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Factors Influencing Childhood Immunization Coverage Among Children Aged 12–23 Months at Primary Health Care Centers in Maiduguri (MMC and Jere LGAs), Borno State, Nigeria

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Abstract

Background Childhood immunization remains one of the most cost-effective public health interventions, yet coverage in conflict-affected settings such as Borno State, Nigeria, remains suboptimal. This study aimed to determine the factors influencing childhood immunization coverage among children aged 12–23 months attending Primary Health Care centers in Maiduguri Metropolitan Council (MMC) and Jere Local Government Areas.

Method A descriptive cross-sectional mixed-methods design was employed, involving quantitative surveys of 328 caregivers and qualitative interviews with healthcare workers and selected caregivers. Quantitative data were analysed using SPSS version 27, while qualitative data were thematically analysed with NVivo version 12. A significance level of $p \leq 0.05$ was applied.

Result The findings showed that maternal education, occupation, household wealth, and decision-making autonomy were significantly associated with full immunization. Health system barriers such as vaccine stockouts, long distances to facilities, and weak cold-chain infrastructure reduced uptake, while sociocultural beliefs, misinformation, and the influence of community and religious leaders contributed to vaccine hesitancy. Multivariate analysis identified maternal education, caregiver knowledge, and facility accessibility as the strongest predictors of full immunization.

Conclusion In conclusion, improving maternal health literacy, strengthening health system capacity, and engaging trusted community leaders are essential to enhancing immunization coverage in conflict-affected settings like Maiduguri. Multisectoral and context-specific strategies are recommended to bridge immunization gaps and support Nigeria's progress towards achieving the Immunization Agenda 2030 targets. **Keywords:** Childhood immunization, Coverage, Predictors, Borno State, Nigeria.

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Introduction

Childhood immunization remains one of the most cost-effective public health interventions, preventing an estimated six million deaths annually from vaccine-preventable diseases (VPDs) such as measles, polio, and diphtheria World Health Organization, 2020. The World Health Organization (WHO), through the Global Vaccine Action Plan (GVAP) and subsequent immunization strategies, has set ambitious targets of achieving at least 90% national and 80% district-level vaccination coverage by 2030. Despite these efforts, approximately 22.7 million children worldwide remain either unvaccinated or under-vaccinated, with the majority residing in low- and middle-income countries World Health Organization & UNICEF, 2023. These persistent gaps highlight the continuing challenges of equitable vaccine delivery, particularly in fragile and conflict-affected settings.

In Africa, vaccine-preventable diseases account for nearly 33% of under-five morbidity and mortality Omale et al., 2025. Although several countries have made notable progress, immunization coverage across the continent remains uneven. Countries such as Rwanda and Ghana report coverage rates of approximately 90% and 85%, respectively, while Nigeria and South Sudan record substantially

lower rates of 31% and 28% Galadima et al., 2021. Nigeria alone contributes about 14% of the global burden of zero-dose children, representing approximately 3.1 million children who have not received any routine vaccine Adeloye et al., 2017, Sato, 2022. Within Nigeria, Borno State accounts for more than 250,000 of these zero-dose children, reflecting profound structural and contextual challenges to immunization service delivery World Health Organization & UNICEF, 2023.

Coverage disparities are particularly pronounced in Northern Nigeria, where routine immunization rates remain extremely low in several states, ranging from as little as 0.2% in Zamfara to approximately 6% in Sokoto Henry et al., 2016 UNICEF, 2023. These disparities reflect a complex interplay of insecurity, weak health infrastructure, poverty, and sociocultural factors. Historical episodes of vaccine resistance have also contributed to persistent mistrust. For example, the widely reported polio vaccine boycott in Northern Nigeria in 2003 was largely driven by rumors that vaccines were linked to infertility Jegede, 2007. More recent studies suggest that religious misinformation continues to influence vaccine refusal in the region, accounting for approximately 43% of cases Sidikou et al., 2023. In addition, household decision-making dynamics often limit maternal autonomy in health-related matters, with men reportedly making unilateral health decisions in about 68% of householdsNational Population Commission (NPC) & ICF, 2019.

