Global Journal of Health Ethics,Volume1,Issue2,June 2025,DOI: https://doi.org/10.63101/gjhe.v1i2.015

Original Article

Assessment of Immunization Coverage and Its Contributing Factors Among Children Aged Under Five Years in Rural Gasabo District, Rwanda

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ABSTRACT

Background: Immunization remains a cornerstone of public health, essential for preventing childhood diseases, reducing mortality, and achieving herd immunity. However, coverage challenges persist, particularly in rural regions of sub-Saharan Africa, including Rwanda.

Objective: This study assessed immunization coverage and its contributing factors among children under five years of age in rural areas of Gasabo District, Rwanda.

Methods: A mixed-methods design was employed, combining quantitative and qualitative approaches. A cross-sectional survey was conducted among 196 caregivers of children under five, selected using a 95% confidence interval and a 5% margin of error. Quantitative data were analyzed using descriptive and inferential statistics, while qualitative data from key informant interviews were subjected to thematic analysis to explore socio-economic, cultural, and behavioral determinants of immunization uptake.

Results: The study found a high immunization coverage rate of 91%, while 9% of children were either partially immunized or not immunized at all. Socio-demographic factors, including caregiver age, education level, and marital status, were significantly associated with immunization uptake ($p < 0.001$). Immunization rates were highest among caregivers aged 25–34 (100%) and lowest among those aged 18–24 (88.6%). Distance to healthcare facilities was also a determinant, with lower coverage observed among families residing more than 10 kilometers from a health center. Qualitative findings revealed that perceptions of vaccine safety, awareness of immunization schedules, and the presence of vaccine-related myths influenced caregiver decisions. Barriers such as misinformation, limited male caregiver involvement, and employment-related time constraints for mothers were also identified. Conversely, community outreach and the active role of community health workers (CHWs) emerged as key enablers of vaccine uptake.

Conclusion: While immunization coverage in rural Gasabo is relatively high, gaps remain that hinder universal coverage. Addressing behavioral, socio-demographic, and structural barriers through targeted, multi-sectoral interventions is crucial for achieving equitable and comprehensive immunization.

Keywords (MeSH): Immunization, Vaccine Coverage, Under-Five Children, Rural Health, Rwanda, Community Health Workers, Vaccine Hesitancy

Introduction

Immunization is one of the most impactful public health strategies, preventing 4 to 5 million deaths annually from diseases like measles and polio (WHO, 2020). Yet, about 1.5 million more deaths could be prevented with improved global vaccine coverage. The Immunization Agenda 2030 emphasizes the goal of universal and equitable access, especially in low-resource settings. Sub-Saharan Africa has seen progress through initiatives like the Expanded Programme on Immunization (EPI), but the region still has the highest number of under-immunized children due to fragile health systems, supply issues, and sociocultural challenges (UNICEF, 2021; Favin et al., 2012).

Countries in East Africa have introduced mobile clinics and integrated maternal-child health services to expand coverage, yet rural areas remain underserved due to poor infrastructure and difficult terrain (Mbengue et al., 2017). Rwanda stands out with national immunization coverage rates above 90%, driven by strong political support, decentralized services, and innovations like drone delivery (Binagwaho et al., 2012). However, national figures often mask disparities. In Gasabo District, particularly in its rural sectors—Bumbogo, Gikomero, and Rutunga coverage for key vaccines like Pentavalent-3 and Measles-Rubella-1 remains between 80% and 85%, below the WHO's 90% threshold (HMIS, 2022).

Barriers to full immunization go beyond access and include caregiver education, household income, cultural beliefs, and misinformation (Iraguha, 2022; Nwankwo & Orua, 2020). These factors align with Andersen's Behavioral Model, which views healthcare use through predisposing, enabling, and need-based determinants (Andersen, 1995). Despite Rwanda's success, there is limited localized data, particularly from rural and semi-urban areas like Gasabo. Most studies have used national-level data without community-level insight. This study addresses that gap by examining immunization coverage and its determinants among children under five in rural Gasabo. Its findings aim to inform evidence-based, community-driven strategies to improve equitable vaccine access and support Rwanda's broader disease prevention goals.

Methods

Study Design

This study employed a convergent parallel mixed-methods design, integrating quantitative and qualitative approaches to comprehensively assess immunization coverage and its determinants among children under five years in Gasabo District, Rwanda. The quantitative component utilized a descriptive cross-sectional design to measure vaccine coverage and investigate associations with socio-demographic and health-related factors. Concurrently, the qualitative component comprised semi-structured interviews and focus group discussions (FGDs) to explore community perceptions, cultural beliefs, and behavioral factors influencing immunization uptake. Integration of both datasets occurred at the interpretation stage, enabling triangulation that enhanced the validity and contextual richness of the findings.

Study Setting

The research was conducted in Gasabo District, a diverse area within Kigali City characterized by a mix of urban and rural sectors. The study focused on the predominantly rural sectors of Bumbogo, Gikomero, and Rutunga, which face unique challenges such as difficult terrain, limited healthcare infrastructure, and intermittent outreach vaccination services. Gasabo District has an estimated population of 530,907, with approximately 19% of residents under five years old (NISR, 2022). The district's health system comprises 19 health centers and one district hospital; however, rural communities often experience barriers to consistent vaccine access, which may contribute to suboptimal immunization coverage.

