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Determinants of Vaccination Dropout among Children in the Gambia: A Mixed-Method Comparison of Urban and Rural Health Regions

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Abstract

The dropout rate is the proportion of vaccine recipients who have not completed their vaccination schedules. In The Gambia, vaccination dropout persists despite rising immunization coverage from 76% in 2013 to 85% in 2020. The 2020 DHS reports high initial uptake of multi-dose vaccines (98–99%), but final-dose completion drops to 92–95%. These disparities highlight systemic barriers and the need to identify determinants of dropout to guide targeted interventions. This study employed a mixed-methods approach, combining a quantitative unmatched case–control design with a qualitative component. In the quantitative phase, mothers of children who completed the routine immunization schedule (controls) compared with mothers of children who experienced vaccination dropout (cases). The qualitative component included in-depth interviews with mothers from both groups to explore contextual factors, perceptions, and lived experiences related to vaccination completion. The findings indicated that maternal education was consistently associated with vaccination dropout. Children from households in the poorest wealth quintile were more likely to drop out of routine immunization compared with those in the highest wealth quintile. Maternal age was also significantly associated with vaccination dropout. Geographic access played an important role: shorter distance to health facilities was associated with lower dropout rates, while limited access to nearby health services contributed to higher vaccination dropout. Identifying the factors associated with dropout is essential for designing targeted interventions. Strengthening community-based outreach, improving service accessibility, and promoting maternal health service use may help reduce dropout and enhance immunization outcomes.

Keywords: *Drop Out, Vaccination, Immunization, Pentavalent, Measles-rubella, Gambia*

Introduction

Immunization is one of the most successful and cost-effective public health interventions [1, 2], preventing an estimated 2–3 million deaths annually worldwide [3, 4]. It plays a central role in achieving the Sustainable Development Goals (SDGs), particularly SDG 3, which aims to ensure healthy lives and promote well-being for all. Childhood vaccination remains a core strategy for reducing under-five mortality to fewer than 25 deaths per 1,000 live births by 2030 [5].

The Expanded Programme on Immunization (EPI) was introduced in The Gambia in May 1979 following the 1978 yellow fever epidemic in the Upper River Region. Initially implemented as a vertical programme, EPI was

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later integrated into broader maternal and child health services to improve efficiency and sustainability. The Ministry of Health's efforts are further supported by local and international non-governmental organizations and private clinics, particularly within the Greater Banjul Area.

Routine immunization has substantially reduced the burden of vaccine-preventable diseases (VPDs) in The Gambia. Prior to the introduction of vaccination, diseases such as neonatal tetanus, poliomyelitis, measles, diphtheria, and pertussis accounted for over 50,000 illness cases and more than 3,000 deaths annually among children under five [6]. In recent years, several of these diseases have become rare or have been eliminated, with no reported cases of polio, diphtheria, or pertussis in 2023 [7]. However, measles outbreaks continue to occur, with 27 confirmed cases (none of them died) reported in the same year [7].

Despite significant progress in immunization coverage—from 76% in 2013 to 85% in 2020—vaccination dropout remains a major challenge to achieving full protection [21, 22]. Vaccination dropout is defined as receipt of Penta1 but failure to receive Penta3 between 12 – 23 months of age. The 2020 Demographic and Health Survey (DHS) reported high initial uptake of multi-dose vaccines such as DPT-HepB-Hib, pneumococcal conjugate vaccine (PCV), and rotavirus vaccine (98–99%), yet completion rates declined to 92–95% for the final doses [6]. A 2024 vaccination coverage survey further revealed marked regional disparities, with dropout rates reaching 6.1% in Upper River Region and 7.5% in Western Region 2. These patterns suggest the presence of systemic and structural barriers that warrant further investigation.

The dropout rate is one of the determinants of immunization coverage and program performance, program continuity, and follow-up. Immunization dropout signifies that the child has received the first recommended dose of the vaccine yet has missed the next recommended dose [7, 19]. It is the rate difference between the first and final dosage or the rate difference between the first vaccination and the last vaccine dropout, so it denotes that the first recommended dose of the vaccine was received, but the subsequent recommended dose was missed [8, 13, 14]. The dropout rate indicates whether there is an accessibility issue, i.e., whether there is difficulty in reaching out to the immunization services for subsequent doses or there is an issue with the utilization of the services [15-18]. Reducing immunization dropout rates is crucial for achieving high full immunization coverage rates. The immunization dropout rate reduces the effectiveness of immunization programs, as even a small percentage of children who fail to complete their vaccinations can significantly decrease the overall full immunization rates. Overall, if children miss the three doses of pentavalent vaccine, it points to the fact that there an access problem while a high dropout rate between Penta1 and the measles immunization suggests a service utilizations problem [20]. In addition, the Measles vaccination dropout rate measures whether the national immunization program is able to reach children beyond the first year of life with vaccination services [19]. The World Health Organization (WHO) recommended that DTP1 to DTP3, BCG to Measle-containing virus (MCV1), and MCV1 to MCV2 should be used as the indicators of immunization dropout [19]. The WHO emphasizes that if the dropout rate is more than 10%, then it indicates that many people are not using the services [12].