The situation in Borno State is further complicated by a prolonged insurgency that has severely disrupted health systems and infrastructure. It is estimated that approximately 35% of health facilities in the state have been destroyed, while an additional 30% have been damaged during the conflict World Health Organization, 2017. These disruptions have forced many caregivers to travel long distances to access basic health services, including routine immunization Borno State Government, 2019. The consequences of these gaps in immunization coverage are reflected in repeated outbreaks of vaccine-preventable diseases. For instance, between January and May 2019 alone, Maiduguri recorded 1,125 suspected measles cases out of a total of 15,237 cases reported across Borno State Jean Baptiste et al., 2020.

Despite the presence of numerous Primary Health Care (PHC) facilities within Maiduguri Metropolitan Council (MMC) and Jere Local Government Areas, childhood immunization coverage remains suboptimal. Both supply-side and demand-side factors appear to contribute to this situation. Health system constraints such as vaccine stockouts, weak cold-chain infrastructure, and inadequate staffing may limit service availability, while sociocultural influences, misinformation, and limited maternal decision-making power may reduce demand for immunization services National Primary Health Care Development Agency, 2022. Although several studies have examined immunization coverage at national and state levels in Nigeria, relatively little evidence exists regarding the local determinants of immunization uptake at the PHC level, particularly within conflict-affected communities.

Against this backdrop, the present study seeks to examine the determinants of childhood immunization coverage among children aged 12–23 months attending Primary Health Care centers in Maiduguri, specifically within MMC and Jere Local Government Areas of Borno State. The study focuses on understanding the interplay between sociocultural influences, maternal knowledge and attitudes, and health system constraints that may shape immunization decisions and service utilization. By generating localized evidence on both barriers and enabling factors affecting routine immunization, the study aims to inform targeted interventions that can strengthen immunization service delivery in conflict-affected settings and support Nigeria's progress toward achieving the goals of the Immunization Agenda 2030 and broader national health development strategies.

Methods

Study Design

This study employed a descriptive cross-sectional mixed-methods design integrating quantitative and qualitative approaches. A convergent parallel design was used in which both quantitative and qualitative data were collected concurrently within the same cross-sectional timeframe. The two datasets were analyzed independently and subsequently integrated during interpretation to enable triangula-

tion of findings. This approach facilitated the identification of areas of convergence, divergence, and complementarity between the datasets, thereby providing a deeper contextual understanding of the barriers and facilitators influencing childhood immunization in a conflict-affected setting.

Study Area

The study was conducted in Maiduguri Metropolitan Council (MMC) and Jere Local Government Area (LGA) in Borno State, Northeastern Nigeria. Borno State occupies an area of approximately 79,898 km^2 and comprises 27 local government areas Forbi et al., 2023. The state shares boundaries with Adamawa State to the south, Gombe State to the west, and Yobe State to the northwest, and also borders the Republic of Niger to the north, Chad to the northeast, and Cameroon to the east.

Maiduguri, also known as MMC, is the capital city of Borno State and is located at latitude 11°50′N and longitude 13°09′E. The city has an average annual temperature of approximately 34.4°C Muhammad, 2023. Its elevation ranges between 291 and 352 m above sea level. The rainy season typically lasts from May to September, with peak rainfall occurring in July and August, and the average annual rainfall is approximately 452 mm World Weather and Climate, n.d.

Jere LGA lies between latitudes 11°40′N and 12°05′N and longitudes 13°05′E and 12°20′E. The area experiences a predominantly hot and dry climate for most of the year, with temperatures ranging from 15 to 45°C. The rainy season also occurs between May and September, with an annual rainfall ranging between 500 and 700 mm Ezema et al., 2021.

MMC has 38 Primary Health Care Centres (PHCs), while Jere LGA has 32 PHCs, distributed across 23 political wards. These LGAs represent the urban and peri-urban zones of Maiduguri and have a combined estimated population of approximately 1.2 million people Borno State Government, 2019; National Population Commission (NPC) & ICF, 2019.