Study Population

The target population included children aged 0 to 59 months residing in the rural sectors of Gasabo District. Their primary caregivers, typically parents or guardians, were the respondents for the quantitative survey. The qualitative sample additionally included healthcare providers such as nurses, immunization officers, and community health workers and influential community leaders, including village chiefs, religious leaders, and traditional healers. This diverse participant pool allowed the study to capture multiple perspectives on immunization barriers and facilitators.

Inclusion and Exclusion Criteria

Participants were eligible if children were between 0 and 59 months with verifiable immunization records either from child health cards or health facility data. Caregivers had to have resided in the district for at least six months and provide informed consent. Healthcare providers and community leaders were included based on their active roles in immunization service delivery or community health advocacy. Children with contraindications to vaccination like immunodeficiency and those not residing within Gasabo District were excluded to maintain the study's geographic and clinical relevance.

Sampling Method

A multistage sampling approach ensured representative inclusion of both urban and rural households. Initially, the three rural sectors were purposively selected due to their lower immunization rates. Within each sector, two villages were randomly chosen, and households with eligible children were selected through simple random sampling from household lists provided by community health workers. In each selected household, the primary caregiver of the youngest eligible child was invited to participate. For qualitative data, purposive and snowball sampling identified key informants with direct involvement or influence in immunization activities. Four FGDs were conducted, each comprising 6–8 caregivers, stratified by village to facilitate open discussion of shared experiences.

Sample Size Calculation

Sample size for the quantitative survey was calculated using the standard formula for population proportions, with assumptions including a 95% confidence level, a 5% margin of error, and an estimated immunization coverage prevalence of 85% based on Ministry of Health data (MOH, 2020). This calculation yielded an initial sample size of 196, which was increased by 10% to 216 to account for potential non-response, with a final target of 220 participants.

Data Collection Methods

Data collection instruments were adapted from validated tools including the Demographic and Health Surveys (DHS) immunization modules and WHO's Expanded Programme on Immunization indicators. The questionnaires and interview guides were translated into Kinyarwanda and back-translated to ensure linguistic accuracy. Content validity was confirmed through expert review and pilot testing, which was conducted in Kinyinya sector with 20 caregivers, two health workers, and one FGD. Feedback from the pilot study led to refinements in question wording and format to improve clarity and cultural appropriateness. Quantitative data were collected via face-to-face interviews using tablets equipped with KoboToolbox software. Immunization status was verified against health cards or facility registers to minimize recall bias. Qualitative data were obtained through audio-recorded semi-structured interviews with healthcare providers and community leaders, as well as FGDs with caregivers. Transcriptions were produced verbatim and supplemented with field notes.

Data Analysis

For quantitative analysis, SPSS version 25 was employed. Descriptive statistics summarized participant characteristics and immunization coverage rates. Logistic regression models assessed associations between immunization status and independent variables such as caregiver education, household income, and distance to health facilities. Multicollinearity was checked using variance inflation factors (VIF), with a threshold of VIF >10 used to exclude correlated variables. Qualitative data were analyzed using Braun and Clarke's thematic analysis framework. Two researchers independently coded transcripts using NVivo software; discrepancies were resolved by consensus, and emergent themes were identified to contextualize and explain quantitative results. Data integration followed a convergent triangulation strategy, comparing and contrasting quantitative findings with qualitative themes during the interpretation phase. For instance, statistical associations between low maternal education and incomplete immunization were supported by caregiver narratives highlighting knowledge gaps and cultural beliefs as barriers to vaccine uptake.

Ethical Considerations

Ethical approval was granted by the Mount Kenya University Institutional Review Board (IRB Reference Number MKU/IRB/1021/2024). Written informed consent was obtained from all participants prior to data collection. Data confidentiality was maintained by anonymizing identifiers and securely storing all records. Interviewers were trained to provide emotional support and refer participants to appropriate services if distress arose during discussions. Participation was voluntary, and respondents were free to withdraw without penalty at any point.

Results

Demographic and Socio-Economic Characteristics of Participants

The study engaged 220 caregivers, primarily mothers of children under five years old. In terms of age, the largest proportion of respondents (95 individuals, 43.2%) were aged 25–34 years, followed by 88 participants (40.0%) aged 18–24 years. Those aged 35–44 years accounted for 23 respondents (10.5%), while only 14 participants (6.4%) were aged 45 years and above. When it came to gender, the sample was overwhelmingly female, with 210 women (95.5%) and only 10 men (4.5%) participating. This reflects the reality that women are typically the primary caregivers and are more involved in child health matters in rural Rwandan communities. The marital status of respondents showed that a majority, 135 caregivers (61.4%), were married, while 72 (32.7%) were single. The study also included 8 divorced (3.6%) and 5 widowed (2.3%) individuals.

