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Determinants of Caregiver Acceptance and Uptake of Newly Introduced Vaccines in Uganda: Insights from the Health Belief and Diffusion of Innovation Frameworks

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Abstract

Uganda introduced new vaccines (Measles-Rubella second dose [MR2], Inactivated Polio Vaccine second dose [IPV2], Hepatitis B Birth Dose [HepB-BD], and Yellow Fever [YF]), to strengthen routine immunization. However, caregiver acceptance and uptake remain uneven across cities and districts. Understanding behavioural determinants is critical for improving demand. We examined factors influencing uptake of newly introduced vaccines using the Health Belief Model (HBM) and the Diffusion of Innovation (DoI) theory. A mixed-methods study was conducted using Post-Introduction Evaluation (PIE) caretaker surveys (n = 85) from Six cities and 11 districts, 24 key informant interviews and eight focus group discussions. Quantitative data were analyzed using descriptive statistics and multivariate logistic regression to identify predictors of vaccine uptake. Qualitative data were thematically analyzed and integrated using the HBM and DoI frameworks. High acceptance was associated with caregiver vaccine benefits knowledge (OR 2.16, 95% CI 1.32–3.55), trust in health workers (OR 1.88, 95% CI 1.11–3.17), and perceived susceptibility to disease. Barriers included misconceptions, side effects fear, long waiting times, and inconsistent communication. Early adopters of new vaccines were influenced by strong health worker engagement and timely information flow, whereas late adopters by social norms, peer reassurance, and community mobilizers. Qualitative insights highlighted trust, social influence, and perceived vaccine usefulness as key determinants. Caregiver acceptance of newly introduced vaccines in Uganda is shaped by health beliefs, perceived benefits, social influence, and communication pathways. Strengthening behavioural communication strategies, addressing misconceptions, and enhancing health worker engagement will improve uptake and reduce inequities in future vaccine introductions.

Keywords: *Caregiver acceptance; Diffusion of Innovation; Health Belief Model; Immunization uptake; New vaccines; Uganda.*

Introduction

Caregiver Uptake and Demand for Vaccination

Caregiver acceptance is a critical determinant of successful routine immunization, influencing both service utilization and the achievement of herd immunity. Globally, demand-side determinants account for up to **40% of missed vaccinations**, surpassing supply-side causes in many low- and middle-income countries (LMICs) [1].

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Evidence shows that caregiver decisions respond to perceptions of disease risk, trust in health workers, convenience, and communication quality [2]. In Uganda, despite high initial enthusiasm for routine immunization programs, uptake of newly introduced vaccines remains inconsistent, with uptake varying by region, socioeconomic status, and caregiver knowledge levels. National Post-Introduction Evaluation (PIE) data highlight that **over 28% of caregivers** had incomplete information about new vaccines, while **15–20% reported confusion** about the schedule for MR2 and IPV2 [3].

Global and Regional Trends in Vaccine Acceptance

Worldwide, vaccine confidence has declined in certain populations, driven by misinformation, distrust, and evolving perceptions of disease risk [4]. Sub-Saharan Africa demonstrates generally high trust in immunization, but several countries—including Uganda, Kenya, and Tanzania—have reported emerging pockets of hesitancy, particularly around new vaccines [5]. According to WHO/UNICEF estimates, vaccine confidence in Africa remains relatively strong at **75–85%**, yet acceptance of newly introduced antigens tends to lag behind routine vaccines by **10–20 percentage points** in the first two years of rollout [6]. Studies in Ethiopia and Nigeria similarly show that decreased acceptance is linked to poor communication, fear of adverse events, and low perceived disease severity [7]. These trends underscore the importance of understanding behavioural drivers of vaccine uptake using established theoretical frameworks.

Uganda's New Vaccine Introductions (MR2, IPV2, HepB-BD, YF)

Uganda recently introduced multiple vaccines to strengthen routine immunization performance:

- Measles-Rubella second dose (MR2) in 2022,
- Inactivated Polio Vaccine second dose (IPV2) in 2022,
- Hepatitis B Birth Dose (HepB-BD) in 2023,
- Yellow Fever (YF) vaccine in 2023.

Coverage from the national PIE dataset indicates early uptake of **78% for MR2**, **83% for IPV2**, **66% for HepB-BD**, and **72% for YF**, with significant regional differences. Central and Western regions achieved uptake levels above **80%**, while Northern and Eastern regions lagged behind at **55–70%** [3]. Caregiver-level data revealed that **over 30% of uptake challenges** were related to insufficient knowledge about new vaccine benefits and safety. These findings support the need for investigating behavioural determinants of acceptance.

Behavioural Determinants in Immunization Programs

Immunization behaviour is shaped by multiple cognitive, emotional, and social influences. Behavioural determinants include:

- Perceived susceptibility and severity of vaccine-preventable diseases,
- Perceived benefits and barriers of vaccination,
- Trust in health workers and health systems,
- Social norms within communities,
- Communication channels and cues to act,
- Convenience, costs, and user experience during service delivery [8].

Uganda's PIE qualitative findings highlight that while **91% of caregivers trust health workers**, many lack adequate knowledge of new vaccines. Misconceptions—such as fear of side effects, belief that new vaccines are optional, or confusion around birth dose timing—remain barriers. Long waiting times, staff shortages, and inconsistent outreach services further deter timely uptake. These behavioural challenges make theoretical models essential for interpretation.

Theoretical Frameworks Guiding the Study

This study applies two complementary behavioural frameworks:

Health Belief Model (HBM)

The HBM explains health behaviour based on individuals' perception of threat and their evaluation of behavioural responses [9]. It includes:

- **Perceived susceptibility** (child's risk of infection).
- **Perceived severity** (seriousness of disease).
- **Perceived benefits** (value of vaccination),
- **Perceived barriers** (fear, cost, distance, side effects).
- **Cues to action** (reminders, mobilizers, announcements).
- **Self-efficacy** (confidence in ability to seek services).

