned governance, such as where governance is not the focus of the article, publications that only focused on national-level governance without including sub-national health governance, non-English publications and those outside the timeframe.

Study Selection

The selection process for the studies followed the PRISMA-ScR guidelines. The titles and abstracts for all articles that were returned from the initial search were screened. Full-text screening was conducted for articles meeting inclusion criteria. This full screening was conducted independently by MC and EN, and the selection of the articles for final inclusion was done by both on consensus. A flow diagram was used to document the screening and selection process.

Data Extraction

A standardized data extraction form was developed in Excel and the relevant information from included studies was captured to include the author/s, publication year, title, study design, aim, target population and the key findings.

Overview of Included Studies

This scoping review included a total of 10 publications in the final analysis. These publications explicitly addressed sub-national health governance in Zimbabwe, examining the governance structures and processes at provincial, district and facility levels. The studies comprised empirical research articles, case studies, and policy analyses, spanning the period from 2000 to 2026. The included articles were heterogeneous, with different designs, scope, governance levels and context.

Evidence Synthesis of Included Articles

Considering the heterogeneity of the studies included, narrative synthesis method was applied for analyzing and summarizing the findings from the included studies [15]. Thematic synthesis was employed to identify emerging themes across articles. The themes were aligned as much as possible with - but not limited to - the WHO health governance dimensions. This was necessary so that evidence dictates the themes and not vice versa.

Ethical Considerations

This study utilizes published literature and does not involve human participants; hence ethical approval is not required. However, relevant ethical principles such as acknowledgment of sources and accuracy were consistently upheld.

Study Limitations

The included articles were methodologically heterogenous; hence the findings and conclusions need to be interpreted with this mind. The review only searched published sources, hence automatically excludes any unpublished reports which could potentially enrich the evidence. While clearly the small literature base which is too few for the 26 years considered under this review is a notable limitation for making meaningful conclusions for Zimbabwe's national landscape, it is also a clear justification for the appropriateness of a scoping review design for this study. Other potential limitations for this scoping review include language restriction to English and restrictions to Zimbabwean context which limits generalizability beyond Zimbabwe.

Results

Search Results

A total of 3,511 records were retrieved from the systematic search. Following de-duplication and application of exclusion criteria, 86 articles were retained for abstract screening and 46 selected for full-text review. After detailed review based on the inclusion criteria, a total of 10 publications were deemed eligible and included in the final synthesis. The figure 1 below shows the PRISMA ScR Flow Diagram which provides a summary of the search results.

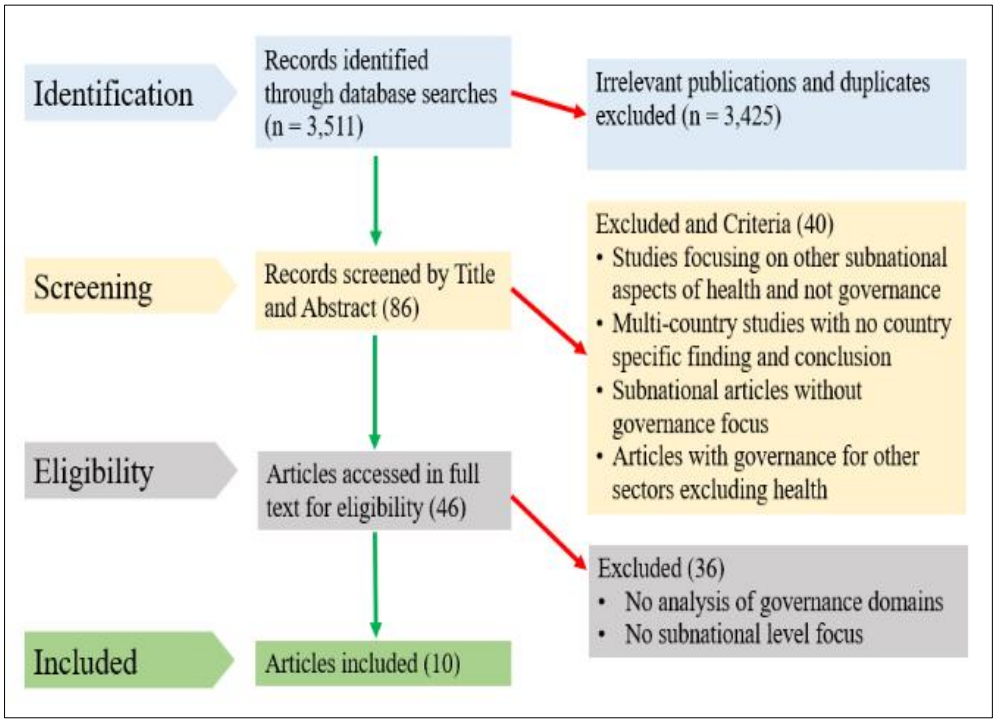


Figure 1. The Process of Screening and Selecting Studies

Individual Sources of Evidence

Table 2 below provides a summary of all the publications included in the final analysis of this scoping review. The summary includes for each publication, information on the author/s, title of article, study design, study population and key governance domains studied.

Summary Characteristics of Included Studies

Overall, 10 studies were included in the scoping review, with considerable heterogeneity in study design, focus and scale. Methodologically the evidence base included mixed methods cross-sectional descriptive studies (4), mixed-methods implementation or programme evaluation studies (2), qualitative case studies (1), literature or document reviews (2), and national mixed-methods health systems assessment (1). Most studies (8/10) reported empirical findings only at subnational levels, while three studies examined governance across both national and subnational levels. The primary study populations were health system actors at subnational levels, such as provincial and district health executives, programme managers, hospital management board members, frontline health workers, and HCC members.