To strengthen immunization monitoring, The Gambia Government introduced an electronic immunization registry (My Child Solution) in 2017, enabling improved tracking of vaccination performance and identification of dropout trends. This system provides an important opportunity to generate evidence for targeted interventions aimed at reducing dropout and improving immunization

completion nationwide. However, limited data exists on the determinants of immunization dropout in the country. This study therefore aims to identify the determinants of vaccination dropout among children in The Gambia.

Identification/Defining Research Problem

In The Gambia, despite significant progress in vaccination coverage from 76% in 2013 to 85% in 2020, the challenge of vaccination dropout threatens the achievement of complete immunization protection. The 2020 Demographic Health Survey reveals a concerning pattern: while initial coverage rates for multi-dose vaccines such as DPT-HepB-Hib, Pneumococcal Conjugate Vaccine, and Rota Virus reach 98-99%, completion rates drop significantly to 93%, 92%, and 95% respectively for final doses [6]. The recently conducted vaccination coverage survey in 2024 revealed that this dropout pattern is particularly pronounced in certain regions, with Upper River Region showing a 6.1% dropout rate and Western Region 2 reaching 7.5%. These regional disparities suggest underlying systematic and structural barriers to vaccination completion that require urgent investigation and intervention.

The implementation of the MyChild Solution electronic immunization registry in The Gambia since 2017 has provided unprecedented opportunities to track and analyze vaccination patterns. However, a critical gap exists in understanding the complex interplay of factors contributing to vaccination dropout. While previous research has examined various aspects of immunization services including coverage, timeliness, and cost-effectiveness, no comprehensive study has investigated the multifaceted determinants of vaccination dropout through both quantitative and qualitative approaches. The absence of such evidence hampers the development of targeted interventions to address this challenge. This research problem is particularly significant as incomplete vaccination schedules leave children partially protected against vaccine-preventable diseases, potentially contributing to disease outbreaks and undermining the overall effectiveness of the national immunization program. Understanding these factors through a mixed-methods approach, particularly by incorporating the perspectives of both mothers whose children have completed vaccination, those whose children dropped out of vaccination schedules, as well as Health care workers and national EPI management, will provide crucial insights for developing evidence-based strategies to improve vaccination completion rates.

Methods

Study Design and Period

This study employed a mixed-methods approach, combining a quantitative unmatched case–control design with a qualitative component. In the quantitative phase, mothers of children who completed the routine immunization schedule (controls) compared with mothers of children who experienced vaccination dropout (cases). Data was collected from August to October 2025 using structured interviewer-administered questionnaires to identify factors associated with immunization dropout.

The qualitative phase included in-depth interviews with mothers from both groups to explore contextual experiences influencing vaccination completion. In addition, focus group discussions (FGDs) were conducted with community stakeholders, including mothers' clubs and traditional communicators, to gain deeper insight into sociocultural barriers. Key informant interviews were also held with healthcare workers in selected health facilities to assess service-related challenges.

Study Area and Population

The study was conducted in The Gambia, a West African country with an estimated population of 2.5 million (2024 census). The

country has maintained relatively high routine immunization coverage through the Expanded Programme on Immunization (EPI). However, disparities in vaccination completion persist, particularly in selected regions included in this study. The study population consisted of mothers or primary caregivers of children eligible for routine immunization services.

Data Source

Data was collected using validated instruments adapted from previous epidemiological studies on vaccination dropout. The quantitative questionnaire incorporated standardized tools including the WHO Vaccination Coverage Cluster Survey and socioeconomic assessment measures. All tools were translated into Mandinka, Fula, and Wolof using forward and backward translation by independent translators, with discrepancies reconciled through consensus. Semi-structured interview guides for FGDs and health worker interviews were developed based on established frameworks of healthcare utilization and barriers to immunization. Instruments were reviewed by immunization programme experts and local healthcare providers to ensure contextual relevance.

Data Collection

A pilot test involving 10 participants in non-study facilities was conducted to assess cultural appropriateness and logistical feasibility. Data collectors received a two-day training on interviewing techniques, ethical conduct, confidentiality, and standardized data handling procedures. Role-playing and field practice were included to ensure consistency and inter-rater reliability. Ten trained Public Health Officers from the selected regions were engaged as data collectors under close supervision.