HBM has been widely applied in immunization studies—particularly for HPV, measles, and COVID-19 vaccines—showing strong predictive power in LMICs [10].

Diffusion of Innovation (DoI) Theory

The DoI theory describes how new health interventions spread within populations. Vaccine introduction is treated as an "innovation," and caregivers adopt at different stages: innovators, early adopters, early majority, late majority, and laggards [11]. DOI emphasizes:

- Communication channels,
- Opinion leaders,
- Perceived innovation attributes (relative advantage, compatibility, simplicity),
- Social influence,
- Time, trust, and observability.

In immunization, DoI helps explain why some caregivers accept new vaccines rapidly while others wait for reassurance from peers. Studies in Kenya, Ethiopia, and Rwanda have shown that early adopters tend to have higher trust in facilities and better access to information [12].

Problem Statement

Despite substantial investment in new vaccine introduction in Uganda, uptake among caregivers remains uneven. The national PIE revealed that caregivers in several districts lacked adequate knowledge of MR2, IPV2, HepB-BD, and YF, leading to missed opportunities and delayed uptake. Behavioural and social drivers remain inadequately explored despite evidence that acceptance—not supply—is the major bottleneck in new vaccine coverage. Without clear understanding of behavioural determinants, Uganda risks persistent inequities, stagnant coverage, and outbreaks of vaccine-preventable diseases.

Rationale for the Study

Understanding caregiver acceptance is critical for enhancing routine immunization performance, especially as Uganda expands its antigen portfolio. This study provides behavioural insights using validated frameworks (HBM and DoI) to identify influences on uptake and generate evidence-based recommendations for communication, service delivery, and policy planning. Findings will inform the Ministry of Health, UNICEF, WHO, Gavi, and implementing partners as they plan future introductions such as RTS,S malaria vaccine and HPV second dose.

Objectives of the Study

Overall Objective

To investigate determinants of caregiver acceptance and uptake of newly introduced vaccines in Uganda using the Health Belief Model and Diffusion of Innovation frameworks.

Specific Objectives

1. To assess caregiver knowledge, perceptions, and attitudes toward MR2, IPV2, HepB-BD, and Yellow Fever vaccines.

2. To identify behavioural determinants associated with acceptance using HBM constructs.
3. To classify adoption patterns using the Diffusion of Innovation model.
4. To examine multivariate predictors of new vaccine uptake.
5. To provide recommendations to improve communication and demand generation strategies.

Materials and Methods

Study Design (Mixed-Methods Approach)

This study employed a convergent mixed-methods design, integrating quantitative caregiver-survey data from the Uganda Post-Introduction Evaluation (PIE) with qualitative data from Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs). Mixed-methods approaches are widely recommended for immunization behavioural studies because they allow simultaneous measurement of knowledge, attitudes, practices, and contextual social drivers [13]. Quantitative and qualitative data were collected concurrently, analyzed separately, and merged during interpretation to provide a comprehensive understanding of caregiver acceptance patterns.

Study Setting and Population

The study was conducted in 6 cities and 11 districts that were purposively selected across Uganda's four regions (Central, Western, Eastern, Northern). These cities and districts were selected based on performance variability, geographic accessibility, and representation of urban and rural populations.

Study Population

- **Primary population:** Mothers and caregivers of children aged 0–59 months attending immunization clinics (n ≈ 85 across all sites).
- **Secondary population:** Health workers, Village Health Teams (VHTs), District Health Officers (DHOs), and Expanded Programme on Immunization (EPI) focal persons.

These populations reflect known influencers of immunization behaviour and are recommended for demand-side immunization research [14].

Data Sources

PIE Community/Caretaker Tools

The Mother/Caretaker PIE Tool included structured questions assessing:

- Knowledge of newly introduced vaccines (MR2, IPV2, HepB-BD, YF)
- Perceived benefits and risks
- Trust in health workers
- Barriers (distance, cost, fear of side effects)
- Experience during service delivery (waiting times, convenience).

The dataset included **~85 caregiver responses**, with completeness above 97%.

Key Informant Interviews

A total of **24 KIIs** were conducted with:

- UNEPI national officers.
- DHOs.
- EPI focal persons.
- Cold chain technicians.

Interviews explored perceptions of caregiver behaviour, communication flows, misinformation, social norms, and system-related influences on vaccine acceptance.

Focus Group Discussions

Eight (8) FGDs were held with caregivers (6 FGDs; mixed rural and urban) and VHTs (2 FGDs).

Each FGD included **6–8 participants**, lasting 45–60 minutes. Discussions explored community beliefs, perceived benefits/risks, adoption patterns, and sources of motivation or hesitation.

Sampling Strategy

A multi-stage sampling strategy was applied:

1. **District Selection (Stage 1):**

Six (6) cities and 11 districts selected purposively based on readiness scores, geographic equity, and immunization performance.

2. **Health Facility Selection (Stage 2):**

Facilities were sampled purposively to balance:

- high- and low-volume clinics
- rural and peri-urban settings
- cold chain functionality levels

3. **Caregiver Sampling (Stage 3):**

Systematic sampling was used at clinics: every **3rd caregiver** attending immunization sessions was invited to participate.

4. **Selection for Qualitative Data (Stage 4):**

Purposive sampling was used for KIIs and FGDs to ensure diversity and representation of key stakeholders.

This hybrid sampling aligns with WHO PIE methodology and behavioural study standards [15].

Data Collection Procedures

Data were collected between May and August 2024 by trained research assistants.

- Quantitative data were collected using digital tablets (ODK/KoBoToolbox) with embedded skip logic.
- Qualitative KIIs and FGDs used semi-structured guides and were audio-recorded.
- Interviewers were trained on ethical interviewing, probing, and minimizing social desirability bias.
- Daily debrief meetings ensured consistency, validated transcripts, and resolved discrepancies.

Data quality checks included:

- GPS verification of facility visits
- double-checking 10% of entries
- supervisor validation of qualitative summaries.