Study Population

The study population comprised caregivers of children aged 12–23 months attending routine immunization services at selected PHCs and healthcare workers involved in immunization service delivery. Caregivers were eligible to participate if they provided informed consent and had a child within the specified age group. Healthcare workers were included if they had at least six months of experience in immunization service provision at the selected facilities.

Sampling Technique and Sample Size Determination

A multistage sampling technique was employed to select study participants.

Stage 1: Selection of wards. Ten political wards were selected using simple random sampling, comprising six wards from MMC and four wards from Jere LGA to ensure proportional representation of both urban and peri-urban areas.

Stage 2: Selection of PHCs. One functional PHC was randomly selected from each of the ten selected wards, resulting in a total of ten PHCs included in the study. A PHC was considered functional if it:

- provided routine immunization services at least three days per week,
- had at least one trained health worker responsible for immunization activities,
- possessed an operational cold-chain system (e.g., functional refrigerator or vaccine carrier with temperature monitoring), and
- had conducted at least one immunization session within the previous 30 days.

Stage 3: Selection of participants. At each selected PHC, caregivers of eligible children were selected using systematic sampling from the immunization clinic attendance register. The sampling interval was determined using the formula:

$$k = \frac{N}{n}$$

where N represents the estimated number of eligible caregivers attending the PHC over the previous two weeks, n represents the required number of respondents per PHC (26), and k represents the sampling interval.

For the qualitative component, two caregivers and at least two immunization health workers were

purposively selected from each PHC based on their experience with immunization services or professional role. Key informant interviews continued until data saturation was reached.

Sample Size Estimation

The sample size for the quantitative component was determined using Cochran's formula for proportions Cochran, 1977:

$$n = \frac{Z^2 p(1-p)}{E^2}$$

where n is the required sample size, Z is the standard normal deviate corresponding to a 95% confidence level (1.96), p is the estimated proportion of fully immunized children, and E is the margin of error.

Based on the 2023–2024 Nigeria Demographic and Health Survey (NDHS), approximately 20% of children aged 12–23 months were fully vaccinated. Therefore, $p = 0.20$ and $E = 0.05$.

$$n = \frac{(1.96)^2 \times 0.20 \times (1-0.20)}{(0.05)^2} = 246$$

To account for clustering in the multistage sampling design, a design effect of 1.2 was applied:

$$n = 246 \times 1.2 = 295$$

To further account for a potential non-response rate of 10%, the adjusted sample size was calculated as:

$$n = \frac{295}{0.9} = 328$$

Thus, the final sample size for the quantitative component was 328 caregivers.

Data Collection Methods

Quantitative data were collected using a structured questionnaire adapted from the Demographic and Health Survey (DHS) instruments. The questionnaire captured information on sociodemographic characteristics, maternal knowledge and attitudes toward immunization, and health system access barriers. The questionnaire was translated into Hausa and Kanuri and subsequently back-translated to ensure consistency. The instrument was pretested, and internal consistency reliability was assessed using Cronbach's alpha, with a value of ≥ 0.70 considered acceptable.

Qualitative data were collected through Key Informant Interviews (KIIs) with healthcare workers and In-Depth Interviews (IDIs) with caregivers. The interviews explored sociocultural beliefs, religious influences, logistical barriers, and health system challenges affecting childhood immunization. Interviews were conducted in English, Hausa, or Kanuri depending on participants' preferences and were audio-recorded with participants' consent. Audio recordings were transcribed verbatim and translated into English for analysis.

Data Analysis

Quantitative data were analyzed using Statistical Package for the Social Sciences (SPSS) version 27. Descriptive statistics were used to summarize participants' characteristics. Bivariate analysis using the chi-square test assessed associations between independent variables and immunization status, while multivariable logistic regression was used to identify predictors of full immunization. Statistical significance was set at $p \leq 0.05$.

Qualitative data were analyzed using NVivo version 12 following a thematic analysis approach. Transcripts were coded, and emerging themes were identified and organized into categories reflecting sociocultural, logistical, and health system factors influencing immunization uptake. Integration of quantitative and qualitative findings was conducted during interpretation using narrative synthesis to provide a comprehensive understanding of the study findings.