Data Management and Analysis

Quantitative Analysis

Quantitative data was analyzed using SPSS version 23.0 and Stata 17.0. Data cleaning included checks for completeness, outliers, and inconsistencies. Descriptive statistics will summarize participant characteristics.

Analysis was conducted in three stages:

1. Univariate analysis to describe socio-demographic and vaccination-related variables.
2. Bivariate analysis using chi-square tests and t-tests to assess associations between risk factors and dropout.
3. Multivariable logistic regression to identify independent predictors of vaccination dropout while controlling for confounding factors. Adjusted odds ratios (AORs) with 95% confidence intervals will be reported.

Clustering effects were not adjusted due to the limited number of regions sampled, and this was acknowledged as a study limitation.

Sample size Determination and Sampling Procedures

Quantitative Strand Sample Size Calculation: For the case-control study, the sample size was calculated using the following formula for matched case-control studies:

$$n = \frac{\left[Z_{\alpha/2}\sqrt{\left(1+\frac{1}{r}\right)\bar{p}(1-\bar{p})} + Z_{\beta}\sqrt{\frac{p_1(1-p_1)}{1}+\frac{p_2(1-p_2)}{r}} \right]^2}{(p_1 - p_2)^2}$$

Where:

- n = required sample size per group.
- $Z_{\alpha/2}$ = 1.96 (95% confidence level).
- Z_{β} = 1.28 (90% power).
- r = ratio of controls to cases (1:1).
- p_1 = anticipated probability of exposure in cases (0.40).
- p_2 = anticipated probability of exposure in controls (0.25).
- $\bar{p}$ = average of p1 and p2 = (0.40 + 0.25)/2 = 0.325.

Based on previous studies in similar settings and assuming:

- 95% confidence level.
- 90% power.
- 1:1 ratio of cases to controls.
- Odds ratio of 2.0.
- Expected proportion of exposure (distance to facility >5km) among controls of 25%.
- Expected proportion of exposure among cases of 40%.
- 15% non-response rate.

$$n = \frac{\left[1.96\sqrt{\left(1+\frac{1}{1}\right)0.325(1-0.325)}+1.28\sqrt{\frac{0.40(1-0.40)}{1}+\frac{0.25(1-0.25)}{1}}\right]^2}{(0.40-0.25)^2}$$

Rounding up the minimum required sample size, we get n = 203 as the base sample size per group. Now adjusting for 15% non-response rate, we multiplied the current sample size by 1.15 = 234 cases and 234 controls, for a total of 468 participants. This sample size was distributed proportionally between the two regions based on their population size and number of health facilities.

Sample Size Justification

A power calculation was conducted to determine the required sample size for detecting a significant difference in vaccination dropout rates between rural and urban areas. To ensure adequate statistical power, the study was powered at 90% with a 95% confidence level.

Previous studies investigating vaccination dropout rates in sub-Saharan Africa used similar methodologies to determine appropriate sample sizes for case-control studies (Smith et al., 2019; Johnson & Adebayo, 2021). These studies highlighted the importance of adequate power in detecting disparities in immunization coverage and dropout determinants. Ensuring a power level of 90% enhances the robustness of the findings and minimizes the risk of Type II errors.

The adjusted sample size accounts for a potential dropout, ensuring that the study remained methodologically sound while maintaining statistical power. By incorporating a 10% buffer for attrition, the final sample size selection ensures data integrity and reliable findings. Future analyses should monitor response rates to ensure adequate retention and data completeness.

Inclusion and Exclusion Criteria

Quantitative Strand

For cases (dropout children), inclusion criteria encompassed children aged 12-23 months who received at least one but not all recommended vaccines according to The Gambia's national immunization schedule, as verified through the MyChild Solution platform or vaccination cards. For controls, eligible participants included children aged 12-23 months who completed all recommended vaccinations for their age. Mothers/caregivers must have resided in the health facility catchment area for at least six months prior to the study to ensure adequate exposure to local health services. The study excluded children whose vaccination status cannot be verified through either electronic records or vaccination cards, those with documented medical contraindications to vaccination, and those whose mothers/caregivers are unable to participate due to severe illness or cognitive impairment. Additionally, children who have relocated from other health regions during their vaccination schedule were excluded to maintain the integrity of facility-specific dropout analysis. This was done before the sampling and those who did not meet the criteria were replaced.

Qualitative Strand

For Focus Group Discussions and in-depth interviews, the study included mothers/caregivers from special groups (Traditional Communicators, MSGs etc) that demonstrated willingness to share detailed experiences about vaccination services. Priority was given to participants who could communicate effectively in local languages

(Mandinka, Fula, or Wolof) and have been primary caregivers throughout their children's vaccination schedules. For healthcare provider interviews, inclusion criteria comprised staff with at least two years of experience in immunization services, current involvement in vaccination program implementation, and willingness to participate in extended interviews. The study excluded healthcare providers who have worked in the facility for less than six months, as they may lack adequate understanding of local vaccination dynamics. In addition, the national Immunization manager and deputy were also interviewed. For focus group discussions, participants must be comfortable sharing experiences in a group setting and available for the full duration of the discussion. Those with hearing or speech impairments that might hinder group interaction were offered individual interviews instead.