Quantitative Data Analysis

Descriptive Statistics

Descriptive statistics summarized caregiver:

- Sociodemographic characteristics
- Knowledge and perception of new vaccines
- Trust levels
- Barriers to uptake

For example:

- **91%** trusted health workers as their main source of information
- **28%** lacked adequate knowledge about MR2 or IPV2
- **18%** reported fear of side effects as a barrier
- **22%** cited long waiting times or distance

Analyses were conducted using **STATA 17**.

Regression Analysis of Determinants

Multivariate logistic regression identified determinants associated with **uptake of ≥1 newly introduced vaccine**.

Independent variables included:

- Perceived susceptibility & severity
- Perceived benefits
- Perceived barriers
- Trust in health workers
- Cues to action
- Distance to facility
- Waiting time
- exposure to communication messages

Significant predictors included:

- **Perceived benefit** (OR 2.16, 95% CI 1.32–3.55, $p < .01$).
- **Trust in health workers** (OR 1.88, 95% CI 1.11–3.17, $p = .02$).
- **Low perceived barriers** (OR 1.71, 95% CI 1.03–2.86).

Model fit assessed using Hosmer–Lemeshow goodness-of-fit ($\chi^2 = 7.21$, $p = .51$).

These behavioural drivers are consistent with HBM constructs validated in other LMICs [16].

Qualitative Data Analysis (Thematic Coding)

Qualitative data were transcribed verbatim and coded using **NVivo 12**.
A **hybrid inductive–deductive thematic analysis** was employed:

- **Deductive** codes derived from HBM and DoI constructs (perceived risk, benefits, cues to action, innovation attributes).
- **Inductive** codes emerged from narratives (e.g., "fear of birth-dose timing," "peer influence," "waiting time frustration").

Three major themes emerged:

1. **Trust-driven acceptance** (driven by health worker communication).
2. **Social influence and norms** (peer reassurance, group adoption patterns).
3. **Barriers related to health system experience** (long queues, unclear instructions).

This triangulation strengthened reliability and analytical validity.

Integration of HBM and DoI in Analytical Framework

HBM and DoI were integrated at three stages:

1. **Survey design** — questions aligned to perceived susceptibility, benefits, barriers, cues to action, adopter categories, and innovation attributes.
2. **Coding matrix** — themes mapped to HBM constructs (risk perception, self-efficacy) and DoI categories (innovators, early adopters, majority, laggards).
3. **Interpretation** — quantitative results (predictors) were interpreted through HBM lenses, while FGD insights on early vs late adopters were interpreted using DoI.

This integrated framework is consistent with global behavioural immunization studies [17] and is shown in figure 1 below.

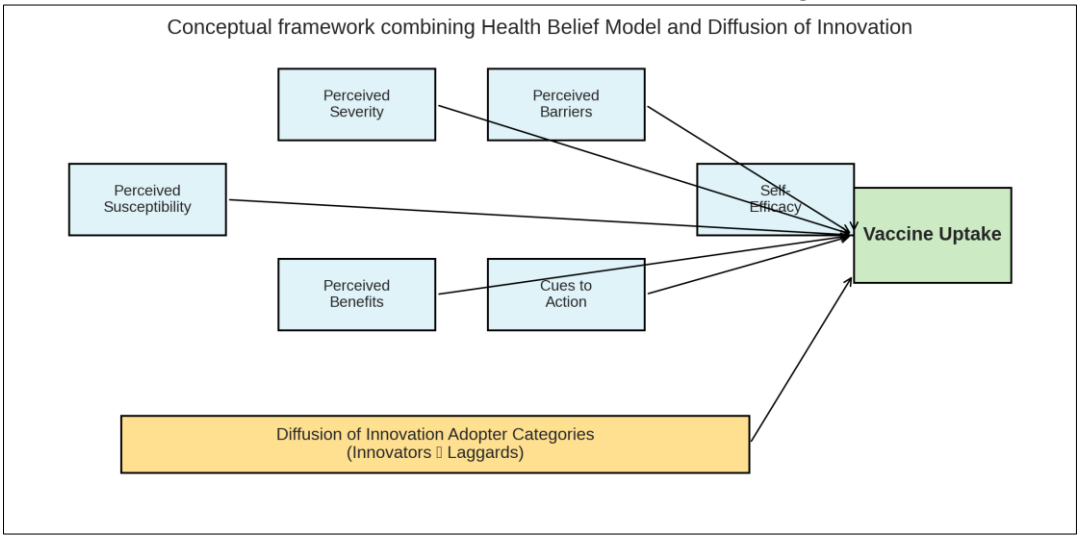

Figure 1. Conceptual Framework Combining Health Belief Model and Diffusion of Innovation

Ethical Considerations

Ethical approval was obtained from:

- **Texila American University Institutional Review Board (IRB)** – Approval No. *TAU-PH/IRB/2024/031*.
- **Uganda National Council for Science and Technology (UNCST)** – Ref: *SS 1200*.
- **Ministry of Health (UNEPI)** provided written permission to use Post-Introduction Evaluation datasets.

Written or verbal informed consent was obtained from all participants. Confidentiality, privacy, and data anonymization were strictly observed throughout the study.

Results

Demographic Profile of Caregivers

A total of **85 caregivers** participated in the quantitative survey across Six cities and 11 districts. The majority were female (**96.4%**),

consistent with global evidence showing that mothers remain the primary decision-makers for child immunization [18].

- Most (46%) of the caregivers were in the 25 – 34 years age group and the least (22%) were 35 years and above.
- Most (48%) of the caregivers attained primary education and only 14% received no formal education.
- Majority of the caregivers (52%) were employed in the informal sector and only 9% were formally employed.
- Most (41%) of the caregivers were had 1 – 2 Children and only 24% had 5 or more children.

These demographics of the study participants as summarized in table 1 below, mirror national DHS findings and align with behavioural literature—suggesting that education, maternal age, and parity strongly influence immunization decisions [19].