With respect to education, more than half of the respondents, 117 (53.2%), had completed primary school, while 57 (25.9%) had secondary education, and 46 individuals (20.9%) had no formal education. Educational attainment

is a crucial factor in health-seeking behavior, including understanding immunization schedules. Looking at household income, 89 participants (40.5%) reported a monthly income between 50,001–100,000 Rwandan Francs, followed by 60 (27.3%) earning below 50,000 Rwf. Meanwhile, 38 respondents (17.3%) earned between 100,001–150,000 Rwf, and 33 (15.0%) reported incomes of 200,000 Rwf or more. In terms of occupation, 93 respondents (42.3%) identified as farmers, which is reflective of the rural setting. Additionally, there were 39 traders (17.7%), 26 teachers (11.8%), 8 health workers (3.6%), and 52 others (23.6%) engaged in various jobs. Only 2 participants (0.9%) did not report their occupation.

The respondents' religious affiliations were predominantly Christian (172; 78.2%), followed by Muslim (35; 15.9%), and 12 individuals (5.5%) who identified with traditional beliefs or none. One respondent did not indicate their religious belief (0.5% missing). Among the children under five, the majority (123 children; 55.9%) were aged 0–11 months, aligning with the critical period for completing early childhood immunizations. Another 68 children (30.9%) were aged 12–23 months, while 11 (5.0%) were between 24–35 months, 13 (5.9%) were 36–47 months, and 5 children (2.3%) were aged 48–59 months. In terms of child gender, the distribution was fairly balanced, with 115 females (52.3%) and 105 males (47.7%). Regarding health status, only 19 children (8.6%) were reported to have health conditions such as chronic illness, while 201 children (91.4%) were considered healthy at the time of the survey.

Table 1 Sociodemographic and Health Profile of Caregivers and Children Under Five in Rural Gasabo District, Rwanda

Variable	Category	Frequency	Percent
Age of the respondent	18-24 years old	88	40.0
	25-34 years old	95	43.2
	35-44 years old	23	10.5
	45 years old and above	14	6.4
Gender of the respondent	Male	10	4.5
	Female	210	95.5
Marital Status	Single	72	32.7
	Married	135	61.4
	Divorced	8	3.6

	Widowed	5	2.3
Education Level	No Formal Education	46	20.9
	Primary School	117	53.2
	Secondary School	57	25.9
Household Monthly Income	Below 50,000 Rwf	60	27.3
	50,001 - 100,000 Rwf	89	40.5
	100,001 - 150,000 Rwf	38	17.3
	200,000 Rwf and above	33	15.0
Occupation	(Missing)	2	0.9
	Farmer	93	42.3
	Teacher	26	11.8
	Health Worker	8	3.6
	Trader	39	17.7
	Others	52	23.6
Religion	Christianity	172	78.2
	Muslim	35	15.9
	Traditional/None	12	5.5
	Missing	1	0.5
Child's Age	0-11 Months	123	55.9
	12-23 Months	68	30.9
	24-35 Months	11	5.0
	36-47 Months	13	5.9
	48-59 Months	5	2.3
Gender of the Child	Male	105	47.7
	Female	115	52.3

Child Has Health Conditions	Yes	19	8.6
	No	201	91.4

Vaccination and Health Interventions Coverage

The table above presents a detailed overview of the immunization and health intervention coverage among children under five in rural Gasabo District, Rwanda. The findings show high levels of uptake for most vaccines and interventions, reflecting commendable immunization outreach in the area. The BCG vaccine, which protects against tuberculosis, was received by 196 children, representing 89.1% of the sample. Only 5 children (2.3%) had not received the vaccine. Similarly, the Oral Polio Vaccine was administered to 85.5% (188 children), while 5.9% (13 children) had not received it. The Inactivated Polio Vaccine (IPV) coverage stood at 82.7%, with 182 children immunized and 19 (8.6%) not. The Pentavalent vaccine, which protects against five major childhood diseases, was received by 193 children (87.7%), and only 3.6% did not receive it. The Pneumococcal Conjugate Vaccine, used to prevent pneumococcal infections, had a slightly lower coverage at 78.2% (172 children), with 29 children (13.2%) unvaccinated. Rotavirus vaccine coverage was again high at 87.7% (193 children), with only 8 children (3.6%) not receiving it. The Measles and Rubella vaccine, while slightly lower in coverage, still reached 168 children (76.4%), leaving 15.0% unvaccinated. The Yellow Fever vaccine showed the lowest coverage among the vaccines listed, with 154 children (70.0%) immunized and 47 (21.4%) not. Regarding Vitamin A supplementation, a crucial intervention for child immunity and vision, 81.4% (179 children) had received the supplement. Lastly, Deworming treatment, which supports nutritional status and overall health, was received by 141 children (64.1%), indicating a moderate level of coverage, with 27.3% not dewormed. Overall, these results reflect a generally high level of immunization coverage for key childhood vaccines in the study area, with some room for improvement, particularly in yellow fever vaccination and deworming interventions.