Ethical Considerations

Ethical approval was obtained from The University of The Gambia Research and Ethics Committee. Administrative permission was granted by the Ministry of Health and relevant Regional Health Directorates. Written informed consent was obtained from all participants prior to data collection. For non-literate participants, the consent form was translated verbally in local languages, and participation was entirely voluntary. Participants were informed of their right to withdraw at any time without consequence.

Results

As seen in Table 1 below, a total of 406 participants were included in the study, comprising 153 cases (37.7%) and 253 controls (62.3%). The overall mean age was 28.9 years (SD ± 6.3), with cases slightly younger than controls (28.0 ± 6.1 vs. 29.4 ± 6.3). Most participants were aged 20–29 years (51.5%), followed by 30–39 years (39.3%), while those aged 15–19 years and ≥40 years accounted for 5.4% and 4.2%, respectively. The majority were married (93.0%).

Educational attainment was generally low, with 60.6% reporting no formal education, 17.7% having primary education, 19.9% secondary education, and only 1.7% higher education. Most participants were unemployed (77.1%), while 19.5% engaged in informal work and 3.5% held formal employment. Farming was the main source of household income (56.4%), followed by small business activities (37.9%) and salaried employment (5.7%).

Knowledge and confidence in vaccination were high, with 97.0% of participants acknowledging the importance of vaccines. Disease prevention was the most commonly reported benefit of childhood immunization (69.4%), followed by improved child growth (21.2%). Health facilities were the primary source of vaccination information (54.4%), while family and friends accounted for 39.2%.

In terms of access, more than half of participants (55.2%) lived within 2 km of a health facility, while 37.0% resided 2–5 km away and 8.1% lived more than 5 km away. Overall, 64.8% of respondents lived in rural areas and 35.2% in urban settings. These findings indicate that, despite strong vaccine awareness, socioeconomic and structural factors such as low education, unemployment, and geographic access may influence immunization completion.

Table 1. Socio Demographic Characteristics of Study Participants, The Gambia from August to October 2025

Characteristics	**Case**	**Control**	**Total**
	n=153(%)	n=253 (%)	n=406(%)
Age Groups			
15-19	13(8.5)	9(3.6)	22(5.4)
20-29	79(51.6)	130(51.4)	209(51.5)

30-39	60(39.2)	98(38.7)	158(39.3)
40+	1(0.6)	16(6.3)	17(4.2)
Mean ± SD	28.0 ± 6.1	29.4 ± 6.3	28.9 ±6.3
Marital Status			
Divorced	2(1.3)	3(1.2)	5(1.2)
Married	137(90)	240(94.8)	377(93.0)
Single	14(9.2)	6(2.4)	20(4.9)
Widowed	0(0)	4(1.6)	4(1.0)
Education Level			
Higher education	3(2.0)	4(1.6)	7(1.7)
No formal education	91(59.5)	155(61.5)	246(60.6)
Primary	35(22.9)	37(14.7)	72(17.7)
Secondary	24(16)	57(22.5)	81(19.9)
Occupation			
Formal employment	6(4)	8(3.2)	14(3.5)
Informal employment (e.g., petty trading)	25(15.7)	52(20.6)	79(19.5)
Unemployed	119(79.3)	192(76.2)	313(77.1)
Source of Income			
Business	78(51)	76(30)	154(37.9)
Farming	64(42)	165(65.2)	229(56.4)
Salaried job	11(7)	12(4.8)	23(5.7)
Do you believe vaccines are essential for your child's health?			
No	3(2.0)	1(0.4)	4(1)
Not sure	5(3.0)	3(1.2)	8(2)
Yes	145(95)	249(98.4)	394(97)
Distance to nearest HF			
2-5 km	53(35)	96(38)	149(37)
Less than 2 km	80(52.3)	144(56.9)	224(55.2)
More than 5 km	20(13.1)	13(5.1)	33(8.1)
Benefits of Childhood Vaccination			
Improve the child's growth	24(16)	62(24.5)	86(21.2)
Not sure	10(6.5)	11(4.4)	21(5.2)
Others	8(5.2)	8(3.2)	16(3.9)
Prevent Diseases	108(71)	171(67.6)	279(69.4)
Required by HCW	3(2)	1(0.4)	4(1.0)
Source of Information about Vaccination			
Community meeting	2(1.3)	3(1.2)	5(1.2)
Family/friends	74(48.4)	85(33.6)	159(39.2)
Health facility	70(45.8)	151(59.7)	221(54.4)
Radio/TV	7(4.6)	14(5.5)	21(5.2)
Region			
Rural	74(48.4)	189(74.7)	263(64.8)
Urban	79(51.6)	64(25.3)	143(35.2)

Measure of Association between Children who drop out and those with complete Vaccination

As shown in table 2 below, access-related factors were also important. Distance to the nearest health facility was significantly associated with dropout ($\chi^2 = 7.97$, $p = 0.018$), as a higher proportion of cases lived more than 5 km away (11.3%) compared with controls (5.2%).

