

Research Article

Determinants of Full Immunization Coverage among Children Aged 12–23 Months in Rural Nigeria

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Abstract

Background: Childhood immunization is one of the most effective interventions for preventing vaccine-preventable diseases and reducing childhood morbidity and mortality. However, incomplete vaccination remains a public health concern in Nigeria, particularly in rural communities. This study assessed immunization coverage and factors associated with full immunization among children aged 12–23 months in rural Nigeria. **Method:** An analytical cross-sectional study was conducted using secondary data from the 2024 Nigeria Demographic and Health Survey (NDHS). The analysis included 3,214 children aged 12–23 months residing in rural Nigeria. Full immunization was defined according to the study's operational definition, while partially immunized and unimmunized children were classified as not fully immunized. Descriptive statistics and bivariate analyses were performed, followed by multivariable logistic regression. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were reported. Statistical significance was set at $p < 0.05$. **Results:** Of the children assessed, 952 (32.99%) were fully immunized, giving a prevalence of 32.99% (95% CI: 30.22–35.89). After adjustment, place of delivery, antenatal care (ANC) attendance, number of children living, and region of residence remained significantly associated with full immunization. Children delivered in health facilities had higher odds of full immunization (AOR=1.37; 95% CI: 1.05–1.79; $p=0.021$), while those whose mothers attended ANC had substantially higher odds (AOR=4.31; 95% CI: 3.16–5.89; $p < 0.001$). Having five or more children was also associated with higher odds (AOR=2.09; 95% CI: 1.38–3.16; $p=0.001$). Regional differences were observed, with higher odds in the North East (AOR=1.51; 95% CI: 1.08–2.12) and lower odds in the North West (AOR=0.61; 95% CI: 0.39–0.94). **Conclusion:** Full immunization coverage remained low among rural children, with important healthcare and regional differences. Strengthening maternal healthcare and routine immunization services is warranted.

1. Introduction

Immunization is a fundamental component of child survival and one of the most effective public health interventions for preventing vaccine-preventable diseases [1]. By protecting against infectious diseases such as tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus, measles and hepatitis B, childhood vaccination substantially reduces the risk of illness, disability and premature death [2]. Beyond its direct

health benefits, immunization contributes to improved child development, reduced healthcare costs and strengthened population health [3]. Over the past five decades, the expansion of vaccination programmes has profoundly improved global child survival, with vaccines estimated to have averted approximately 154 million deaths between 1974 and 2024, including about 101 million deaths among infants [4]. Despite these remarkable gains, the benefits of immunization have not been distributed equally, as millions of children, particularly those living in underserved and disadvantaged communities, continue to miss essential vaccine doses and remain vulnerable to vaccine-preventable diseases [5, 6].

Global childhood immunization coverage has improved considerably over the years, but progress remains uneven [7]. In 2024, approximately 89% of infants globally received at least one dose of a diphtheria-tetanus-pertussis (DTP)-containing vaccine, and about 85% received all three recommended doses. Nevertheless, approximately 20 million children missed at least one DTP-containing vaccine dose, including an estimated 14.3 million who received no vaccination at all and were therefore classified as zero-dose children [8]. The persistence of zero-dose and under-immunized children shows that improvements in national coverage do not necessarily translate into equitable access to vaccination. Children living in fragile, remote, and socioeconomically disadvantaged settings continue to bear a disproportionate burden of missed vaccination opportunities [9]. Thus, achieving high national immunization coverage requires attention not only to overall coverage but also to the inequalities that affect whether individual children complete the recommended vaccination schedule [10].

The challenge is particularly important in sub-Saharan Africa, where many countries continue to experience substantial gaps in routine childhood immunization [11]. Although immunization programmes have contributed to considerable reductions in vaccine-preventable diseases and child mortality in the region, coverage remains below the levels required to provide optimal population protection [12]. Immunization contributes significantly to child survival in Africa, where vaccination against major childhood diseases has reduced infant deaths attributable to the diseases included in global immunization analyses by more than 50% [4]. However, geographic isolation, poverty, weak health infrastructure, inadequate access to health services, limited health information, and other social determinants continue to affect vaccination uptake. Consequently, immunization coverage within countries may vary substantially by residence, socioeconomic position, and access to health services [13].