Table 2. Individual Sources Included in the Review

Authors	Year	Title	Study Design	Study Population and Subnational Focus	Governance Dimensions
Funhiro, et al., [16]	2021	Standardization and strengthening the functionality of hospital management boards in central hospitals: Evidence of a developing economy	Mixed-method study design using the questionnaire and interviews	six central hospital management boards with each comprising seven non-executive and four executive board members	Leadership, Oversight, Transparency, Accountability, Planning
Muchekeza, et al., [17]	2012	District health executives in Midlands Province, Zimbabwe: are they performing as expected?	Descriptive cross-sectional study	District health services managers across 5 districts in Midlands Province (Gokwe South, Chirumanzu, Gweru, Shurugwi and Zvishavane).	Leadership, Coordination, Oversight, Accountability, Human Resources, Administration
Osika, et al., [18]	2010	Zimbabwe Health System Assessment 2010	Mixed-methods, rapid, integrated, cross-sectional national Health Systems Assessment (HSA) methodology	MOHCC headquarters officials, Provincial and district health managers, Hospital managers and clinical staff, Pharmacy and Laboratory personnel, Health information officers Donor Agency,	Stewardship, Decentralization, Authority, Accountability, Transparency, Equity, Health committees, community governance and participation

				Civil Society and faith-based organization	
Zhanda, and Chitongo [19]	2023	Devolution as a health governance paradigm amidst the COVID-19 pandemic in Zimbabwe: Convergences and divergences	literature review of published documents, press releases and reports aided by content analysis	Sub-national tiers of government, local-level health front-line institutions, and local communities	Decentralization and Decision -making autonomy ("decision space"), Accountability, Resource governance and, Coordination, Community participation.
Loewenson, et al., [20]	2004	Assessing the impact of HCCs on health system performance and health resource allocation	cross-sectional community surveys	Three districts Makoni, Gweru, Goromonzi), covering HCC and non-HCC wards including women, youth, the elderly, men in each ward, covering a total of 8 health facilities	Participatory governance, Accountability, decision-space, Oversight and performance, Resources Management
Maponga, et al., [21]	2022	Lessons learnt from implementing the Good Governance for Medicines Programme in Zimbabwe	Descriptive, qualitative implementation analysis / lessons-learnt study	Programme implementers and technical experts, Regulatory, procurement stakeholders at national and subnational levels in the MOHCC, Medicines Control Authority of Zimbabwe, National Pharmaceutical Services and Quality Assurance Units	Transparency, Accountability and oversight, capacity, decentralization, governance reforms

Witter et al., [22]	2019	The political economy of results-based financing: the experience of the health system in Zimbabwe	retrospective qualitative case study	National level and in two provinces (Midlands and Mashonaland East), including four districts (Murewa, Marondera, Gokwe North and Gokwe South).	Decision Making. Roles and multi-level relations, Ownership and Accountability
Chung et al., [23]	2020	Scaling up malaria elimination management and leadership: a pilot in three provinces in Zimbabwe, 2016-2018	Mixed-methods pilot implementation and programme evaluation	Provincial, District malaria programme managers; focal persons, Nurses, frontline malaria staff; health surveillance, case management, and vector control staff	Leadership skills and Management capacity, accountability and ownership, coordination (vertical and horizontal), decentralization
Kanonhuhwa [24]	2020	COVID-19 and the Environmental Hygiene Question: Some Proposals for Urban Health Governance in Zimbabwe	Case Study Literature Review	Urban cities within and outside Zimbabwe	Accountability, Resource mobilization, Community participation, social governance, coordination,
Taderera et al., [25]	2017	Human resource for health reform in peri-urban areas: a cross-sectional study of the impact of policy interventions on healthcare workers in Epworth, Zimbabwe	Cross-sectional study	Healthcare workers employed in health facilities located in Epworth, a peri-urban settlement near Harare, Zimbabwe.	Accountability, Stewardship, Human resource management and administrative governance, Policy implementation

Findings from Included Studies by Governance Domains

The most common governance domains across the included studies were accountability, appearing in (8/10) of the included articles, followed by leadership and management (6/10), coordination (6/10), decentralization and decision-space (5/10), community participation (5/10), and cross-cutting factors affecting governance such as human resource or administrative capacity (4/10).

Accountability

Accountability in health system governance means actors hold themselves responsible for their decisions and actions they take and will be answerable to the outcomes of those decisions and actions. Common accountability measures from included studies are; reporting, performance audits, and oversight activities such as supervision, among others. The findings from the review show that accountability is one of the most studied governance domains, featuring across the sources included in this

review. Notably, across most of these studies, accountability was found to be deficient. A common observation across both urban hospital management boards and rural District Health Executives (DHEs), was that both urban and rural governance structures performed inconsistently regardless of context [16-18]. Similarly, challenges of meeting reporting requirements were also common across rural and urban contexts. Further, multi-level reporting accountabilities, such as between district and province or health facility and community, were compromised during a crisis response to the COVID-19 pandemic. During this period, accountability functions became more centralized, with upwards reporting prioritised and downward reporting to the communities compromised [19].