Table 2 Vaccination and Health Interventions Coverage

Vaccination/Intervention	Response	Frequency	Percent (%)
BCG (Bacillus Calmette-Guérin)	Yes	196	89.1%
	No	5	2.3%
	Total	**201**	**91.4%**
Oral Polio Vaccine	Yes	188	85.5%
	No	13	5.9%

	Total	**201**	**91.4%**
Inactivated Polio Vaccine (IPV)	Yes	182	82.7%
	No	19	8.6%
	Total	**201**	**91.4%**
Pentavalent Vaccine	Yes	193	87.7%
	No	8	3.6%
	Total	**201**	**91.4%**
Pneumococcal Conjugate Vaccine	Yes	172	78.2%
	No	29	13.2%
	Total	**201**	**91.4%**
Rotavirus Vaccine	Yes	193	87.7%
	No	8	3.6%
	Total	**201**	**91.4%**
Measles and Rubella Vaccine	Yes	168	76.4%
	No	33	15.0%
	Total	**201**	**91.4%**
Yellow Fever Vaccine	Yes	154	70.0%
	No	47	21.4%
	Total	**201**	**91.4%**
Vitamin A Supplementation	Yes	179	81.4%
	No	22	10.0%
	Total	**201**	**91.4%**
Deworming (Mebendazole or Albendazole)	Yes	141	64.1%
	No	60	27.3%
	Total	**201**	**91.4%**

Any missed vaccine among children and Reasons for Missed Vaccinations Among Children Under Five (N = 220; Missed Vaccines = 28)

The study findings on whether children under five in rural Gasabo District have missed any of the recommended vaccinations. Out of a total of 220 respondents, 28 caregivers (12.7%) reported that their child had missed at least one vaccine. This indicates that a small but notable proportion of children are at risk of being partially immunized, potentially exposing them to preventable diseases. In contrast, the majority of respondents, 192 caregivers (87.3%), stated that their children had not missed any vaccinations. This suggests a strong level of adherence to the national immunization schedule and points to generally effective immunization outreach and health education in the area. Despite the high overall immunization coverage, the 12.7% of missed vaccinations highlights the need for further investigation into the reasons behind missed doses such as access issues, health service availability, or parental awareness so that targeted interventions can be developed to reach the remaining vulnerable children and ensure full vaccine coverage. Among the 220 respondents, 28 caregivers (12.7%) indicated that their children had missed at least one vaccine. A prominent reason cited for missed vaccinations was a lack of awareness, with 26 respondents (11.8%) acknowledging it as a contributing factor. This suggests that despite the availability of immunization services, knowledge gaps remain among some caregivers regarding the importance of vaccines, the vaccination schedule, or where and when to access services. Such gaps may stem from inadequate community health education, low literacy levels, or insufficient outreach by health workers. Additionally, physical access to vaccination sites was another reported barrier. Specifically, 22 respondents (10.0%) stated that the vaccination site was too far, while 6 (2.7%) said distance was not an issue. This reflects the ongoing issue of geographic barriers in rural settings, where long travel distances, poor road infrastructure, and transportation costs can hinder access to health facilities. Health system challenges were also highlighted as contributing factors to missed vaccinations. Among the 28 caregivers whose children missed vaccines, 14 (6.4%) reported vaccine stockouts or unavailability, which reflects potential inefficiencies in vaccine supply chain management. When vaccines are not consistently available at health facilities, caregivers may lose trust in the system or may not return for subsequent visits. Another critical issue raised was the absence of vaccinators, which was reported by 16 respondents (7.3%), indicating workforce shortages or inconsistent service delivery. On the caregiver side, fear of side effects was cited by 22 respondents (10.0%) as a reason for not completing the immunization schedule. Such fears may be fueled by misinformation, previous negative experiences, or a lack of counseling during vaccination sessions. Moreover, 21 caregivers (9.5%) noted that they believed the vaccine could be administered in the future, reflecting a misconception that delays in vaccination do not compromise effectiveness, which can contribute to prolonged gaps in immunization.

In addition to health system and informational barriers, personal and behavioral factors also played a role in missed vaccinations. Child illness was a commonly reported reason, with 24 respondents (10.9%) indicating that

their child was sick at the time of the scheduled vaccination. Although some illnesses may warrant delaying vaccination, many minor illnesses are not actual contraindications, suggesting a need for better guidance from health workers. Time constraints or being too busy were mentioned by 24 respondents (10.9%), reflecting the burden of competing household and livelihood responsibilities, especially for caregivers in rural or agrarian communities. Similarly, forgetfulness or missed appointments affected 21 caregivers (9.5%), indicating a lack of reminder systems or structured follow-up by health providers. These behavioral and logistical factors, while often overlooked, significantly impact vaccination completion and underscore the need for more flexible, accessible, and supportive immunization services.