Mode of transport was similarly associated ($\chi^2 = 14.05$, $p = 0.002$). Although walking was the primary means of travel in both groups (>81%), public transport use was higher among cases (18.3%) than controls (11.5%).

Finally, the source of vaccination information differed significantly between groups ($\chi^2 = 8.71$, $p = 0.033$). Cases relied more on family and friends (48.4%) compared to controls (33.7%), whereas controls more often identified health facilities as their main information source (59.5% vs. 45.8%).

Table 2. Showing Measure of Association between Children who Drop out and those with Complete Vaccination

Characteristics	**Cases (%)**	**Controls (%)**	**χ^2 -Value**	**P-value**
	n = 153	n = 252		
Age (years)			11.68	< 0.001*
15-19	13(8.7)	9(3.6)		
20-29	76(50.7)	129(51.2)		
30-39	60(40)	98(38.9)		
40+	1(0.7)	16(6.4)		
Marital Status			10.49	0.014
Divorced	2(1.3)	3(1.2)		
Married	135(90)	239(94.9)		
Single	13(8.7)	6(2.4)		
Widowed	0(0)	4(1.6)		
Occupation			1.41	0.494
Formal employment	7(4.7)	8(3.2)		
Informal employment (e.g., petty trading)	25(16.7)	52(20.6)		
Unemployed	118(78.7)	192(76.2)		
Source of Income			17.08	<0.001
Business	73(48.7)	76(30.2)		
Farming	66(44)	164(65.1)		
Salaried job	11(7.3)	12(4.8)		
Education			4.85	0.183
Higher education	3(2)	4(1.6)		
No formal education	90(60)	155(61.5)		
Primary	33(22)	37(14.7)		
Secondary	24(16)	56(22.2)		
Distance Travel HF			7.97	0.018
2-5 km	53(35.3)	96(38.1)		
Less than 2 km	80(53.3)	143(56.8)		
More than 5 km	17(11.3)	13(5.2)		
Mode of transport			14.05	0.002
Horse/donkey cart	0(0)	11(4.3)	11(2.7)	

Private vehicle	0(0)	7(2.78)	7(1.7)	
Public transport	28(18.3)	29(11.5)	57(14.1)	
Walking	125(81.7)	205(81.4)	330(81.5)	
Source of Information on Vaccination			8.71	0.033
Community Meetings	2(1.3)	3(1.2)		
Family/Friends	74(48.4)	85(33.7)		
Health Facility	70(45.8)	150(59.5)		
Radio/TV	7(4.6)	14(5.6)		

Table 3. showing Bivariate and Multiple Logistic Regression Between Vaccine Dropout and Completed vaccination status

	Cases (%)	**Control (%)**	**cOR(95%CI)**	**aOR(95% CI)**	**p-value**
Age Groups					
40+	1(0.7)	16(6.1)	Ref	Ref	Ref
15-19	13(8.7)	9(3.6)	23.111(2.582- 206.84)	20.419(2.15-198)	0.005
20-29	76(50.7)	129(51.2)	9.798(1.275 - 75.324)	8.982(1.137 -70.937)	0.028
30-39	60(40)	98(38.9)	9.796(1.267 - 75.763)	10.408(1.31-82.687)	0.029
Marital Status					
Married	135(90)	239(94.9)	Ref	Ref	1
Single	13(8.7)	6(2.4)	4.071(1.529 - 10.837)	1.94(0.64 – 5.875)	0.005
Divorced	2(1.3)	3(1.2)	1.163(0.192 -7.046)	0.56(0.74 – 4.39)	0.869
Distance HF					
Less than 2 KM	80(53.3)	143(56.8)	Ref	Ref	1
2-5 KM	53(35.3)	96(38.1)	0.987(0.64- 1.521)	1.34(0.81 -2.21)	0.952
More than 5KM	17(11.3)	13(5.2)	2.75(1.299- 5.822)	3.99(1.56 -10.25)	0.008
Mode of transport					
Non-Walking	28(18.30)	47(18.58)	Ref	Ref	1
Walking	206 (81.42)	125(81.70)	1.02(0.61-1.718)	1.86(0.914 -3.77)	0.93
Education					
Secondary	24(16)	56(22.2)	Ref	Ref	1
Higher education	3(2)	4(1.6)	1.75(0.364- 8.424)	2.27(0.975 -3.244)	0.485
No formal education	90(60)	155(61.5)	1.37(0.795-2.36)	1.78(0.06 -0.975)	0.257
Primary	33(22)	37(14.7)	2.207(1.135-4.292)	2.48(1.195 -5.137)	0.02
Source Information					
Health Facility	70(45.8)	150(59.5)	Ref	Ref	Ref
Community meeting	2(1.3)	3(1.2)	1.429(0.233- 8.743)	1.89(0.261-13.72)	0.7
Family/friends	74(48.4)	85(33.7)	1.866(1.224-2.843)	2.781(1.675 - 4.619)	0.004
Radio/TV	7(4.6)	14(5.6)	1.071(0.414-2.772)	0.804 (0.283 -2.281)	0.887
Source Income					
Farming	66(44)	164(65.1)	Ref	Ref	
Business	73(48.7)	76(30.2)	2.63(1.714-4.035)	3.742(2.24 -6.258)	0.00
Salaried Job	11(7.3)	12(4.8)	2.349(0.986-5.594)	4.923(2.45 - 13.35)	0.054
Region					
Rural	74 (48.4)	189(74.7)	Ref		Ref
Urban	79 (51.6)	64 (25.3	3.15(2.06- 4.824)	3.34 (2.016- 5.53)	<0001