Additional accountability deficits revealed from the review were that while most hospitals had hospital boards established, these boards lacked institutional guidance as they did not have clear policy framework to evaluate their performance. On the other hand, some DHEs were found to be failing to meet their deliverables for accountability such as conducting DHE meetings and documenting DHE minutes. Challenges such as inadequate training and staff capacity, resource constraints and unclear accountability guidelines were among the key factors attributed to accountability gaps.

At the community and local facility level, accountability was also a challenge. The review found that accountability to communities was better where HCCs existed, yet, they only existed in few facilities, and where they existed, they were either inadequately capacitated or resourced [20]. The poor accountability demonstrated by these findings is mainly driven by inadequate training, staff's lack of clarity regarding their leadership roles and unclear requirements on how they are to implement their accountability functions. However, it was found, from programme specific governance strategies, that there is potential of improving accountability and enhancing oversight efforts [21].

Leadership and Stewardship

Leadership and stewardship is another domain that frequently featured in most of the included studies. For this review, leadership and stewardship refer to the institutional structures, their management function, as well as their role in translating policy into action at the subnational level.

Evidence from the included studies shows that while the Ministry's vision on health governance is clearly articulated in the National Health Strategy (2021–2025), this does not always translate into strong leadership across all subnational levels. Health leaders at both provincial and district levels were found to be not sufficiently knowledgeable about their roles, with majority confessing they did not have adequate management skills and capacity [17, 18]. Governance actors at these levels attributed some of these gaps to unavailability of institutional guiding frameworks which they could use as reference in delivering on their mandate. The review, however, noted how deliberate effort to create an enabling environment and capacitating subnational health leaders with formal governance policy documents and tools, systematic oversight activities, and leadership training could empower and guide subnational teams on their governance functions [16, 21].

This scoping review observed how leadership and stewardship roles of subnational structures can be hampered in contexts where there is resource competition. In Districts implementing the results-based financing (RBF) model, it was found that the leadership and management functions of district management teams or HCCs were compromised, as they fell under what was described as '*guided democracy*', where they were expected to follow instructions from superior offices or funding agencies [22]. This

meant that decision making would be influenced by resources and who controls them.

In-spite of all these challenges, evidence from specific programme interventions found that targeted management and leadership support led to better leadership capacity, decision making, role clarity, sense of ownership and stronger health governance [23].

Transparency and Integrity

From the sources included in this review, transparency and integrity were among the key health governance domains that came up, although these were less pronounced than leadership or accountability. The review notes that transparency was widely regarded as an area of concern, with financial management or human resources issues often seen as opaque [16, 18, 22]. This had the effect of undermining trust and threatening unified efforts by subnational health governance bodies and ultimately affecting their overall performance. In unique ways, other included studies showed gaps in transparency as seen by fragmented urban health governance [24] and limited public access to information during emergency governance responses to COVID-19 [19]. In contrast, the 'Good Governance for Medicines Programme' provides an example of how integrity can be achieved when safeguards for transparency and integrity are deliberately integrated in routine systems [21]. At the interface of the health facility and local communities through HCCs, the evidence indicates that the presence of HCCs enhanced transparency in information sharing, which translated to improved decision-making and community participation [35].

Decentralization and Decision-Space

The concept of decentralization and decision-space refers to the efforts towards and the extent of delegation of authority and effectual decision-making power from central to subnational structures. Despite decentralization being an intrinsic factor of Zimbabwe's health system governance structure, evidence from this review shows that intention – as revealed by established MOHCC's governance structures 'on paper' – has in practice, not always translated to full delegation of authority and actual decision-space for subnational structures [18, 22]. Notably, this 'withholding' of authority by superior structures is not consistent across the board, but more control is retained on matters considered of strategic importance such as policy decision-making, financing, and human resources. In this scenario, effective authority has not been fully ceded by superior offices but only given on a 'piecemeal' basis, making the concept of decentralization remain largely more rhetorical than practical and more discretion based than systematic. Furthermore, it was found that where subnational structures lack control of key issues such as financing or staffing, they are found to be largely weakened and sometimes demoralized [24, 25].

Another scenario from the evidence is that decentralized authority can be re-centralized, as observed during the COVID-19 pandemic where the MOHCC's Headquarters led the pandemic response efforts by taking more control, directing how the response would be implemented across all levels of jurisdictions [19]. This limited the decision space of subnational teams with the effect of delaying response actions. At the community level, HCCs were present but not ubiquitous across all health facilities. Nonetheless, this is one structure where notable decision-space has been observed, despite some evident capacity and resource constraints [20]. However, the review also made some positive findings, where some studies demonstrated that autonomy at the provincial and district levels can be enhanced if the subnational structures are fully capacitated and allowed the decision-space to adapt strategies and tailor interventions according to their context [23].

Community Participation

The review found very few publications focusing on community participation as a health governance dimension. Unlike other governance domains which were observed from studies across different contexts and levels, the studies focusing on communication were primarily at the community level. The review found that health facilities with active HCCs managed to establish stronger collaboration and partnership between the service providers and service users in the community [20]. This strong engagement meant that communities were better informed about services available to them, and they were also engaged in planning, decision making and oversight of the health centre staff. Consequently, both the communities and health centre staff would become more responsive to each other's needs with a better sense of collective ownership. However, the study noted that the rollout of the HCC structure was uneven across provinces and districts and not adequately supported across all levels.

Cross-Cutting Governance Issues

In this review, cross-cutting governance issues are those underlying systemic conditions that apply across multiple governance domains and influence - both directly and indirectly - how governance functions are exercised across the domains. They are not in themselves governance domains. From the sources included in this review, some of the common cross-cutting issues that shaped subnational health governance include: the disconnect between formal governance arrangements and operational capacity, financing modalities, human resource constraints, inadequate staff capacity, underutilization of health information for decision making, and wider socio-political dynamics.