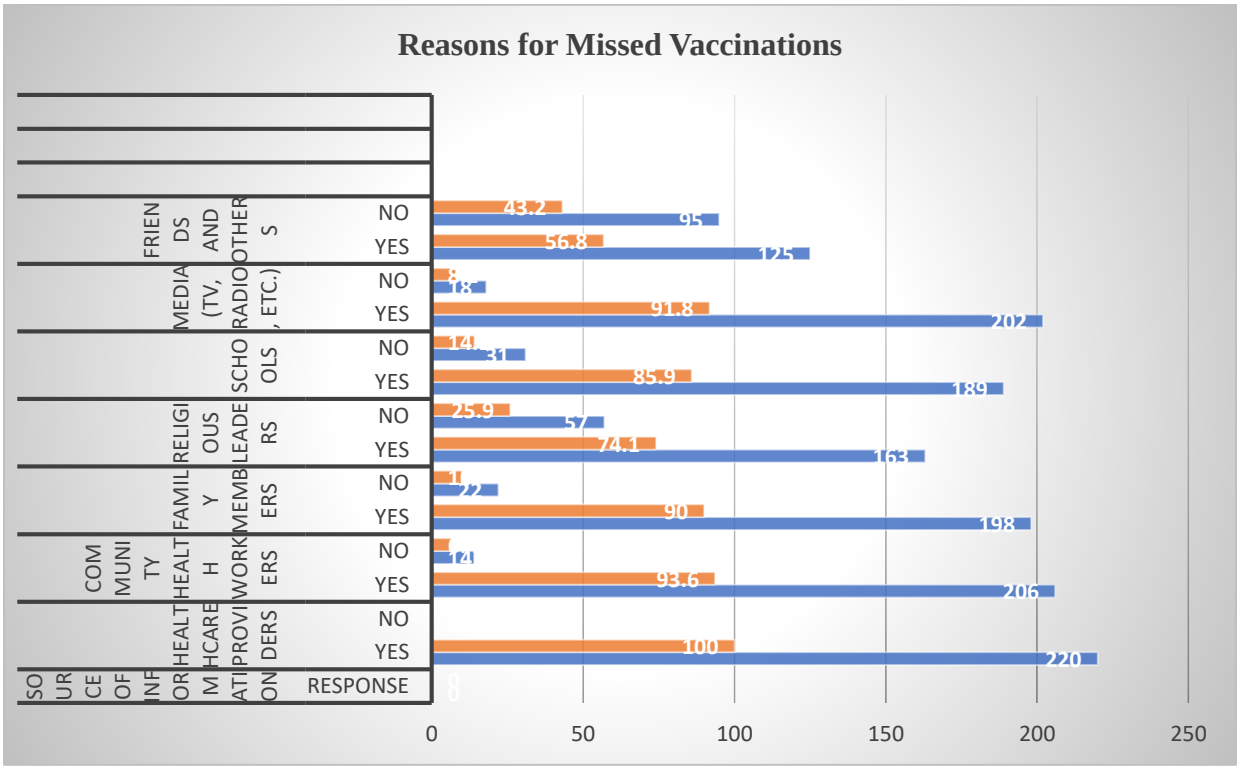

Figure 1 Reasons for Missed Vaccinations Among Children Under Five (N = 220; Missed Vaccines = 28)

Association Between Socio-Demographic Factors and Immunization Coverage Level

This section integrates both quantitative and qualitative data to explore how various socio-demographic characteristics influence immunization coverage among children in Gasabo District. The quantitative analysis revealed that the age of the respondent significantly influenced immunization status (p = 0.001), with the majority of fully immunized children having caregivers aged 25–34 years. Complementing this, qualitative insights from key informant interviews (KIIs) indicated that caregivers in this age bracket are more likely to be active in seeking maternal and child health services due to greater health awareness and fewer traditional misconceptions compared

to older caregivers. One key informant stated, "Most mothers in their late twenties and early thirties are well-informed through community health talks and mobile reminders. They are more likely to complete the vaccination schedule."

Marital status also had a significant statistical association (p = 0.001). Children of married caregivers had the highest immunization rates, while single caregivers reported higher non-immunization. KIIs reinforced this trend, suggesting that married individuals often benefit from spousal support for childcare responsibilities, which facilitates consistent clinic visits. A health worker noted, "When both parents are present, there is often more follow-up, and immunization is treated as a shared responsibility." Education level (p = 0.001) and household income (p = 0.014) were also significantly associated with immunization coverage. Respondents with secondary education had no non-immunized children, while most of those reporting low education levels had multiple non-immunized children. Interviews emphasized that education enhances understanding of immunization benefits and schedules, while income enables access to transport and time off work, mitigating logistical barriers.

Occupation and religion were not significantly associated with immunization statistically, yet narratives from health personnel highlighted that farmers often prioritize agriculture over clinic appointments, especially during planting or harvesting seasons. Gender of both respondent and child, child's age, and religion did not exhibit statistically significant associations. Nonetheless, the qualitative data suggested that these variables do not inherently deter immunization efforts but might interact with more influential factors such as caregiver beliefs or logistical challenges. Finally, the child's health condition showed a strong association (p = 0.001), with children suffering chronic illnesses being less likely to be immunized. According to caregivers, fear of vaccine side effects and contradictory medical advice were primary deterrents.