Nigeria represents an important setting for understanding these inequalities because of its large population, high burden of childhood illness, and persistent gaps in routine immunization [14]. Although Nigeria has implemented the Expanded Programme on Immunization and subsequently strengthened routine immunization through the National Primary Health Care Development Agency and other partners, childhood vaccination coverage remains suboptimal [15]. Findings from the 2024 Nigeria Demographic and Health Survey (NDHS) indicate that only 39% of children aged 12–23 months were fully vaccinated against all basic antigens, while 31% had received no vaccinations. Coverage according to the national immunization schedule was considerably lower, with only 20% of children aged 12–23 months fully vaccinated according to the schedule [16]. These figures show that, despite improvements over previous decades, a substantial proportion of Nigerian children remain inadequately protected against vaccine-preventable diseases [17].

Analysis of the 2018 NDHS found that only 26% of Nigerian children aged 12–23 months were fully immunized, with substantial regional variation in coverage. Maternal education, household wealth, and geographic region were significant predictors of full immunization, indicating that vaccination uptake is influenced by broader socioeconomic and demographic circumstances rather than vaccine availability alone [13, 18, 19]. Similarly, a systematic review of childhood immunization in Nigeria identified substantial inequalities associated with socioeconomic, geographic, maternal, child, and healthcare characteristics [20].

Rural communities are of particular concern because geographic and health-system barriers can make it harder for children to receive all recommended doses within the appropriate time intervals [21]. Rural populations may face longer distances to health facilities, limited transportation, irregular outreach services, shortages of healthcare personnel, inadequate information about immunization schedules, and greater opportunity costs associated with repeated visits to health facilities [22]. Evidence from Enugu State illustrates this disparity: although overall full immunization coverage was 78.9%, only 55.5% of children in rural communities were fully immunized, compared with 94.5% in urban communities. Rural residence, a distance of more than 30 minutes from a vaccination facility, low household income, poor maternal knowledge of routine immunization, and failure to receive postnatal care were among the factors associated with incomplete immunization [23]. These findings highlight the importance of examining immunization coverage specifically within rural settings rather than relying solely on national estimates [24].

Full immunization is influenced by multiple, interacting determinants operating at the child, maternal, household, community, and health-system levels [14]. At the maternal and household levels, factors such as maternal education, maternal age, household wealth, parity, employment status and knowledge of immunization have been associated with vaccination completion [25]. At the health-service level, antenatal care attendance, postnatal care, skilled birth attendance, availability of vaccination information, possession of an immunization card and geographical accessibility to vaccination services may influence whether children complete the recommended schedule [26]. For example, a study conducted in a rural district of Osun State found that antenatal care attendance, maternal tetanus immunization, access to immunization information and good maternal knowledge were significant determinants of full immunization [27]. Similarly, studies in Nigeria have shown that maternal education and household wealth are important predictors of vaccination completion, reinforcing the influence of social and economic circumstances on childhood immunization [20, 23].

The age group of 12–23 months is particularly important for assessing childhood immunization because it provides an opportunity to determine whether children have completed the primary series of vaccines recommended during infancy and early childhood [28, 29]. Assessing vaccination status within this age group makes it possible to identify children who have completed the recommended schedule, those who are partially immunized, and those who have received no vaccines [24]. Such assessment is important because national or regional averages can conceal pockets of low coverage within rural communities. Moreover, identifying the determinants of full immunization alongside measuring coverage provides a stronger basis for developing targeted interventions. Rather than simply establishing that coverage is low or high, understanding the factors associated with completion can help policymakers and programme managers identify children and communities at greatest risk of being left behind [13, 30].

Despite ongoing immunization efforts in Nigeria, the persistence of incomplete vaccination among children aged 12–23 months indicates that important gaps remain in achieving equitable immunization coverage [13, 31]. National-level estimates provide an important overview but may not adequately capture the circumstances of children living in rural communities, where access barriers and social disadvantages may be more pronounced. There is therefore a need for context-specific evidence that simultaneously quantifies the level of immunization coverage and identifies the factors that determine whether children achieve full immunization. Such evidence can inform the design of

targeted strategies, including strengthened outreach services, improved maternal education, enhanced community mobilization, better geographical access to vaccination facilities, and interventions addressing socioeconomic barriers.