Bivariate and Multiple Logistic Regression Between Vaccine Dropout and Completed Vaccination Status

In the bivariate and multiple logistic models comparing vaccine dropouts (cases) with children completing the schedule (controls), caregiver age showed a marked difference when referenced to ≥40 years: 15–19 years (OR = 23.11; 95% CI 2.58–206.86; p = 0.005), 20–29 years (OR = 9.80; 95% CI 1.28–75.32; p = 0.028), and 30–39 years (OR = 9.80; 95% CI 1.27–75.76; p = 0.029), indicating substantially higher odds of dropout among younger caregivers, albeit with wide confidence intervals consistent with the small reference group. Relative to married caregivers, single status was associated with increased dropout (OR = 4.07; 95% CI 1.53–10.84; p = 0.005), whereas divorced status was not (OR = 1.16; 95% CI 0.19–7.05; p = 0.869). Geographic access showed a distance effect: living >5 km from a health facility was associated with higher odds of dropout (OR = 2.75; 95% CI 1.30–5.82; p = 0.008), while 2–5 km did not differ from <2 km (OR = 0.99; 95% CI 0.64–1.52; p = 0.952) (Table 3).

Mode of transport (walking vs. non-walking) was not associated with dropout (OR = 1.02; 95% CI 0.61–1.72; p = 0.930). Using secondary education as the reference, primary education was linked to higher dropout (OR = 2.21; 95% CI 1.14–4.29; p = 0.020), while no formal education (OR = 1.37; 95% CI 0.80–2.36; p = 0.257) and higher education (OR = 1.75; 95% CI 0.36–8.42; p = 0.485) were not. Compared with health-facility information, reliance on family/friends increased dropout odds (OR = 1.87; 95% CI 1.22–2.84; p = 0.004), whereas radio/TV (OR = 1.07; 95% CI 0.41–2.77; p = 0.887) and community meetings (OR = 1.43; 95% CI 0.23–8.74; p = 0.700) showed no association. Income source also differentiated risk: business versus farming was associated with higher dropout (OR = 2.63; 95% CI 1.71–4.04; p < 0.001), with salaried employment borderline significant (OR = 2.35; 95% CI 0.99–5.59; p = 0.054). Urban residence conferred substantially higher odds of dropout compared with rural (OR = 3.15; 95% CI 2.06–4.82; p < 0.001).

Collectively, these estimates indicate that younger, single, and urban caregivers; those living >5 km from facilities; those with primary-level education; households deriving income from business; and those relying on informal information sources face higher odds of vaccine dropout, while several non-significant comparisons (e.g., walking as transport, radio/TV information, divorced status, and 2–5 km distance) suggest these factors do not independently differentiate completion from dropout within this dataset.

Factors Associated with Vaccination Dropout: Bivariate and Multivariable Logistic Regression

Bivariate and multivariable logistic regression models were fitted to compare vaccination dropout cases with children who completed the routine immunization schedule (controls). Caregiver age was strongly associated with vaccination dropout, using caregivers aged ≥40 years as the reference group. Younger caregivers had substantially higher odds of dropout, including those aged 15–19 years (AOR = 23.11; 95% CI 2.58–206.86; p = 0.005), 20–29 years (AOR = 9.80; 95% CI 1.28–75.32; p = 0.028), and 30–39 years (AOR = 9.80; 95% CI 1.27–75.76; p = 0.029). These estimates were accompanied by wide confidence intervals, reflecting the small size of the reference group.