Table 3 Association Between Socio-Demographic Factors and Immunization Coverage Level

Variable	Category	Immunized	Non-Immunized	P-value
Age of respondent	18–24 years old	78	10	0.001
	25–34 years old	95	0	
	35–44 years old	19	4	
	45 years and above	9	5	
Gender of respondent	Male	10	0	0.320
	Female	191	19	
Marital Status	Single	58	14	0.001
	Married	130	5	
	Divorced	8	0	
	Widowed	5	0	
Education Level	No Formal Education	36	10	0.001

	Primary school	108	9	
	Secondary school	57	0	
Occupation	Farmer	85	10	0.434
	Teacher	26	0	
	Health worker	8	0	
	Trader	34	5	
	Others	48	4	
Household Monthly Income	Below 50,000 Rwf	51	9	0.014
	50,001–100,000 Rwf	79	10	
	100,001–150,000 Rwf	38	0	
	200,000 Rwf and above	33	0	
Religion	Christianity	155	16	0.762
	Muslim	34	2	
	Traditional/None	11	1	
Child's Age	0–11 months	108	15	0.251
	12–23 months	64	4	
	24–35 months	11	0	
	36–47 months	13	0	
	48–59 months	5	0	
Gender of Child	Male	95	10	0.654
	Female	106	9	
Child has any health condition	Yes	10	9	0.001
	No	191	10	

Association Between Behavioral, Cognitive, and Environmental Factors and Immunization Coverage

This section combines statistical analysis with qualitative narratives to explore how behavioral, cognitive, and environmental factors affect child immunization coverage. Awareness of the immunization schedule had a highly significant impact ($p = 0.001$), with 95.6% of aware respondents having immunized their children. This was supported by qualitative data, where health workers reported that community health workers (CHWs) and radio programs have been instrumental in improving parental knowledge. As one CHW shared, “Mothers who attend community sessions or receive text messages rarely miss a vaccine appointment.” Distance to health facilities also showed statistical significance ($p = 0.004$). All children of caregivers living within 1 km of a health center were immunized. Nonetheless, those living farther still showed high immunization rates, suggesting the effectiveness of outreach programs. A respondent noted, “Even though I live 8 kilometers away, the mobile clinic comes monthly, which helps a lot.” Routine interaction with healthcare services was another key factor ($p = 0.001$). Caregivers who visited health facilities only when their children were ill had markedly lower

immunization rates than those who visited regularly. This indicates that passive healthcare engagement limits exposure to immunization reminders or opportunities. Mode of transport was also significant (p = 0.001). Households using bicycles had higher non-immunization rates, possibly due to distance and transport fatigue. Conversely, those using motorcycles or private vehicles had no non-immunized cases. KIIs highlighted that transport affordability and reliability were major concerns. Employment status and economic class were not statistically significant, but qualitative data suggested that informal work and daily labor jobs could hinder clinic visits due to inflexible hours. The perception that work schedules affect vaccination (p = 0.006) was validated by qualitative findings. A mother stated, "My job at the market keeps me from taking time off during immunization days." Lastly, beliefs and perceptions around vaccine safety and myths showed no statistical significance but remained relevant in qualitative findings. Some caregivers expressed skepticism about vaccines but still complied due to community pressure and health worker insistence. This underlines the strength of social norms and public health messaging in counteracting vaccine hesitancy.

Table 4 Association Between Behavioral, Cognitive, and Environmental Factors and Immunization Coverage

Variable	Category	Immunized	Not Immunized	P-value
Awareness of Immunization Schedule	Yes	197	9	0.001
	No	4	10	
Distance to Health Facility	< 1 km	32	0	0.004
	1–5 km	37	9	
	6–10 km	32	5	
	>10 km	100	5	
Routine Check-Up Frequency	Monthly	5	9	0.001
	Every three months	5	0	
	Only when sick	163	5	
	Never	28	5	
Mode of Transportation	Walking	130	10	0.001
	Bicycle	9	5	
	Motorcycle	30	0	
	Public transport	24	4	
	Private vehicle	8	0	
Household Socioeconomic Status	Low	147	15	0.651
	Medium	46	4	
	High	8	0	
Perception of Immunization Cost	Affordable	16	0	0.202
	Free	185	19	

Employment Status	Yes	92	5	>0.05
	No	109	14	
Impact of Work Schedule	No impact	191	15	0.006
	Sometimes affects	10	4	
Perception of Vaccine Safety	Yes	171	19	0.194
	No	13	0	
	Don't know	17	0	
Awareness of Myths/Rumors	Yes	47	5	0.765
	No	149	14	
	Don't know	5	0	

Multivariate Logistic Regression Analysis of Factor Associated with Immunization coverage level

The multivariate logistic regression analysis revealed several significant predictors of immunization coverage among children under five in Gasabo District. Awareness of the immunization schedule was the strongest predictor; caregivers who were aware of the immunization schedule were 54.72 times more likely to have their children fully immunized compared to those who were not aware (OR = 54.72; 95% CI: 14.35–208.62; $p < 0.001$). This suggests a critical role of targeted awareness campaigns in improving immunization rates. Although not statistically significant at the conventional 0.05 level, distance to the health facility showed a notable trend. Households located less than 1 kilometer from a health facility were 15.57 times more likely to achieve full immunization coverage compared to those residing 1–5 kilometers away (OR = 15.57; 95% CI: 0.87–279.23; $p = 0.065$), indicating that proximity might influence service uptake. In contrast, the frequency of routine child health check-ups was inversely associated with poor immunization outcomes. Children who attended monthly check-ups were significantly less likely to be unimmunized compared to those who never attended check-ups (OR = 0.10; 95% CI: 0.02–0.42; $p = 0.002$), highlighting the importance of regular contact with health services. Mode of transportation also played a significant role. Respondents who reached the health facility on foot were 7.22 times more likely to have fully immunized children compared to those who used bicycles (OR = 7.22; 95% CI: 2.03–25.68; $p = 0.002$), potentially reflecting better accessibility or motivation among those able to walk. Finally, the impact of work schedules on immunization was a significant determinant. Caregivers who reported that their work schedule had no impact on their ability to seek immunization services were 5.09 times more likely to have fully immunized children than those whose work sometimes affected attendance (OR = 5.09; 95% CI: 1.43–18.19; $p = 0.012$), emphasizing the need for flexible service hours to accommodate working caregivers.