Therefore, this study focuses on immunization coverage and determinants of full immunization among children aged 12–23 months in rural Nigeria. By assessing the level of immunization coverage and examining the individual, maternal, household, socioeconomic and health-service factors associated with full immunization, the study seeks to generate evidence that can contribute to improving routine immunization performance and reducing inequities in access to life-saving vaccines among children living in rural communities.

2. Materials and Methods

2.1. Study Design and Setting

This study employed an analytical cross-sectional design using secondary data from the 2024 Nigeria Demographic and Health Survey (NDHS). The 2024 NDHS was a nationally representative household survey conducted to provide reliable information on population and health indicators in Nigeria, including maternal and child health, childhood immunization, nutrition, fertility, household socioeconomic characteristics, and access to health services.

The present study focused on children aged 12–23 months residing in rural areas of Nigeria. The 12–23-month age group was selected because it is the standard reference age group commonly used for assessing routine childhood immunization coverage, as children within this age range are expected to have received the vaccines recommended under the national childhood immunization schedule.

Nigeria is located in West Africa and comprises 36 states and the Federal Capital Territory (FCT), Abuja. The country is commonly grouped into six geopolitical zones: North Central, North East, North West, South East, South-South, and South West. These regions differ in socioeconomic conditions, healthcare infrastructure, maternal education, access to health services, cultural practices, and other factors that may influence childhood immunization. Rural populations may face additional challenges related to geographical accessibility, transportation, availability of health facilities, household socioeconomic conditions, and access to health information, which may affect children's access to and completion of routine immunization.

The 2024 NDHS collected information from households across Nigeria using standardized survey instruments and a multistage, stratified sampling design. The survey collected information on children, women, households, and other population and health indicators. For the present study, the analysis was restricted to children aged 12–23 months who lived in rural areas of Nigeria.

2.2. Study Population

The study population comprised children aged 12–23 months residing in rural areas of Nigeria who were included in the 2024 NDHS. The child was the unit of analysis, while information on the child's vaccination history and relevant maternal and household characteristics was obtained primarily from mothers or caregivers.

Children aged 12–23 months were selected because this is the standard age group used for assessing childhood vaccination coverage in population-based surveys. The study population was restricted to children residing in rural areas because the study specifically examined the immunization coverage and associated factors among children living in rural Nigeria.

2.3. Sampling Technique

The 2024 Nigeria Demographic and Health Survey (NDHS) employed a multistage, stratified cluster sampling design to obtain nationally representative estimates of population and health indicators in Nigeria. The survey was designed to generate reliable estimates at the national level and across major geographic and administrative domains, including urban and rural areas, the 36 states, and the Federal Capital Territory (FCT). A total of 41,115 households were selected for the survey, comprising 20,800 households in urban areas and 20,315 in rural areas. Of the selected households, 40,047 were successfully interviewed, representing a household response rate of 99.3%.

For the present study, the sampling procedure was based on the existing 2024 NDHS sample. The relevant children's dataset was examined to identify children aged 12–23 months, after which the sample was restricted to children whose place of residence was classified as rural. The resulting records were further assessed according to the inclusion and exclusion criteria established for the study. Children with the required information for determining immunization status and the relevant explanatory variables were retained for analysis.

Following these procedures, 3,214 children aged 12–23 months living in rural areas of Nigeria constituted the final analytical sample for the study. This sample was used to assess childhood immunization coverage, determine factors associated with full immunization, examine socioeconomic inequalities in immunization, and assess regional disparities among children aged 12–23 months in rural Nigeria. Since the study involved secondary analysis of an existing nationally representative survey, no independent sample-size calculation or primary sampling was undertaken.

To obtain population-representative estimates, the complex sampling structure of the 2024 NDHS was taken into account during statistical analysis. The sampling weights, primary sampling units (PSUs), and sampling strata provided in the dataset were incorporated into the analysis. The application of sampling weights accounted for differences in the probability of selection, while specification of the PSUs and strata accounted for clustering and stratification in the survey design. This approach ensured that the findings appropriately reflected the population of children aged 12–23 months residing in rural areas of Nigeria.

2.4. Inclusion and Exclusion Criteria

Children were included in the analysis if they:

1. Were aged 12–23 months at the time of the survey;
2. Resided in a rural area of Nigeria;
3. Were included in the 2024 NDHS dataset; and
4. Had sufficient information to determine their immunization status and the explanatory variables included in the analysis.

Children were excluded if they were younger than 12 months or older than 23 months, resided in urban areas, or had missing information that prevented determination of the primary outcome or relevant variables required for the analysis.