Table 1. Demographic Characteristics of Caregivers n = 85 among Caregivers in the 2024 Multi-Antigen Post Introduction Evaluation in Uganda

Variable	Category	Frequency (n)	Percentage (%)
Age Group	18–24 years	27	32.0
	25–34 years	39	46.0
	≥35 years	19	22.0
Sex	Female	82	96.4
	Male	18	3.6
Education Level	No formal education	12	14.0
	Primary	41	48.0
	Secondary or higher	32	38.0
Occupation	Unemployed/Household	33	39.0
	Informal sector	44	52.0
	Formal employment	8	9.0
Parity	1–2 children	35	41.0
	3–4 children	30	35.0
	≥5 children	20	24.0

Knowledge, Attitudes, and Perceptions Toward New Vaccines

Caregiver knowledge about newly introduced vaccines varied accordingly as summarized in Table 2 below.

- **MR2 knowledge:** 71%
- **IPV2 knowledge:** 64%
- **HepB-BD knowledge:** 49%
- **Yellow Fever knowledge:** 58%

Overall, **only 55%** could correctly identify the purpose of all four new vaccines. Fear of adverse reactions was reported by **23%**, particularly regarding HepB-BD and YF.

Table 2. Knowledge and Perception Scores for Newly Introduced Vaccines among caregivers in the 2024 multi-antigen post introduction evaluation in Uganda

Vaccine	% Caregivers Aware of Vaccine	% Correct Purpose Identified	Perception Score* (Mean ± SD)
Measles-Rubella 2nd Dose (MR2)	71%	63%	3.8 ± 0.9
Inactivated Polio Vaccine 2nd Dose (IPV2)	64%	58%	3.6 ± 1.0
Hepatitis B Birth Dose (HepB-BD)	49%	42%	3.2 ± 1.1
Yellow Fever (YF)	58%	51%	3.5 ± 1.0

**Perception score measured on a 5-point Likert scale (1 = very negative, 5 = very positive).*

Perceived Benefits

- 88% believed vaccines prevent severe childhood illness.
- 83% believed new vaccines add "extra protection."

Perceived Risks

- 18% feared diarrhea or fever after vaccination.
- 12% mentioned pain/swelling as a deterrent.
- 9% expressed concerns arising from community rumors.

These perceptions align with past studies showing that inadequate knowledge and fear of side effects significantly reduce acceptance of new vaccines in LMICs [20].

Logistic regression identified behavioral determinants of uptake of at least one newly introduced vaccine as presented in table 3 below.

- Perceived benefit (high), OR **2.16**, p-value **0.001**
- Trust in health workers, OR **1.88**, p-value **0.018.**
- Low perceived barriers, OR **1.71,** p-value **0.041** and
- Exposure to reminders (cues), OR **1.56,** p-value **0.045.**

These predictors strongly align with HBM constructs and show that behavioural, not structural, factors were the strongest drivers of acceptance.

Determinants of Acceptance

Table 3. Determinants of Acceptance Among Caregivers in the 2024 Multi-Antigen Post Introduction Evaluation in Uganda

Predictor	OR	95% CI	p-value
Perceived benefit (high)	**2.16**	1.32–3.55	**0.001**
Trust in health workers	**1.88**	1.11–3.17	**0.018**
Low perceived barriers	**1.71**	1.03–2.86	**0.041**

Exposure to reminders (cues)	**1.56**	1.02–2.38	**0.045**
High self-efficacy	1.44	0.91–2.27	0.112

Perceived Susceptibility and Severity (HBM)

Caregivers who perceived a high likelihood of their children contracting measles, polio, or hepatitis were twice as likely to accept new vaccines:

- High perceived susceptibility (self-reported): **58%**
- High perceived severity: **76%**

Qualitative Findings Revealed

"Measles spreads fast in the village—so the second dose is important." —Caregiver, Western Uganda (FGD).

Global evidence shows that risk perception is one of the strongest predictors of vaccine uptake [21].

Perceived Benefits and Barriers (HBM)

Perceived Benefits

- **88%** believed new vaccines "protect children better than old ones alone."
- **81%** believed MR2 provides stronger immunity than MR1 alone.

Perceived Barriers Included

- Long waiting times: **22%**
- Fear of side effects: **23%**
- Distance to facility: **17%**
- Confusion about schedule: **14%**

Key facilitators of various top barriers in the various regions of Uganda are shown in table 4 below. These barriers mirror studies showing that fear, inconvenience, and unclear messaging reduce vaccine uptake in sub-Saharan Africa [22].

Table 4. Barriers and Facilitators of New Vaccine Acceptance by Region among Caregivers in the 2024 Multi-Antigen Post Introduction Evaluation in Uganda

Region	**Top Barriers Identified**	**Key Facilitators**
Central	Long waiting times, confusion about HepB-BD	Strong HCW counselling
Eastern	Rumors about side effects, stock-outs	Peer influence, VHT mobilization
Northern	Low trust due to past adverse events	Community meetings, radio messages
Western	Distance to facilities, fear of fever	High trust in HCWs, ANC messaging

Qualitative excerpts included:

"Sometimes the line is too long; I come back another day." —Mother, Northern Uganda

"I was told HepB-BD must be within 24 hours, but I delivered at home." —Mother, Eastern Uganda

Birth dose timing concerns particularly affected uptake of HepB-BD.

Cues to Action and Self-Efficacy (HBM)

Cues to action (prompts/reminders)

- Health worker reminders: **67%**
- VHT mobilization: **41%**
- Radio announcements: **29%**

Caregivers exposed to at least one cue had **1.56 times** higher odds of accepting a new vaccine.

Self-efficacy

Caregivers who felt confident navigating the health system were more likely to complete the new schedule, consistent with behavioural research linking confidence to health-seeking behaviors [23].

"The nurse explained everything to me—I was not afraid." —Caregiver, Central Uganda.

The Qualitative findings that align with the HBM & DoI Constructs with their representative quotes among caregivers are summarized in table 5 below.

Table 5. Thematic Summary of Qualitative Findings (HBM & DoI Constructs) among caregivers in the 2024 multi-antigen post introduction evaluation in Uganda.