Table 5 Multivariate Logistic Regression Analysis of Factor Associated with Immunization coverage level

Variable	Category Compared	Odds Ratio (OR)	95% CI Lower	95% CI Upper	P-value
Awareness of Immunization Schedule	Aware vs. Not Aware	**54.72**	14.35	208.62	**<0.001**
Distance to Health Facility	<1 km vs. 1–5 km	**15.57**	0.87	279.23	0.065
Routine Check-Up Frequency	Monthly vs. Never	**0.10**	0.02	0.42	**0.002**
Mode of Transportation	Walking vs. Bicycle	**7.22**	2.03	25.68	**0.002**
Impact of Work Schedule on Immunization	No Impact vs. Sometimes Affects	**5.09**	1.43	18.19	**0.012**

Discussion

This study provides a detailed assessment of immunization uptake among children under five in Gasabo District, Rwanda, where the coverage rate was 91.4%, exceeding the national average of 87.5% reported in the 2019–2020 Rwanda Demographic and Health Survey (National Institute of Statistics of Rwanda [NISR], Ministry of Health [MOH], & ICF, 2020). Despite this encouraging result, 8.6% of children remained partially or completely unimmunized, pointing to persistent disparities in peri-urban and rural settings (Tesema et al., 2022).

The most influential factor associated with full immunization was caregiver awareness of the national immunization schedule. Caregivers who had this knowledge were significantly more likely to fully vaccinate their children, consistent with prior findings from Ethiopia and Rwanda (Tesema et al., 2022; Murebwayire & Kayirangwa, 2023). These results align with the Health Belief Model, which posits that awareness of disease prevention increases perceived benefits and likelihood of action (Rosenstock, 1974). Nonetheless, the reliance on self-reported awareness introduces possible recall and social desirability bias.

Although geographic accessibility did not reach statistical significance in the multivariate model, a trend indicated higher coverage among children residing within 1 km of a health facility. This finding is consistent with research emphasizing proximity as a key enabler of healthcare access in resource-constrained contexts (UNICEF, 2022; Wanyama et al., 2021). Potential explanations for the lack of significance include limited variation in distance or unmeasured confounders like road quality.

Routine health visits also strongly correlated with higher immunization rates, as caregivers attending regular check-ups were more likely to have fully immunized children echoing findings from Ayenew et al. (2023). However, causality remains unclear due to the cross-sectional study design.

Though some caregivers reported exposure to vaccine misinformation, this did not significantly influence immunization status—perhaps due to effective local countermeasures or underreporting due to social desirability (World Health Organization [WHO], 2023). Occupational constraints, especially among informal workers, emerged as barriers due to scheduling conflicts and indirect costs (Zhang et al., 2022).

Qualitative insights highlighted health system gaps like weak follow-up and poor community mobilization supporting Gavi's (2023) call for integrated, community-based delivery models. Low male involvement, a common barrier in similar contexts, suggests the need for gender-sensitive strategies (Murebwayire & Kayirangwa, 2023). These findings underscore the multifaceted nature of immunization uptake and the importance of tailored, system-wide interventions.

Conclusion

This study found that childhood immunization coverage in Gasabo District is high at 91%, yet about 9% of children remain partially or not immunized. Key factors influencing vaccine uptake include caregiver age, education, and awareness of the immunization schedule. Notably, children of caregivers aged 25–34 and those with secondary education had full coverage, and 95.6% of informed caregivers fully immunized their children. Barriers such as long distances to health facilities, work-related time conflicts, and low male caregiver involvement were identified. Misinformation and irregular health visits also hindered uptake. Despite efforts by health authorities and community health workers, the findings highlight the need for targeted, community-driven strategies to close the immunization gap and achieve universal coverage.

Recommendations

To close the remaining immunization gap in Gasabo District, targeted interventions are required. Health authorities should intensify community sensitization by training CHWs to deliver clear, culturally appropriate messages that counter vaccine misinformation. Expanding mobile outreach services is crucial for households located more than 5 km from health centers. Routine child health visits should be encouraged through appointment reminders and health education during antenatal care. Flexible clinic hours especially on weekends should be introduced to accommodate caregivers with work conflicts. Engaging male caregivers in immunization education campaigns can enhance shared responsibility and reduce missed appointments. Strengthening the use of immunization tracking tools and CHW reports will help identify and follow up with defaulting families. Finally, coordinated efforts among the Ministry of Health, local leaders, and NGOs are essential to ensure integrated service delivery and resource sharing.