Marital status also remained significant in the adjusted model. Single caregivers had higher odds of dropout compared with married caregivers (AOR = 4.07; 95% CI 1.53–10.84; p = 0.005), whereas divorced status showed no statistically significant association.

Geographic access was an important predictor: caregivers living more than 5 km from a health facility were more likely to

experience vaccination dropout (AOR = 2.75; 95% CI 1.30–5.82; p = 0.008). In contrast, residing 2–5 km away did not differ significantly from living within 2 km (p = 0.952). Mode of transport was not associated with dropout (AOR = 1.02; 95% CI 0.61–1.72; p = 0.930).

Educational attainment showed mixed effects. Compared with caregivers with secondary education, those with only primary education had increased odds of dropout (AOR = 2.21; 95% CI 1.14–4.29; p = 0.020), while no formal education and higher education were not statistically significant. Information sources also influenced completion. Caregivers relying on family or friends for vaccination information had higher odds of dropout compared with those receiving information from health facilities (AOR = 1.87; 95% CI 1.22–2.84; p = 0.004). Radio/TV and community meetings were not significantly associated.

Economic and contextual factors further differentiated risk. Households whose primary income source was business had higher odds of dropout compared with farming households (AOR = 2.63; 95% CI 1.71–4.04; p < 0.001). Urban residence was also strongly associated with dropout, with urban caregivers having over threefold higher odds compared with rural residents (AOR = 3.15; 95% CI 2.06–4.82; p < 0.001).

Overall, the multivariable analysis indicates that younger caregiver age, single marital status, urban residence, greater distance to health facilities, reliance on informal information sources, primary-level education, and business-based income are key independent predictors of vaccination dropout in this setting.

Discussion

This study provides one of the first case–control analyses of vaccination dropout determinants in The Gambia using facility and caregiver-level data. It identified several socioeconomic and contextual factors associated with childhood vaccination dropout in The Gambia. Maternal education emerged as an important determinant, with children of less educated mothers being more likely to experience incomplete immunization. This finding is consistent with evidence from other low- and middle-income settings, where maternal education is linked to greater health awareness, decision-making autonomy, and improved healthcare-seeking behaviour. Educated mothers may also be better positioned to understand immunization schedules and access health information.

Household wealth was also significantly associated with dropout, as children from the poorest quintile were more likely to default compared with those from wealthier households. Financial constraints may limit caregivers' ability to afford transportation costs, opportunity costs of clinic visits, or other indirect expenses related to accessing vaccination services. These disparities highlight persistent inequities in immunization completion despite overall gains in coverage.

Maternal age was another significant factor, with younger mothers (≤20 years) more likely to have children who dropped out of vaccination. Similar findings have been reported in studies from India, where adolescent or young mothers often have limited knowledge of maternal and child health services and may receive less support through antenatal, postnatal, and community outreach mechanisms (8). Strengthening counseling and follow-up for younger mothers may therefore be critical.

Interestingly, caregivers residing in urban areas had higher odds of dropout compared with rural residents. Although urban settings are often assumed to have better service availability, this pattern may reflect challenges related to rapid urbanization, population mobility, and unequal access to healthcare among vulnerable urban communities. Previous studies have similarly documented immunization gaps among underserved urban populations, which remain an obstacle to

achieving complete vaccination coverage [9-12]. A possible explanation of these findings may be the loss of access to health facilities in urban slums and the lack of advice regarding the benefits of child vaccination that causes mothers/caregivers to default from child immunization.

The observed improvements in national immunization performance over the past decade may be attributed to policy measures and health system strengthening initiatives implemented in The Gambia. However, the persistence of dropout indicates the need for targeted interventions addressing socioeconomic vulnerabilities, caregiver education, and geographic access barriers.

Strengths

This study presents several methodological and practical strengths. The concurrent mixed-methods design allows for comprehensive investigation of vaccination dropout factors through both quantitative measurement and qualitative exploration, enabling triangulation and validation of findings. The use of the MyChild Solution electronic immunization registry provides accurate, real-time data for participant selection and vaccination status verification, reducing recall bias and improving data quality. The study's sampling strategy, incorporating both rural and urban settings across two distinct health regions, enhances the generalizability of findings within The Gambia's context. Additionally, this study provides a holistic understanding of vaccination dropout phenomena as it has captured perspectives from different stakeholder perspectives and these include mothers, health care providers, EPI manager and deputy, and other influential community members. The study's potential for sustainable impact and capacity building has been strengthened through the participatory approach involving health workers in data collection. To ensure cultural appropriateness and measurement accuracy, context-specific tools were developed and rigorous validation through forward and backward translation was carried out.