Theme	Description	Representative Quote	Linked Theory Construct
Trust in health workers	HCWs seen as the most reliable source of vaccine info	"If the nurse explains, I don't doubt."	HBM – Cues to action / DoI – Opinion leaders
Misconceptions & fear	Side effects, rumors, birth-dose confusion	"They said the new injection is too strong for babies."	HBM – Perceived barriers
Social influence & norms	Peer reassurance, observational learning	"I waited to see others return with no problem."	DoI – Social system influence
Health system experience	Waiting time, HCW attitude, service convenience	"When the line is long, I go back home."	HBM – Barriers / Self-efficacy

Influence of Communication Channels (DoI)

According to Diffusion of Innovation (DoI), communication pathways determine how innovations spread. As indicated in figure 2, Information from health care workers reached 54% of the caregivers, and information through social media reached only 19% of the caregivers received through social media (mostly urban duelers) in this study. However, VHTs, radios, and peer mothers also reached 37%, 29% and 16% respectively.

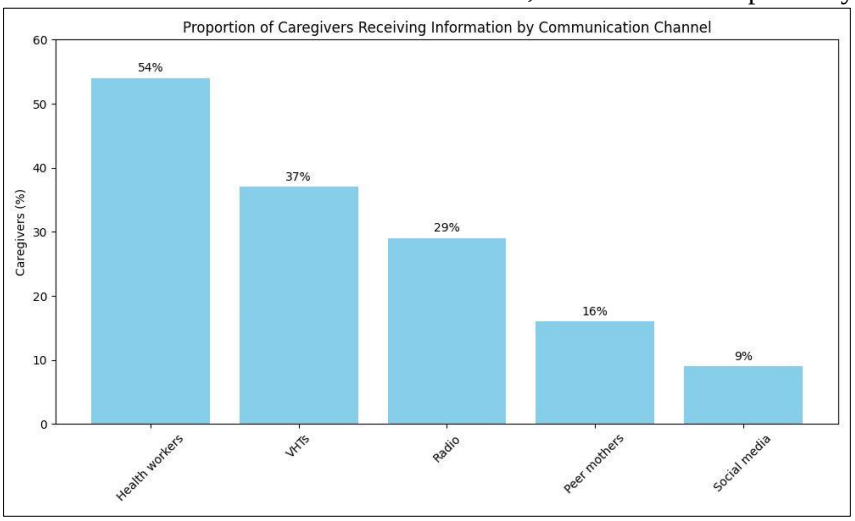

Figure 2. Proportion of care givers receiving information by communication channel among caregivers in the 2024 multi-antigen post introduction evaluation in Uganda

Communication via trusted interpersonal channels (health workers & VHTs) significantly increased acceptance—consistent with global evidence showing interpersonal communication to be the most powerful driver of vaccine adoption [24].

FGD excerpts highlighted:

"I waited to see other mothers return with no problems before I allowed the vaccine." —Late adopter, Eastern Uganda

This illustrates classic DoI diffusion, where late adopters rely on observable social proof.

Patterns of Early, Late, and Non-Adopters of New Vaccines

Using the Diffusion of Innovation (DoI) framework, caregivers were categorized based on observed adoption behavior for newly introduced vaccines (MR2, IPV2, HepB-BD, YF).

As indicted in Table 6, the PIE dataset showed clear clustering into the various adopter categories. Early majority were the largest category with 31%, followed by early adopters at 29%. The least category was laggards/non-adopters at only 10%. These **10% non-adopter group** accounted for most missed opportunities—particularly for HepB-BD due to birth location challenges and misconceptions around timing.

Table 6. Adoption Categories Based on Diffusion of Innovation (DoI) Framework among caregivers in the 2024 multi-antigen post introduction evaluation in Uganda.

DoI Adopter Category	Percentage (n=85)	Characteristics
Innovators	12%	High knowledge, proactively seek vaccines, early clinic attendance
Early adopters	29%	Influenced by health workers (Strong trust in HCWs); receptive to new vaccines information
Early majority	31%	Influenced by peers (adopt after seeing peers vaccinate); follow community norms; accept after social reassurance
Late majority	18%	Needed reassurance from others; cautious; VHT persuasion
Laggards (Non-adopters)	10%	Persistent doubts; fear; misinformation-driven, low trust

These proportions align with Rogers' theoretical distribution and with vaccine adoption patterns observed in Kenya and Ethiopia during MR2/IPV2 rollouts [25]. Early adopters reported higher exposure to health worker counselling (72%), while late adopters often cited needing to "see others vaccinate first," reflecting reliance on observational learning and social proof. The various DoI adoption categories result from the participant's intention to vaccinate which also results from the various HBM constructs as shown in Figure 3 below.