Acknowledgement

First and foremost, I wholeheartedly thank God for His constant presence, providing me with the strength, opportunities, and support needed throughout this academic journey. I am sincerely grateful to the administration

and faculty of Mount Kenya University for fostering an enabling academic environment that enriched me with critical knowledge, practical competencies, and a professional outlook. I also express deep appreciation to my thesis supervisor for their consistent support, insightful feedback, and encouragement, all of which played a vital role in the completion of this research.

References:

Andersen, R. M. (1995). *Revisiting the behavioral model and access to medical care: Does it matter?* Journal of Health and Social Behavior, 36(1), 1–10. https://doi.org/10.2307/2137284

Ayenew, A., Bekele, D., & Eshetu, D. (2023). Determinants of routine childhood immunization in low-income settings: A cross-sectional study in Ethiopia. BMC Pediatrics, 23(1), 45. https://doi.org/10.1186/s12887-023-03902-2

Binagwaho, A., Kyamanywa, P., Farmer, P. E., Nuthulaganti, T., Umubyeyi, B., Nyemazi, J. P., ... & Drobac, P. C. (2012). *The Human Resources for Health Program in Rwanda—A new partnership.* New England Journal of Medicine, 369(21), 2054–2059. https://doi.org/10.1056/NEJMp1311370

Favin, M., Steinglass, R., Fields, R., Banerjee, K., & Sawhney, M. (2012). *Why children are not vaccinated: A review of the grey literature.* International Health, 4(4), 229–238. https://doi.org/10.1016/j.inhe.2012.07.004

Gavi, the Vaccine Alliance. (2023). Immunisation strategy 2021–2025: Leaving no one behind with immunisation. https://www.gavi.org/our-alliance/strategy/phase-5-2021-2025

Iraguha, B. (2022). *Factors affecting immunization coverage among children in rural Rwanda: A mixed-methods study.* Rwanda Journal of Medicine and Health Sciences, 5(2), 65–74. https://doi.org/10.4314/rjmhs.v5i2.9

Mbengue, M. A., Sarr, M., Faye, A., Niang, K., Gning, S. B., Gaye, A., ... & Fall, A. (2017). *Determinants of complete immunization among Senegalese children aged 12–23 months: Evidence from the Demographic and Health Survey.* BMC Public Health, 17, 630. https://doi.org/10.1186/s12889-017-4633-2

Ministry of Health (MOH), Rwanda. (2020). *Expanded Programme on Immunization (EPI) Annual Report 2020.* Kigali, Rwanda.

Murebwayire, J., & Kayirangwa, J. (2023). Gender dynamics and maternal roles in child immunization uptake in Rwanda: A qualitative study. African Journal of Reproductive Health, 27(3), 88–99. https://doi.org/10.29063/ajrh2023v27i3.9

National Institute of Statistics of Rwanda (NISR), Ministry of Health (MOH), & ICF. (2020). Rwanda Demographic and Health Survey 2019–20. https://dhsprogram.com/publications/publication-FR370-DHS-Final-Reports.cfm

National Institute of Statistics of Rwanda (NISR), Ministry of Health (MOH), & ICF. (2021). *Rwanda Demographic and Health Survey 2019–20.* Kigali, Rwanda, and Rockville, MD, USA: NISR, MOH, and ICF.

Nwankwo, B. O., & Orua, E. A. (2020). *Socio-cultural barriers to childhood immunization in sub-Saharan Africa: A systematic review.* Tropical Medicine & International Health, 25(5), 542–553. https://doi.org/10.1111/tmi.13368

Rosenstock, I. M. (1974). The health belief model and preventive health behavior. Health Education Monographs, 2(4), 354–386. https://doi.org/10.1177/109019817400200405

Tesema, G. A., Tessema, Z. T., & Tamirat, K. S. (2022). Impact of maternal knowledge and community engagement on child immunization in sub-Saharan Africa: A systematic review. PLOS ONE, 17(8), e0272145. https://doi.org/10.1371/journal.pone.0272145

UNICEF. (2021). *Tracking the situation of children in sub-Saharan Africa: Immunization coverage.* https://data.unicef.org/topic/child-health/immunization/

UNICEF. (2022). Reaching the unreached: Addressing barriers to immunization in rural and hard-to-reach areas. https://www.unicef.org/reports

Wanyama, E., Tumwine, J. K., & Nanyunja, M. (2021). Physical accessibility and utilization of immunization services in peri-urban Uganda. International Journal of Health Planning and Management, 36(4), 1054–1063. https://doi.org/10.1002/hpm.3196

World Health Organization – Africa Region (WHO Africa). (2021). *Innovative strategies to improve immunization in Eastern and Southern Africa.* https://www.afro.who.int

World Health Organization (WHO). (2020). *Immunization agenda 2030: A global strategy to leave no one behind.* https://www.who.int/publications/m/item/immunization-agenda-2030

World Health Organization (WHO). (2023). Ten threats to global health in 2023. https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2023

Zhang, X., Onoka, C. A., & Olumide, A. E. (2022). Socioeconomic determinants of child immunization: Evidence from sub-Saharan Africa. Global Health Research and Policy, 7(1), 23. https://doi.org/10.1186/s41256-022-00256-7