The review observed that centralized financing modalities are a major constraint which limits the flexibility of subnational structures to make decisions and prioritize based on their local needs [18, 22]. It was also observed that innovative approaches such as the RBF or other programme specific financing strategies may introduce bias and distort the governance framework and accountability roles [22, 23]. For instance, dedicated investments through this approach were seen to have a tendency of 'forcing' performance, often due to incentives attached to them. As a result, health managers tend to give priority and become more accountable in delivering and reporting on these programmes.

Another key factor found to constrain governance functions of subnational structures is staffing related issues. Shortage of staffing, limited capacity and inadequate training were found to undermine the staff's ability to make decisions and to effectively deliver on their leadership roles [17, 25]. Moreover, this limited capacity has also been found to contribute to the underutilization of health information for adaptive learning and decision making [18, 23].

Regarding power dynamics, what has been seen as potential overreach of central political control - such as in the emergency response to the COVID-19 pandemic - can usurp the decision-space of subnational structures and also risk relegating communities to just users of services who are not engaged in planning and decision making [19]. In the face of these cross-cutting issues largely negatively impacting subnational governance, the review also found positive impact from deliberate effort towards strengthening leadership capacity, building stronger systems and effective delegation of authority [21, 23].

Interpreting Performance across Governance Domains

Overall, synthesizing the evidence shows that the performance of subnational governance structures is mostly portrayed negatively across governance domains. This includes accountability deficits and transparency gaps at district and facility levels. Effective decentralization and decision-space remain, to

a large extent, a theoretical concept, with incomplete delegation of authority to subnational structures being a common feature. While community participation through HCCs shows potential, this is hampered by inadequate capacity and resources. However, positive lessons are apparent, especially from studies focusing on evaluating pilot health governance or programme specific initiatives.

Discussion

This scoping review is based on 10 studies which examine Zimbabwe's subnational health system governance. Consistent with most similar studies from LMICs, the findings show that subnational structures are mostly functionally constrained, with persistent gaps across all governance domains and across all levels of subnational health governance. Additional similarities are observed where dedicated efforts to enhance governance have produced tangible results, with recommendations for sustainable efforts towards long-term gains.

Assigned but not Capacitated

This review observed that on paper, the subnational health governance structures are established and recognized as existing, but that existence is often not accompanied by the requisite capacity building. This is corroborated by evidence from other LMICs such as Nigeria and Ethiopia where subnational healthcare leaders were found to have a gap in skills or expertise to deliver on their functions, and also demonstrating that where leadership capacity is weak, performance will be poor [26, 27]. The evidence from the review, however, also shows that it is possible to enhance governance across different domains through deliberate effort [23], with global evidence reinforcing this finding, noting that developing leaders through structured capacity building can translate institutional mandates into practical action and deliverables for health governance [28].

Incentives Introducing Governance Bias

This review found that there can be unintended negative consequences on subnational health governance due to some health system financing models which introduce bias towards better resourced programmes or those that have stronger donor requirements [22, 23]. This is consistent with other evidence which demonstrates how certain reforms or strategies - particularly those with some financing attached to them - may entrench control from superiors while undermining social accountability [29]. This distortion has the potential of undermining cohesion at the local level, where a single programme's strength may create disharmony, and negatively affect the broader health system.

Transparency Gaps Undermine Governance

From this review, it was observed that unclear resource management, procurement or staffing processes were major transparency gaps at the subnational level [16, 18]. Evidence from other literature shows that where transparency and integrity is compromised, governance performance and outcomes are also compromised [30]. On the other hand, evidence from the review aligns with other global evidence which shows that institutionalized transparency approaches have potential of improving governance functions within programme specific context, such as the Good Governance for Medicines [21, 31]. However, these programme specific mechanisms risk remaining as siloed 'white elephants', unless deliberately integrated into the wider health system. If appropriately positioned, these strategies can serve as entry points or 'pilots' to generate evidence to inform system-wide subnational health accountability reforms.

Partial Delegation Scuttles Effective Decentralization

In addition to findings from this review on partial delegation, evidence from other Sub-Saharan African countries points to more

sensitive complexities and sometimes political connotations which are seen as both cause and consequence of partial delegation [32]. This has been seen to undermine trust and confidence, resulting in weak relationships between central level policy makers and subnational implementers [33].

Observations from this review also mirror other global evidence, which shows that even those systems with advanced decentralization, are also at risk of re-centralization in the face of crises with need for control and coordination being main justifications [34]. Evidence from this review contradicts this notion, demonstrating that equipping subnational teams and expanding their decision space – not control - could in fact enhance their governance performance, even in the face of public health challenges [23].

While a general observation from the review and other LMICs is that decentralization and decision space are desirable, developed countries such as in Europe present a paradoxical position, with governments seeking to re-centralize, arguing the need to facilitate more coordinated efforts and alignment of strategies across subnational jurisdictions [35]. This raises the question of further research on whether the ideal is to fully or partially decentralize as a recommendation, and whether the recommendation would be the same for developing countries and the more developed countries.