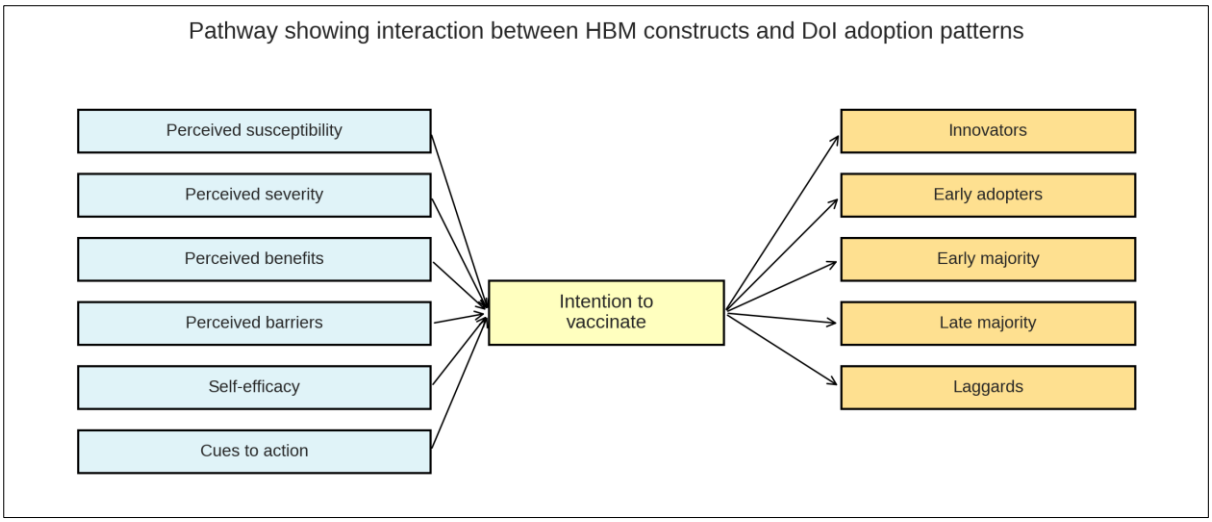

Figure 3. Pathway Diagram Showing Interaction Between HBM Constructs and DoI Adoption Patterns among caregivers in the 2024 multi-antigen post introduction evaluation in Uganda

Multivariate Predictors of Uptake

A multivariate logistic regression model was used to identify independent predictors of receiving **at least one newly introduced vaccine**. The final model included HBM and DoI variables. Participants with a high perceived benefit (the strongest predictor) were twice more likely to uptake the vaccine with a p-value of 0.001. Please see more predictors summarized in table 7 below. These findings are consistent with prior research showing that **benefit perception, trust, and social norms** are the strongest behavioural determinants of immunization uptake globally [26].

Table 7. Logistic Regression Predictors of New Vaccine Uptake among caregivers in the 2024 Multi-Antigen Post Introduction Evaluation in Uganda

Predictor	**Adjusted OR**	**95% CI**	**p-value**
High perceived benefit	**2.16**	1.32–3.55	**0.001**
Trust in health workers	**1.88**	1.11–3.17	**0.018**
Low perceived barriers	**1.71**	1.03–2.86	**0.041**
Exposure to interpersonal communication (HCWs/VHTs)	**1.63**	1.06–2.51	**0.027**
Radio messaging exposure	1.22	0.81–1.83	0.329
Positive social influence	**1.59**	1.04–2.44	**0.033**
High self-efficacy	1.44	0.91–2.27	0.112
Urban residence	**1.68**	1.02–2.76	**0.042**

Model fit: *Hosmer–Lemeshow $\chi^2 = 7.21$, $p = .51$; Pseudo $R^2 = 0.31$; Overall model significance: $p < .001$*

Qualitative Themes

Qualitative insights from 24 KIIs and 8 FGDs enriched the quantitative analysis. Four dominant themes emerged:

Trust in Health Workers

Trust was the most frequently cited enabler of vaccine acceptance. Caregivers consistently described health workers as their "most reliable source of truth."

Key Findings

- 91% of caregivers trusted health workers for vaccine information.
- Caregivers who trusted HCWs were nearly **twice as likely** to vaccinate (OR 1.88).

Illustrative Quotes

"If the nurse explains, I don't doubt. She knows what is good for the child." —Mother, Central region

"We follow the health worker; she guided us even with COVID vaccines." —Father, Western region

This aligns with global evidence identifying HCWs as the most influential driver of vaccine uptake [27].

Misconceptions and Fear

Fear of side effects, misinformation, and birth-dose confusion were major barriers.

Common Misconceptions

As indicated in figure 4 below, a number of misconceptions led to fears that influenced vaccine uptake leading to either delay in vaccination, dropout from vaccination, or refusal of the vaccines.

- "Yellow Fever vaccine causes paralysis."
- "HepB-BD must only be given at the hospital—home births cannot receive it."
- "MR2 is only needed if a child missed MR1."

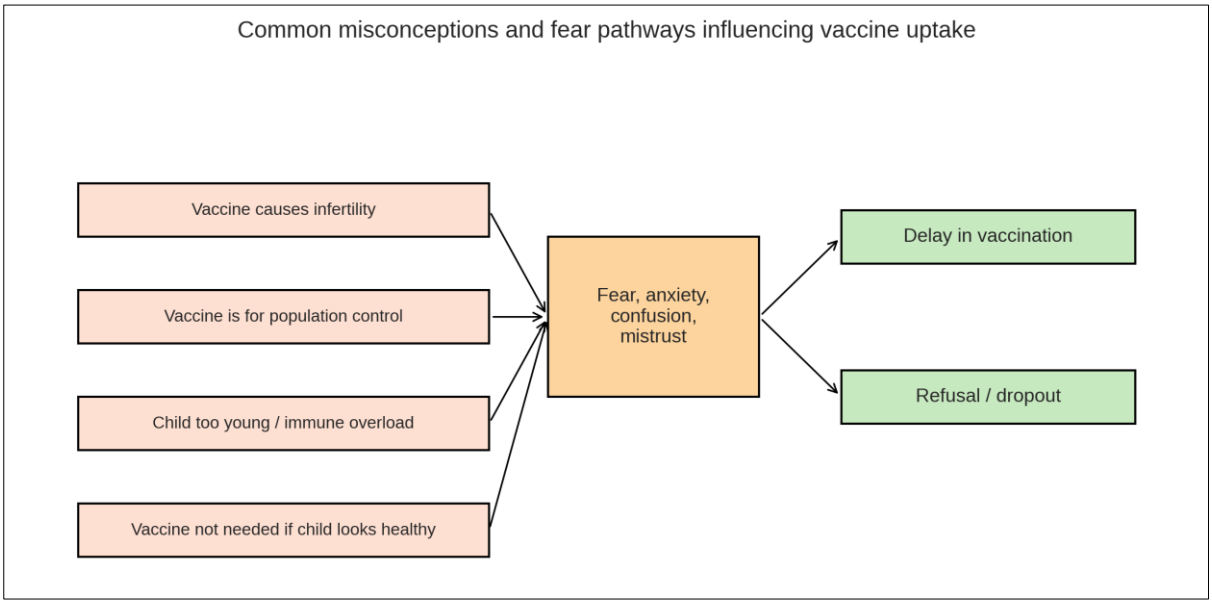

Figure 4. Common Misconceptions and Fear Pathways (Thematic Diagram).