Ethical Considerations

Ethical approval for the study was obtained from the Borno State Health Research Ethics Committee (Reference No: 63/2025). Participation in the study was voluntary, and written informed consent was obtained from all participants. Confidentiality and anonymity were maintained throughout the study, and all procedures were conducted in accordance with established ethical guidelines for research involving human participants.

Results

Note: Median (IQR) = Median (Interquartile Range).

Table 1: Sociodemographic Characteristics of Study Participants Attending Primary Health Care Centres in Maiduguri Metropolitan Council and Jere Local Government Areas, Borno State ($n = 328$)

Characteristic	Category	Frequency	Percentage (%)
Sex of caregiver	Male	8	2.4
	Female	320	97.6
Age (years)	Median (IQR)	28.0 (8)	–
	18–24 years	88	26.8
	25–29 years	126	38.4
	30–34 years	59	18.0
	35–39 years	43	13.1
	≥40 years	12	3.7
Marital status	Single	1	0.3
	Married	308	93.9
	Divorced	3	0.9
	Widowed	16	4.9
Highest level of education	None	52	15.9
	Primary	67	20.4
	Secondary	168	51.2
	Tertiary	41	12.5
Religion	Islam	296	90.2
	Christianity	31	9.5
	Other	1	0.3
Ethnic group	Hausa	70	21.3
	Kanuri	144	43.9
	Other	114	34.8
Occupation	Housewife	140	42.7
	Trader	142	43.3
	Civil servant	41	12.5
	Other	5	1.5
Estimated monthly household income	< ₦77,000	171	52.1
	₦77,000–₦150,000	131	39.9
	> ₦150,000	26	7.9
Number of children under 5 years	1 child	187	57.0
	2 children	110	33.5
	≥3 children	31	9.5

Table 2: Association Between Maternal Knowledge and Attitudes and Childhood Immunisation Status Among Caregivers in Maiduguri, Borno State

Variable	NFI[a] n (%)	FI[b] n (%)	Test Statistic	P-value
Knows vaccine benefits				
No	4 (57.1%)	3 (42.9%)	–	0.0192[f]
Yes	53 (16.5%)	268 (83.5%)		
Source of vaccine info				
Community/Religious leader	3 (37.5%)	5 (62.5%)	–	0.201[f]
Healthcare worker	42 (15.8%)	224 (84.2%)		
Media	0 (0%)	2 (100%)		
Social network	12 (23.1%)	40 (76.9%)		
Believes vaccines are safe				
No	0 (–)	0 (–)	–	< 0.001[f]
Unsure	9 (75%)	3 (25%)		
Yes	48 (15.2%)	268 (84.8%)		
Knows vaccine schedule				
Not aware	6 (60%)	4 (40%)	–	< 0.001[f]
Partially aware	19 (55.9%)	15 (44.1%)		
Fully aware	32 (11.3%)	252 (88.7%)		
Ever refused vaccination				
No	43 (14.1%)	263 (85.9%)	–	0.031[f]
Yes	4 (44.4%)	5 (55.6%)		
Education level				
None	13 (25%)	39 (75%)	15.351	0.002[c]
Primary	18 (26.9%)	49 (73.1%)		
Secondary	26 (15.5%)	142 (84.5%)		
Tertiary	0 (0%)	41 (100%)		
Caregiver age group				
18–24 years	21 (23.9%)	67 (76.1%)	3.616	0.164[c]
25–34 years	27 (14.6%)	158 (85.4%)		
35+ years	9 (16.4%)	46 (83.6%)		

[a] Not Fully Immunized [b] Fully Immunized [f] Fisher's Exact Test [c] Chi-square Test

Table 3: Binary Logistic Regression Analysis of Individual Predictors of Full Immunisation Status Among Children Aged 12–23 Months in Maiduguri, Borno State