HCCs' Untapped Potential

The role of community participation in health governance is widely accepted as a critical factor, especially for fostering social accountability to service users. While global evidence [36]- in line with findings from this review – notes that participatory health governance is most effective at the local service delivery point, it also recognizes that participatory health governance needs to be strengthened at the district or provincial levels as well. Moreover, it is observed that regardless of how strong the HCCs may be, they have limited influence on decisions made at the district level. WHO [37] bemoans the risk of the voices of the HCCs being ignored, especially when their district or provincial levels do not have similar structures. Consequently, the potential of HCCs risks remaining under-utilized.

Crosscutting Structural Factors Constrain Health Governance

One revealing finding from this review was that determinants of governance performance and drivers of governance challenges go beyond individual domains. They are influenced by several underlying, cross-cutting structural barriers which include challenges with financing and resource management, influence from external players, power dynamics, human resource gaps among others [18, 22]. Similar challenges have been reported in other African countries, where dependence on external funding, administrative inefficiencies, and poor organizational culture of performance have been found to undermine subnational health governance [38]. Moreover, weak information management and poor data usage at all governance levels have deprived managers of the requisite tools to drive evidence based and adaptive decision-making and governance.

Implications for Policy and Research

The number of publications included in this review is a genuine indication of a dearth of evidence on subnational health governance in Zimbabwe. It raises attention on the need for more research on this topic more broadly. More specifically, future research will need to explore how different governance domains - individually and collectively - impact health service delivery and health outcomes, to help determine prioritization for quicker gains. Moreover, the multi-level relationships between different governance levels need to be studied, to gain insights on how their

interactions affect both their governance performance and service delivery.

The findings also challenge the authorities to support and facilitate holistic and meaningful delegation to subnational structures. It also invokes on all actors' agency, towards enabling meaningful contribution of community level governance platforms for not just their local level, but for system wide impact. The review also brings out the need for systems-thinking, beyond individual governance domains, towards addressing health governance issues in the context of other structural factors that affect them.

Conclusion

This scoping review mapped and synthesized the available evidence on subnational health governance dynamics in Zimbabwe. The review found that accountability, stewardship and leadership, community participation, decentralization and decision space emerging as the most frequently examined domains, often affected by systemic challenges such as financing, staffing, and power dynamics. Health governance was frequently characterized as weak, fragmented, constrained, or inadequately resourced across all subnational levels throughout the period under review, suggesting persisting challenges throughout the period.

Beyond highlighting governance dynamics, this review also revealed that there is relatively scant empirical research on subnational health governance in Zimbabwe. The available literature remains unevenly distributed across governance domains, levels of the healthcare system and geographical settings. This paucity of evidence limits what conclusions can be made about the state of subnational health governance and stifles decision making on policy or practice. Nonetheless, the consistency of findings across studies points to the need for sustained efforts to strengthen subnational health governance across all domains and across all levels.

The evidence base points to the need for more empirical research on subnational health governance broadly, with more focus on the underexplored domains. More robust research could: assess the impact of specific domains – individually or in combination - on health service delivery and outcomes; multi-level dynamics, and determinants of subnational health governance performance. Research could also generate more robust evidence on the functionality, effectiveness and outcomes of subnational health governance structures.

Such evidence will be essential for informing governance reforms and supporting the development of more responsive, accountable, and effective subnational health systems in Zimbabwe.

Conflict of Interest

The author declares no conflict of interest.

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Ethical Approval

This study utilizes published literature and does not involve human participants; hence ethical approval is not required. However, good research practices were adhered to in managing the study.

Data Availability

The datasets generated during the current study are available from the corresponding author upon reasonable request.

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Author Contributions

Mufaro Chiriga conceptualized and designed this scoping review, carried out the data collection and analysis, as well as preparation of the manuscript.

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Fatal Diphtheria in a Rohingya Refugee Settlement in Cox's Bazar, Bangladesh: A Case Study of Clinical, Surveillance and Health-System Gaps

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Abstract *Diphtheria remains a significant threat in humanitarian settings with low vaccination coverage and fragile health systems. Global evidence indicates that outbreaks among displaced populations driven by overcrowding, immunity gaps, delayed clinical recognition, and weak surveillance systems, while limited availability of diphtheria antitoxin (DAT) further constrains effective case management. We conducted a descriptive case analysis of a fatal diphtheria infection, complemented by a public health investigation including contact tracing and surveillance review to identify gaps in clinical management and outbreak response. A 9-year-old unvaccinated boy residing in a Rohingya refugee camp in Cox's Bazar, Bangladesh, presented with fever and sore throat managed symptomatically without a throat examination. Rapid progression to severe disease with cervical swelling (bull neck) and respiratory distress occurred. On re-presentation, suspected diphtheria and later confirmed; however, delayed recognition, lack of access to DAT, and late referral led to death during transfer. Public health investigation identified 10 contacts who received prophylaxis but revealed delayed case notification, missed identification of a probable secondary case, and weak integration between clinical and surveillance systems. This case demonstrates how failures in early clinical recognition, timely access to DAT, and surveillance responsiveness, commonly reported in fragile and outbreak prone settings can converge to result in preventable mortality. Strengthening frontline clinical capacity, ensuring reliable DAT availability, improving real-time clinical–surveillance integration, and addressing immunization gaps are essential to reduce diphtheria deaths in humanitarian contexts.*

Keywords *Contact Tracing, Diphtheria, Humanitarian Settings, Refugee Health, Surveillance, Vaccination.*

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Introduction

Diphtheria is a vaccine-preventable disease caused by Corynebacterium diphtheriae, characterized by pharyngitis, pseudo membrane formation, and systemic toxicity. Despite the availability of effective vaccines, the disease persists in settings with low immunization coverage, particularly among displaced and conflict-affected populations, where outbreaks continue to occur with significant morbidity and mortality [1, 2].