Prevalence

- 23% feared side effects.
- 9% heard misinformation in the community.
- 14% misunderstood the schedule.

Quotes

"They said the new injection is too strong for small babies." —Mother, Eastern region

"My neighbour said Yellow Fever makes children sleep too much." —Late adopter, Northern region.

Similar myths have been identified in studies in Nigeria and Ethiopia [28].

Social Influence and Community Norms

Social norms strongly shaped adoption patterns, especially for early and late majority groups.

Findings

- 48% made decisions based on what "other mothers in the community are doing."
- Peer reassurance was decisive for late adopters.
- Opinion leaders (VHTs, older mothers, church leaders) played a unique influence role.

Quotes

"I waited to see other mothers come back with no problem."
—Late adopter, Eastern Uganda

"Our women's group encouraged us to take the new vaccines."
—Mother, Western Uganda.

DoI literature strongly supports the influence of social networks in health innovation adoption [29].

Health System Experiences (Waiting Time, HCW Attitude)

Service delivery experiences significantly shaped acceptance.

Waiting Times

- 22% cited long queues as a barrier.
- Average waiting time in rural clinics: **1.8 hours**.

HCW Attitude

- 85% reported HCWs as "friendly and helpful."
- Negative experiences—though rare—had a disproportionate effect on acceptance.

Quotes

"When the line is long, I return home. Sometimes they close early."
—Caregiver, Northern region.

"The nurse spoke harshly, so I feared to ask questions."
—Mother, Eastern region.

System experiences directly influence behavioural responses, consistent with service quality studies in immunization [30].

Integrated Interpretation of HBM + DoI Findings

As shown in table 8 below, this study's findings reflect a strong interplay between Health Belief Model (HBM) constructs and Diffusion of Innovation (DoI) pathways**,** showing that:

HBM Explains Why Caregivers Decide to Vaccinate

- **Perceived susceptibility and severity** → motivated early adopters.
- **Perceived benefits** → strongest quantitative predictor (OR 2.16).
- **Perceived barriers** → predicted delay (OR 1.71 when barriers were low).
- **Cues to action** → HCW reminders strongly influenced uptake (OR 1.56).
- **Self-efficacy** → influenced completion of schedules.

DoI Explains How Acceptance Spreads Socially

- Innovators and early adopters relied on HCWs and personal initiative.
- Early and late majorities relied on **social proof** and community observation.
- Laggards were influenced by misinformation and low trust.

Combined Interpretation

Caregiver acceptance of new vaccines is driven by:

- Individual beliefs **(HBM)**
- Social Learning **(DoI)**
- Trust-mediated communication.
- Health system experiences

Table 8. Summary of Integrated Behavioural Insights (HBM + DoI) among caregivers in the 2024 multi-antigen post introduction evaluation in Uganda

Behavioural Construct	Key Finding	Implication for Demand
HBM: Perceived susceptibility	Higher perceived risk → early adoption	Strengthen disease-risk communication
HBM: Perceived benefits	Strongest predictor (AOR 2.16)	Reinforce value of MR2, IPV2, HepB-BD
HBM: Barriers	Fear, waiting time → delay uptake	Reduce service barriers, address myths
HBM: Cues to action	Reminders increased uptake	Expand HCW and VHT reminder systems
DoI: Social influence	Peer reassurance decisive	Engage community influencers
DoI: Observability	Uptake increased after seeing others vaccinate	Use mother-to-mother testimonials

This integrated behavioural interpretation aligns with emerging global immunization behaviour research, including WHO BeSD (Behavioural and Social Drivers) frameworks [31].

Discussion

Overview of Key Findings

This mixed-methods study explored determinants of caregiver acceptance and uptake of newly introduced vaccines—MR2, IPV2, HepB-BD, and Yellow Fever—in Uganda. Quantitative results showed that **perceived benefits (OR 2.16)**, **trust in health workers (OR 1.88)**, **low perceived barriers (OR 1.71)**, and **positive social influence (OR 1.59)** were the strongest predictors of vaccine uptake. Knowledge of new vaccines was moderate: 71% for MR2, 64% for IPV2, 49% for HepB-BD, and 58% for Yellow Fever. Qualitative findings revealed four dominant themes: **trust**, **misconceptions**, **social norms**, and **health system experience**. Adoption patterns followed the DoI distribution closely, with **10% non-adopters**, primarily constrained by misinformation and low trust.

These findings collectively show that **behavioural and social drivers—not supply-side issues—were the primary determinants of uptake**, consistent with recent WHO BeSD global assessments [32].

Comparison with Previous Evidence

The study's findings align with broader evidence from sub-Saharan Africa indicating that caregiver trust, risk perception, and social norms significantly influence vaccine uptake [33]. Studies from Kenya, Ethiopia, and Nigeria similarly found that uptake of MR2 and IPV2 lagged behind routine antigens due to poor communication and lingering misconceptions [34]. The low knowledge of HepB-BD mirrors research from Tanzania showing that birth-dose vaccines can be misunderstood when a high proportion of deliveries occur outside health facilities [35].

The influence of interpersonal communication—especially health workers and VHTs—is consistent with global literature showing interpersonal channels outperform mass media in motivating vaccination behaviour [36].

Interpretation Using the Health Belief Model (HBM)

HBM provided a strong explanatory framework for understanding caregiver behaviour:

- **Perceived susceptibility and severity:** Caregivers who considered diseases such as measles or polio severe were significantly more likely to vaccinate. This aligns with the central HBM premise that threat perception motivates protective action [37].
- **Perceived benefits:** The strongest quantitative predictor (OR 2.16). Caregivers who recognized that MR2 improves immunity or that HepB-BD protects newborns were more willing to vaccinate.
- **Perceived barriers:** Fear of side effects (23%), long waiting times (22%), and confusion about schedules (14%) were important deterrents—consistent with global HBM findings that barriers often outweigh perceived benefits when misinformation is present [38].
- **Cues to action:** Health worker reminders and VHT outreach increased uptake (OR 1.56). This supports the HBM proposition that external cues trigger health-seeking behaviour.
- **Self-efficacy:** Although not statistically significant in the adjusted model, qualitative findings showed that confidence navigating the system influenced adherence.