Variable	Crude OR (95% CI)	P-value	Significance
Religious support for vaccination	10.346 (1.847–57.963)	0.008	**
Needs partner permission	0.818 (0.302–2.215)	0.693	ns
Heard negative beliefs	0.419 (0.211–0.833)	0.013	*
Distance >3km to facility	0.250 (0.129–0.481)	< 0.001	***
Service unavailability experienced	0.324 (0.150–0.702)	0.004	**
Low income	0.303 (0.158–0.580)	< 0.001	***
Knowledge of vaccine benefits	6.872 (1.494–31.612)	0.013	*
Believes vaccines are safe	17.106 (4.466–65.521)	< 0.001	***
Secondary education or higher	2.399 (1.339–4.301)	0.003	**
Caregiver age (years)	1.050 (0.992–1.111)	0.093	ns

OR = Odds Ratio; CI = Confidence Interval. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, ns = not significant.

Sociodemographic Characteristics

A total of 328 caregivers participated in the study. The majority were female (97.6%), married (93.9%), and Muslim (90.2%), with a median age of 28 years. Most respondents had attained secondary education (51.2%), while more than half reported belonging to low-income households. Detailed sociodemographic characteristics of the respondents are presented in Table 1.

Immunization Coverage

Among the 328 children included in the study, 82.6% were fully immunized according to the national immunization schedule, while 16.8% were partially immunized and 0.6% had not received any vaccine (zero-dose). Respondents frequently attributed the relatively high level of immunization coverage to outreach immunization activities and ongoing community mobilization efforts in the study areas.

Sociocultural Factors Influencing Immunization

Most caregivers reported supportive religious attitudes toward childhood immunization (97.9%). However, a small proportion (8.5%) indicated that they had encountered negative beliefs or misinformation about vaccines. Spousal consent for child immunization was reported by 89.6% of caregivers. Statistical analysis revealed that religious support was significantly associated with full immunization status ($p = 0.003$), whereas exposure to vaccine-related myths and misconceptions was associated with reduced likelihood of complete vaccination ($p = 0.023$).

Logistical and Health System Barriers

Logistical and health system factors were also found to influence immunization uptake. Caregivers who lived more than 3 km from the nearest health facility were significantly more likely to have children with incomplete immunization ($p < 0.001$). Similarly, reported unavailability of immunization services ($p = 0.002$) and low household income ($p = 0.002$) were significantly associated with incomplete immunization. In contrast, insecurity was not found to have a statistically significant association with immunization status in this study ($p = 0.263$).

Caregiver Knowledge and Attitudes

Caregivers generally demonstrated high levels of awareness regarding the benefits and safety of childhood immunization. Nearly all respondents (97.9%) recognized that vaccines protect children from infectious diseases, while 96.3% believed that vaccines are safe for children. Knowledge of the immunization schedule was significantly associated with complete immunization status ($p < 0.001$), indicating the importance of caregiver awareness in promoting vaccine uptake.

Predictors of Full Immunization

Multivariable logistic regression analysis identified several significant predictors of full immunization among children aged 12–23 months. Religious support for immunization increased the likelihood of full immunization (OR = 10.3, $p = 0.008$). Similarly, caregiver knowledge of vaccine benefits (OR = 6.9, $p = 0.013$) and belief in vaccine safety (OR = 17.1, $p < 0.001$) were strong positive predictors of complete immunization.

Conversely, several factors were associated with lower odds of full immunization. These included negative vaccine beliefs (OR = 0.42), long distance to health facilities (OR = 0.25), unavailability of immunization services (OR = 0.32), and low household income (OR = 0.30). The full regression results are presented in Table 3.

Discussion

This study examined the determinants of childhood immunization coverage among children aged 12–23 months in Maiduguri Metropolitan Council and Jere Local Government Areas of Borno State. The findings revealed a relatively high level of full immunization coverage (82.6%) among the study population. This estimate is substantially higher than figures reported in the 2018 Nigeria Demographic and Health Survey (NDHS), which documented significantly lower national and regional immunization coverage. The higher coverage ob-

served in this study may partly reflect the facility-based sampling approach, which captured caregivers who were already accessing health services.