Early clinical recognition and prompt administration of diphtheria antitoxin (DAT), alongside antibiotics, are critical to reducing case fatality. However, in humanitarian and resource-limited settings, delays in diagnosis, limited access to essential therapeutics, and weaknesses in surveillance systems frequently result in preventable deaths [3, 4].

Global evidence indicates that diphtheria outbreaks in fragile settings, displaced and conflict-affected populations, including Rohingya refugees driven by a combination of low vaccination coverage, overcrowding, delayed case detection, and inadequate health system capacity [5, 6]. Despite the existence of structured outbreak response mechanisms and surveillance platforms in many settings, fatal outcomes continue to occur, suggesting underlying systemic dysfunctions.

This case provides a micro-level illustration of systemic failures across clinical care, surveillance, and immunization systems in fragile humanitarian settings, demonstrating how gaps across the health system continuum can converge to result in preventable mortality [1, 6].

Background and Setting

Cox's Bazar hosts the world's largest refugee settlement, with over one million Rohingya refugees living in densely populated camps with poor sanitation and limited access to health care, conditions that facilitate transmission of vaccine-preventable diseases such as diphtheria [7, 8]. Following the 2017 mass influx, a major outbreak resulted in widespread transmission and high disease burden [9]. Despite sustained response efforts, recurrent outbreaks have persisted, with surveillance data from 2019-2022 demonstrating ongoing transmission across multiple camps and low-level circulation since 2021. Transmission peaked in 2022 [10], with 335 suspected cases reported including 46 confirmed cases, including two deaths, and 24 probable cases or probable cases. The case fatality rate (CFR) is 4.3% (2/46), slightly below the global range of 5-10% with treatment [11, 12], yet substantially higher than the <1% achievable with timely and effective case management. Cases have been reported from 16 of 33 camps, with evidence of spillover into host communities.

Vaccination coverage among cases remains suboptimal, consistent with documented immunity gaps in this population [13]. Persistent transmission is driven by low immunization coverage, particularly among older children, poor vaccine completion, high population density, and mobility, compounded by gaps in surveillance sensitivity and diagnostic capacity, sustaining endemic risk for both refugee and host populations.

Methods

Study Design

We conducted a descriptive case analysis of a fatal diphtheria infection, complemented by a public health investigation including contact tracing and surveillance review to identify gaps in clinical management and outbreak response.

Case Definitions

According to the Surveillance Guidelines for Diphtheria in Rohingya Refugee's, Cox's Bazar Bangladesh by WHO, following are case definitions [14, 15].

Suspect diphtheria case definition: An illness of upper respiratory tract associated with fever; sore throat characterized by laryngitis or

pharyngitis or tonsillitis, and adherent membranes of tonsils, pharynx, and/or nose.

Laboratory confirmed: A case that meets the clinical case definition where samples are collected, and laboratory results are positive for the suspected disease.

Epidemiologically linked: A case that meets the clinical case definition and is epidemiologically linked to a laboratory-confirmed case. In this situation, a person has had intimate respiratory or physical contact with a laboratory-confirmed case within the 14 days prior to onset of sore throat.

Clinical compatible: This type of case meets the definition of a suspected case and lacks both a confirmatory laboratory test result and epidemiologic linkage to a laboratory-confirmed case.

Discarded case: A discarded case is a suspected case that meets either of these criteria: Corynebacterium spp. but negative Elek test (nontoxigenic Corynebacterium) OR negative PCR for the diphtheria toxin (tox) gene.

Setting and Population

The study was conducted in Cox's Bazar, Bangladesh, home to one of the world's largest Rohingya refugee settlements, characterized by high population density and limited healthcare access. The population of interest comprised forcibly displaced Rohingya residents, particularly children with low immunization coverage, including an unvaccinated child from Camp 07.

Data Sources

Data for this case study were derived from a routine public health investigation conducted in Cox's Bazar. Information was collected through direct field engagement, including patient history obtained from caregivers, clinical records (where available), surveillance databases (EWARS and Go. Data), available on websites, laboratory reports, and contact tracing records. Additional contextual information was obtained through discussions with healthcare providers and public health staff involved in the response. Data were collected in person as part of public health response activities and subsequently anonymized for analysis.

Laboratory Methods

Nasopharyngeal sample was collected and sent in Amies media ensuring cold chain to the nationalized IEDCR Field Laboratory in Coxs Bazar supported by WHO. Diphtheria Triplex Real Time PCR assay Positive Control Kit was used for lab confirmation.

Contact Tracing and Surveillance Review

A structured review of contact tracing and surveillance processes was conducted to assess performance across case detection, notification, reporting, and response. It evaluated timeliness of case identification and notification, initiation of contact tracing, completeness of contact identification, and follow-up mechanisms, as well as data management across surveillance platforms.

The review also examined data integration, outcome verification, and coordination between clinical services, surveillance systems, and community reporting channels, including informal pathways. Delays in laboratory confirmation and case classification and their impact on timely response were assessed.

Overall, the review identified gaps in timeliness, completeness, and system integration affecting early detection and outbreak response effectiveness.

Analytical Framework

We applied a systems-oriented analytical framework to examine determinants of a fatal diphtheria case in a humanitarian setting, integrating clinical pathway analysis, surveillance evaluation, and health system assessment to identify interacting failures across the continuum of care and public health response.