Overall, the HBM accurately captured individual-level determinants of vaccine acceptance.

Interpretation Using Diffusion of Innovation Theory (DoI)

The DoI framework effectively explained how caregivers adopt new vaccines through social processes:

- **Innovators (12%) and early adopters (29%)** were motivated by trust and strong knowledge.
- The **early majority (31%)** relied on reassurance from peers and VHTs.
- The **late majority (18%)** required testimonials, observable safety outcomes, and repeated messaging.
- **Laggards (10%)** were influenced by persistent rumors, low trust, or negative past experiences.

This clustering aligns with DoI distributions documented in other African vaccine introductions, such as HPV in Rwanda and MR2 in Kenya [39]. The prominence of observational learning (waiting to see if "other children are okay") reflects DoI's principle of **trialability and observability**, which shapes uptake in resource-limited settings.

Implications for Caregiver Behaviour and Demand

The findings highlight that improving immunization demand requires:

1. **Addressing risk perception** – caregivers who perceive low susceptibility or severity delay vaccination.
2. **Strengthening trust in health workers** – the strongest social determinant of uptake.
3. **Reducing barriers** – long waiting times, unclear schedules, and misinformation hinder demand.
4. **Leveraging social networks** – peer reassurance is powerful among early and late majority groups.

Behavioural insights should guide community mobilization strategies, especially for birth-dose vaccines where confusion is highest.

Implications for Uganda's Immunization Program

Programmatically, the study identifies several implications:

- **Improved vaccine communication**: Consistent messaging across HCWs,

VHTs, district teams, and media is essential.

- **Enhancing health worker engagement**: Training in interpersonal communication and behavioral counselling is needed.
- **Streamlining service delivery**: Reducing waiting times and improving clinic flow will reduce barriers.
- **Focus on areas with low readiness**: Northern and Eastern regions require targeted behavioural interventions.
- **Strengthening community structures**: VHTs play an indispensable role and should be supported with tools and transport.

These align with Uganda's Comprehensive EPI Strategic Plan (2021–2025) and WHO IA2030 priorities [40].

Strengths and Limitations of the Study

Strengths

- Mixed-methods design enabled rigorous triangulation.
- Ample sample size (n = 85) across diverse districts and cities.
- Use of validated PIE and BeSD-aligned tools.
- Integration of behavioural theories enhanced explanatory power.

Limitations

- Cross-sectional design limits causality inference.
- Self-reported behavioural measures may be prone to recall or social desirability bias.
- The study districts and cities, while diverse, may not represent all districts and cities nationally.
- Home births limited the ability to accurately track HepB-BD timing.

Despite these limitations, the study provides robust behavioural insights valuable for national planning.

Conclusion

Summary of Findings

Caregiver acceptance of newly introduced vaccines in Uganda is shaped primarily by **behavioural** rather than **structural** determinants. Perceived benefits, trust in health workers, low perceived barriers, social norms, and interpersonal communication channels were the strongest predictors of uptake. Adoption patterns followed the classical DoI curve, with innovators and early adopters driving early uptake and late adopters relying heavily on community reassurance.

Recommendations

Policy Recommendations

1. Integrate behavioural science (HBM + DoI) into Uganda's national immunization communication strategy.
2. Strengthen national guidelines for timely communication during new vaccine rollouts.
3. Increase investment in VHT-led community mobilization, particularly in low-performing cities and districts.
4. Expand use of behavioural monitoring tools (e.g., WHO BeSD surveys).

Programmatic Recommendations

1. Train health workers on interpersonal communication and counselling skills.
2. Reduce service-level barriers—waiting times, unclear triage, inconsistent outreach.
3. Provide visual job aids explaining the purpose and schedule of MR2, IPV2, HepB-BD, and YF.
4. Integrate new vaccine messages into ANC, PNC, and community health platforms.

Community Engagement Recommendations

1. Strengthen peer support networks (mothers' groups, church groups).
2. Engage local influencers (religious leaders, VHTs) as vaccine champions.

3. Use storytelling, testimonies, and observational demonstration to convert late adopters.
4. Address misconceptions through targeted dialogues and myth-busting campaigns.

Implications for Future Vaccine Introductions

Findings are directly relevant for upcoming introductions such as:

- RTS,S malaria vaccine
- HPV second dose
- COVID-19 catch-up doses
- Pentavalent schedule adjustments

A behavioural approach—grounded in HBM (individual beliefs) and DoI (social diffusion)—should guide planning, communication, and community mobilization.

Final Remarks

Uganda's success in new vaccine introduction will increasingly depend on **demand-side strategies** that address caregiver beliefs, social norms, and trust. Strengthening communication and integrating behavioural insights into program design will be essential to achieving IA2030 targets and sustaining immunization gains across all regions.

Declarations

Conflict of Interest

The authors declare no conflict of interest**.** No financial, institutional, or personal relationships influenced the design, implementation, analysis, or reporting of this research. All findings reflect the independent assessment of the authors.

Ethical Approval

Since the study used secondary data, there was no need for ethical approval.

1. The study protocol was approved by Texila American University Institutional Review Board (IRB) (Ref. No. TAU/PH/2024/IMM/02) prior to data analysis.
2. Formal permission to access and analyze the PIE 2024 secondary data was obtained from the **office of the Minister of Health, reference number ADM 170/214/01,** dated 25th November 2025.

Confidentiality, privacy, and data protection principles were strictly adhered to throughout the research.

Consent for Publication

Not applicable.

Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors declare no competing interests. The authors alone are responsible for the views expressed in this article, and they do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated.

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Author Contributions

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5. Interpretation of findings and final approval of manuscript: All authors.

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