Religious support emerged as a strong enabling factor for childhood immunization in the study area. Nearly all caregivers reported positive attitudes toward vaccination within their religious communities. This finding contrasts with earlier reports of vaccine resistance in Northern Nigeria, particularly during the 2003 polio vaccine boycott Jegede, 2007. The current results suggest that sustained engagement with religious and community leaders may have played an important role in improving acceptance of immunization services. Nevertheless, the persistence of vaccine-related myths among a minority of caregivers indicates that misinformation continues to pose a challenge, consistent with previous studies linking vaccine hesitancy to misinformation and distrust Ohammah, 2020.

Logistical and structural barriers were also important determinants of immunization uptake. Caregivers who lived farther from health facilities were significantly less likely to have fully immunized children, highlighting the continued importance of physical accessibility to health services. Similar findings have been reported in studies conducted in other parts of Nigeria and sub-Saharan Africa, where transportation costs, distance to facilities, and irregular service availability have been identified as key barriers to routine immunization Aliyu et al., 2019; Lakew et al., 2015. Although insecurity has historically disrupted health services in Borno State, it was not statistically associated with immunization status in this study. This may suggest that ongoing humanitarian and government-supported immunization campaigns have helped mitigate the direct effects of insecurity on service delivery in the study areas.

Caregiver knowledge and attitudes toward vaccines were also strongly associated with immunization outcomes. Mothers who understood the benefits of vaccination and believed in vaccine safety were significantly more likely to have fully immunized children. These findings are consistent with previous studies in Nigeria and Ethiopia that have demonstrated the importance of maternal education, health literacy, and trust in vaccines as key drivers of immunization uptake Oleribe et al., 2017 Habib et al., 2017.

Qualitative findings provided further insight into the contextual factors shaping immunization uptake. Participants highlighted several operational challenges, including inconsistent outreach activities, occasional disruptions in cold-chain maintenance, and communication gaps between health workers and communities. At the same time, respondents emphasized the positive influence of community and religious leaders in promoting vaccine acceptance and mobilizing caregivers for immunization services. These findings underscore the importance of combining strong health system capacity with effective community engagement strategies to sustain high immunization coverage.

Conclusion

This study identified several key determinants of childhood immunization coverage in Maiduguri Metropolitan Council and Jere Local Government Areas of Borno State. Proximity to health facilities, maternal education, and strong confidence in vaccine safety were among the most important predictors of full immunization. Conversely, logistical constraints such as long travel distances, negative vaccine beliefs, and household decision-making dynamics influenced by gender norms were associated with incomplete immunization.

To sustain and further improve immunization coverage in the study area, several strategies are recommended. Strengthening Primary Health Care infrastructure and outreach capacity will help improve physical access to immunization services. Community mobilization efforts should continue to engage trusted religious and community leaders in promoting vaccine acceptance. Additionally, interventions aimed at improving maternal health literacy and addressing vaccine misinformation will be critical for maintaining public trust in immunization programs.

Overall, the findings highlight the importance of addressing both health system and sociocultural factors in immunization programming. Integrating community engagement with strengthened service delivery systems will be essential for sustaining immunization gains and closing remaining coverage gaps, particularly in fragile and post-conflict settings such as Borno State.

What is Known About This Topic

- Childhood immunization is one of the most effective and affordable strategies for preventing child morbidity and mortality globally.
- Immunization coverage in conflict-affected regions such as Borno State, Nigeria, remains below national targets due to insecurity and health system challenges.
- Socioeconomic, cultural, and health system factors, including maternal education, accessibility of health services, and misinformation, are known to influence vaccination uptake.

Authors' Contribution

- **Dotun Sadiq Abubakar:** Conceived and designed the study, supervised data collection, and contributed to manuscript drafting.
- **Amina Abubakar:** Conducted the literature review and assisted with study design.
- **Amina Musa Abubakar:** Conducted data collection and performed data analysis.
- **Jeremiah Yaga Maina:** Interpreted the findings and contributed to manuscript writing.
- **Polycarp Madaki:** Contributed to data interpretation, reviewed the manuscript for intellectual content, and provided critical revisions.
- **Fatima Lawan Bukar:** Contributed to data analysis and interpretation.

All authors read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this study.

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