A cascade model was used to reconstruct the sequence from symptom onset to death and to identify critical points of delay and system breakdown across six domains: population vulnerability, initial clinical assessment, diagnostic recognition, therapeutic intervention, referral and case management, and surveillance detection and response. At each stage, deviations from standard clinical and public health guidance were identified and classified.

Clinical management was assessed against WHO-recommended standards, focusing on timeliness of assessment, early suspicion, and prompt administration of diphtheria antitoxin (DAT). Gaps were categorized as diagnostic, therapeutic, or decision-making failures.

Surveillance performance was evaluated using key attributes—sensitivity, timeliness, completeness, and integration, including mapping of reporting pathways, case notification, laboratory confirmation, and contact tracing. This enabled identification of breakdowns in data flow, delayed reporting, and weak linkage between clinical and surveillance systems.

Systemic determinants were analyzed using the WHO Health System Building Blocks framework, examining service delivery, workforce capacity, medical products, health information systems, governance, and financing to identify structural and operational constraints.

Findings were synthesized using a systems-thinking approach, classifying determinants as immediate, underlying, or structural causes. These were integrated into a cascade failure model to illustrate how multi-level delays and deficiencies interacted to amplify risk and culminate in a preventable death.

Results

A 9-year-old boy, originally from Myanmar, had been living in Camp 07, Ukhiya, Cox's Bazar since 2017. The child had no documented history of vaccination back from Myanmar nor received any diphtheria-containing vaccine since arrival in refugee camps.

Clinical Findings Diagnostic Assessment, Therapeutic Intervention, and Outcome

The child developed mild fever and sore throat on 21 April 2022, which were managed at home with traditional remedies. As the symptoms did not subside, on 23 April 2022, he presented to a sentinel health facility and was treated symptomatically at the outpatient level without detailed clinical evaluation. Within hours of this visit, his condition (around midnight) further deteriorated, with the onset of neck swelling and respiratory distress. The illness progressed rapidly to features consistent with severe respiratory diphtheria, including bull neck swelling and stridor, indicating advanced disease.

Diphtheria was clinically suspected only at representation and subsequently laboratory confirmed, reflecting delayed recognition at initial contact. Initial management was limited to symptomatic treatment without adequate clinical evaluation, and although treatment was initiated later, diphtheria antitoxin (DAT) was not administered due to unavailability, despite classical clinical features. The patient's condition deteriorated rapidly, necessitating referral; however, death occurred during transfer due to progressive airway obstruction and systemic toxicity. A chronological summary of the clinical course, management actions, and missed opportunities is presented in Table 1.

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Timeline

Table 1. Clinical Timeline with Key Analytical Interpretations

Date	Clinical Events	Analytical Interpretation (Missed Opportunities)
21-Apr-22	Onset of symptoms with fever, sore throat, cough, and runny nose	Treated at home considering usual
23-Apr-22	Initial presentation with fever and sore throat; managed symptomatically without further clinical evaluation	Early opportunity for clinical suspicion missed; absence of thorough examination delayed recognition of diphtheria
23 April 2022 (later same day)	Within hours (around midnight), progression to neck swelling and respiratory distress	Rapid disease progression highlights the critical need for early diagnosis and intervention
24-Apr-22	Re-presentation: clinical assessment performed; throat swab and blood samples collected for laboratory confirmation	Delay in diagnostic suspicion; laboratory confirmation initiated but treatment decisions not rapidly aligned with clinical suspicion
25-Apr-22	Referral to a tertiary facility due to clinical deterioration	Referral occurred at an advanced stage, indicating limited early case management and escalation capacity
25 April 2022 (en route)	Death occurred during transfer	Fatal outcome reflects cumulative delays across diagnosis, treatment access, and referral processes

Public Health Investigation

Health facilities screen suspected diphtheria cases using WHO case definitions and report through EWARS. Suspected cases are referred to one of five sentinel sites with isolation and laboratory capacity, where samples are collected, cases isolated, and data recorded in Go. Data. Case notifications are also shared informally (e.g., WhatsApp) to trigger public health actions, including contact tracing, which is expected to start on day zero with reporting within 48 hours. Response activities, such as active case search, immunization, contact tracing, and surveillance are implemented by multiple stakeholders, often with coordination gaps.

In this case, key breakdowns occurred across the clinical and surveillance pathway. The child developed symptoms on 21 April 2022 and was presented to a sentinel facility on 23 April 2022 where he was managed symptomatically without suspicion of diphtheria and was not reported in EWARS. The condition worsened the same evening, and on re-presentation, there was a delay in assessment and admission. Diphtheria was clinically suspected on 24 April 2022, following progression to classical signs, and a sample was collected and entered into Go. Data. Despite treatment with antibiotics, DAT was unavailable, and referral to a tertiary center was initiated; however, the child died during transfer on 25 April 2022. The death was not promptly updated in Go. Data.

Contact tracing began on 26 April 2022 following delayed notification, identifying 10 contacts who received azithromycin prophylaxis but no vaccination. On the same day, the 5-year-old sibling of the deceased developed fever and throat pain. The caregiver sought care outside the formal health system,

where diphtheria was not suspected and no diagnostic testing was performed. The child was treated symptomatically for whitish patches over both tonsils associated with pain and fever. Despite being symptomatic, the sibling was not identified or reported by the contact tracing team.

Laboratory confirmation was received two days after death (27 April 2022), delaying final case classification. The death was later detected through community-based surveillance on 10 May 2022, reflecting poor integration between surveillance platforms and delayed reconciliation of data.