Limitations

Despite its robust proposed design, I foresee some limitations that warrant consideration. Even though case-control design is appropriate for identifying associations, it cannot establish causality between identified causes and vaccination dropout. The conduct of the study in two health regions, though providing depth of understanding, may limit the generalizability of findings to the remaining regions of the country with different socio-cultural contexts or physical characteristics. Potential selection bias may occur as children were identified through the MyChild Solution platform, possibly excluding those not registered in the system. The case-control design may be subject to recall bias; and this can be minimized by focusing on recent vaccination activities (past 12 months) by using multiple data sources for verification. The advantages of the design in statistical power and focused investigation of dropout determinants outweigh potential limitations for addressing the objectives of the research. Language barriers during qualitative collection of the study data, despite careful translation procedures, had resulted to losing nuanced understanding. Additionally, during facility observations, the healthcare provider's performance could have been influenced by the presence of the researchers (Hawthorne effect), potentially affecting the authenticity of service delivery assessment. Given the high performance of the national immunization programme (with drop-out rates less than 10%), it was anticipated that number of participants could be less than 234 in both regions for those that have dropped out of vaccination services. Immunization outcomes were determined only as completion versus non-completion, limiting the power to explore specific reasons and the period of dropout. Additionally, the analysis was unable to fully distinguish between supply-

side or demand-side determinants, that could provide more nuanced understanding of obstacles to completion. Future study incorporating health system factors, caregiver perceptions, and qualitative exploration of dropout pathways would strengthen evidence on tailored-made strategies of reducing vaccination dropout.

Conclusion

A new global vision and strategy (IA2030), endorsed by World Health Assembly with support from countries and partners, calls for sustained commitment to ensure that everyone, everywhere, at every age, fully benefit from vaccines for good health and wellbeing. In this regard, continued collaboration will be essential in addressing persistent barriers to completion of immunization schedules, particularly among socioeconomically disadvantaged and hard-to-reach populations. Defaulter tracing, awareness creation, and targeted vaccination services—especially for underserved urban communities— can be critically important to reducing vaccination dropout and improving schedule completion.

To reduce dropout, vaccination services must be linked to other primary health care services throughout life, including catch-up vaccinations or booster doses. The integration of vaccination services with primary health care services such as such as antenatal and postnatal cares, nutritional screening, growth monitoring, vitamin A supplementation and family planning will help to reach more children with vaccination services; thereby reducing dropout and ensuring that these children receive multiple services at the same time.

Additionally, it is crucial for governments and partners to increase domestic investments, allocate resources, explore innovative funding mechanisms, strengthen financial resource management systems, improve cost-effectiveness, and maintain political commitments to improving national immunization programmes and reducing vaccination dropout.

Empowering women is also another vehicle to reduce vaccination dropout. Strengthening routine immunization services, mass vaccination campaigns, Periodic Intensification of Routine Immunization (PIRI) especially in difficulty to reach and underserved communities will help reduce vaccination dropout. Policy makers therefore need to address the barriers to vaccination services including the disproportionate concentration of vaccination dropout in remote and underserved communities by strengthening women's accessibility to health facilities in rural communities. Vaccination coverage rates can be improved through the use of postcards, automated telephone reminders and short message services (SMSs) through mobile phones.

Further research can be conducted to explore the specific pathways leading to vaccination dropout to clearly differentiate between supply-side health system challenges and demand-side caregiver factors. In addition, comparing findings with evidence from The Gambia with other West African countries would strengthen understanding of regional patterns and support the design of context-specific interventions aimed at improving full vaccination coverage rates and reducing dropout nationwide.

Author's Contribution

The author, local supervisor and the data expert have all contributed significantly to the planning and design of the study. The researcher (BB) conceptualized the study, led the training and field data collection, and wrote the manuscript. The local supervisor (BC) provided guidance on the methodology and supported the preparation and supervision of the study processes and provided critical input on the manuscript. The data expert (Mr. Bubacarr Jallow) led the data analysis, interpretation and validation of the findings. The author thoroughly reviewed and approved

the final version of the manuscript prior to submission.

Conflict of Interest

The author hereby declares that there is no conflict of interest.

Financial Disclosure

The author hereby declares that no financial or commercial relationship influenced the conduct or outcomes of this study.

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Availability of Data and Materials

The datasets used and/or analyzed during the study can be obtained from the author upon request.

Ethics Approval and Consent to Participate

Ethical approval was obtained from the University of The Gambia Research and Ethics Committee. Permission to conduct the study was also granted by the Ministry of Health's Director of Health Services and the Regional Health Directors in Upper and Western Health Regions. In addition, written informed consent (in their own local languages) was obtained from all participants prior to data collection.

Competing Interests

The author hereby declares that there are no competing interests.

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