Subsequent review identified systemic gaps in case detection, reporting, and data integration, which were escalated to the Health Sector and WHO. A concurrent stockout of diphtheria antitoxin across Cox's Bazar, due to procurement challenges and global shortages, further constrained case management, eliminating the only intervention capable of neutralizing circulating toxin and increasing mortality risk.

Discussion

This case illustrates a cascade of interconnected system-level failures contributing to a fatal outcome in a diphtheria patient within a humanitarian setting. Guided by the WHO Health System Building Blocks framework, multiple gaps were identified across service delivery, workforce capacity, medical products, information systems, governance, financing, and community engagement.

Delayed clinical recognition at first contact and late referral reflected deficiencies in service delivery, compounded by the need for strengthened frontline training. The absence of diphtheria antitoxin (DAT), due to procurement challenges and global shortages, represented a critical limitation in case management and was a key determinant of mortality [16-18]. Timely clinical suspicion and early DAT administration are essential, as disease progression can be rapid and life-threatening.

Health information systems showed poor integration, with inconsistencies across EWARS, Go. Data, and community-based surveillance, leading to delayed case notification, incomplete data capture, and fragmented outbreak response. Weak governance mechanisms further contributed to unclear accountability for outcome reporting. Financing and procurement constraints, including the excessive cost and limited global availability of DAT, restricted access to essential treatment.

Contact tracing was initiated and prophylaxis provided; however, limitations in timeliness, completeness of case identification, and follow-up verification reduced its effectiveness. A symptomatic household contact was not reported or investigated, highlighting gaps in surveillance sensitivity and community linkage.

Underlying immunization gaps increased population vulnerability, consistent with evidence that unvaccinated populations are disproportionately affected during diphtheria outbreaks, while vaccination significantly reduces severe disease [1, 13].

In addition, the fatal outcome eroded community trust, resulting in delayed care-seeking and preference for informal healthcare providers, further increasing the risk of transmission. Table 2 summarizes the key health-system gaps identified across the WHO Health System Building Blocks and their contribution to the fatal outcome.

Table 2. Health System Gaps Identified

Building Block	Identified Gap
Service delivery	Delayed clinical recognition and referral
Health workforce	Need for strengthened frontline training
Medical products	DAT stockout
Information systems	EWARS, Go.Data, and community surveillance not fully reconciled
Governance	Unclear accountability for outcome reporting
Financing & procurement	Excessive cost and global DAT shortages
Community engagement	Reduced community trust following death

Overall, failures across clinical care, supply chains, and surveillance systems reduced the effectiveness of case management and outbreak response. Strengthening early recognition, ensuring DAT availability, improving surveillance integration, and rebuilding community trust are essential to reduce preventable mortality in similar settings.

Lessons Learned

Early clinical evaluation, particularly thorough throat examination, is essential for timely suspicion of diphtheria, and prompt administration of diphtheria antitoxin without awaiting laboratory confirmation is critical to reduce mortality. Effective outbreak control depends on strong integration between clinical care and surveillance systems to ensure timely reporting and investigation of cases. Addressing immunity gaps through catch-up vaccination, especially among older unvaccinated children, remains vital in displaced populations. Strengthening monitoring mechanisms and maintaining community trust are key to improving care-seeking behavior and ensuring an effective outbreak response.

Key Operational Recommendations

Immediate (0-6 months)

1. Ensuring uninterrupted supplies and decentralized DAT availability should be prioritized in outbreak-prone humanitarian settings [6-18].
2. Implement standard operating procedures (SOPs) for active case detection, contact tracing, and outbreak response [19].
3. Conduct targeted training for frontline health care providers.

Short-Term (6-12 months)

1. Strengthening surveillance systems with clear case definitions and reporting pathways.
2. Improve integration between clinical and public health response systems [15].

Long-Term (12-18 months)

1. Implement large-scale catch-up vaccination campaigns (6 weeks–15 years) [1].
2. Strengthen routine immunization and retention strategies.

Limitations

This case has several limitations Clinical details were incomplete due to unavailable medical records, including confirmation of DAT administration. Parts of the timeline relied on caregiver recall, introducing potential bias, while limited facility-level data restricted verification of clinical decision-making. Delays and gaps in surveillance reporting may have affected epidemiological reconstruction. As a single-case report, findings have limited generalizability but highlight important

systemic gaps relevant to similar humanitarian settings.

Conclusion

This case demonstrates how failures across clinical care, surveillance, immunization, and community engagement can converge to produce preventable mortality. Reducing diphtheria-related deaths requires not only strong clinical competence but also a well-integrated health system that ensures early diagnosis, timely access to essential treatment, responsive surveillance, and sustained immunization coverage [20].

Conflict of Interest

The authors report no conflicts of interest relevant to this work.

Ethical Considerations

This study was conducted as part of a routine public health investigation and complied with WHO guidelines for the use of routinely collected public health data. Ethical principles, including confidentiality, anonymity, and informed consent, were strictly maintained. Verbal informed consent was obtained from the parents of the deceased child for use of anonymized clinical and public health information. All personal identifiers were removed to ensure confidentiality. As the investigation involved routine public health practice rather than experimental research, formal ethical review was not required. Nevertheless, principles of privacy, beneficence, and respect for persons were rigorously maintained throughout.

Data Availability

The data used in this case study were obtained from publicly available open-source materials and information collected through interviews with the parents of the deceased. Due to privacy and confidentiality considerations, interview data are not publicly available but may be shared by the corresponding author upon reasonable request and subject to ethical considerations.

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