2.5. Data Source and Data Collection

This study used secondary data from the 2024 Nigeria Demographic and Health Survey (NDHS), a nationally representative household survey conducted to provide information on population and health indicators in Nigeria. The present analysis included children aged 12–23 months residing in rural areas. Relevant information on children's immunization status, maternal characteristics, household socioeconomic factors, healthcare-related factors, and geographic characteristics was extracted from the NDHS datasets. After applying the study eligibility criteria, 3,214 children constituted the final analytical sample. The NDHS employed a stratified cluster sampling design, and survey weights, primary sampling units, and strata were incorporated into the analysis to account for the complex survey design.

2.6. Study Variables and Measurement

The primary dependent variable was full immunization status among children aged 12–23 months.

For descriptive analysis, children's vaccination status was classified into three categories: fully immunized, partially immunized, and unimmunized. The classification was based on the vaccination information recorded in the NDHS dataset and the vaccines specified for the study's immunization indicator.

A child was classified as fully immunized if the child had received all vaccines and required doses specified in the operational definition of full immunization used for the study. A child who had received at least one recommended vaccine but had not received all the required vaccines was classified as partially immunized, while a child who had received none of the required routine vaccines was classified as unimmunized.

For the multivariable analysis, immunization status was dichotomized into:

- Fully immunized = 1
- Not fully immunized = 0

The not-fully-immunized category comprised both partially immunized and unimmunized children.

The vaccination variables were derived from the immunization module of the 2024 NDHS. The dataset contains specific vaccination variables for BCG, OPV doses, IPV, pentavalent doses, PCV doses, measles vaccination, yellow fever and MenA vaccination.

The independent variables were selected based on the study objectives, previous literature on childhood immunization, and variables available in the NDHS dataset. They were grouped into child-related, maternal, household socioeconomic, healthcare utilization, media/information, and geographical characteristics.

Child-related characteristics

Child-related variables included child's sex, age, birth order, and number of living children.

Maternal characteristics

Maternal characteristics included maternal age, marital status, educational attainment, and exposure to health-related information.

Healthcare utilization characteristics

Healthcare utilization variables included antenatal care attendance, postnatal care attendance, and place of delivery.

Household socioeconomic characteristics

Household socioeconomic variables included household wealth index, sex of household head, educational attainment of the household head, religion, and household media exposure.

Geographical characteristics

Geographical variables included geopolitical zone of residence and other relevant geographic characteristics available in the dataset.

Measurement of Immunization Coverage

Immunization coverage was assessed by calculating the weighted proportion of children aged 12–23 months who had received each specified vaccine or vaccine dose. Vaccine-specific coverage was presented using weighted frequencies, percentages, and corresponding 95% confidence intervals. The overall immunization status of children was also summarized by classifying children as fully immunized, partially immunized, or unimmunized. The estimates were calculated using the survey weights and accounted for the complex sampling design.

The use of children aged 12–23 months is consistent with the approach used in population-based vaccination coverage surveys, including the 2024 NDHS.

Operational Definition of Full Immunization

For this study, full immunization was operationalized using the vaccination variables available in the 2024 NDHS dataset. The required vaccination doses were identified from the corresponding NDHS immunization variables rather than relying on an assumed vaccination

schedule.

The dataset provides information on BCG, birth-dose hepatitis B, birth-dose and subsequent oral polio vaccination, IPV, three doses of pentavalent vaccine, three doses of pneumococcal conjugate vaccine, measles vaccine, yellow fever vaccine and MenA vaccine.

The final binary full-immunization variable was therefore generated from the relevant vaccination-dose variables in accordance with the immunization definition adopted for the study. Children who did not satisfy all criteria were classified as not fully immunized.

2.7. Statistical Analysis

Data analysis was conducted using the 2024 NDHS dataset for children aged 12–23 months residing in rural Nigeria. Sampling weights were applied to account for the complex survey design and to produce population-representative estimates.

Descriptive statistics, including frequencies and percentages, were used to summarize the characteristics of the study population and determine the level of immunization coverage. Vaccine-specific coverage was presented for the individual recommended vaccines, while the overall proportion of children who were fully, partially, or not immunized was also determined.

To identify factors associated with full immunization, bivariate analyses were initially conducted to examine the relationship between each independent variable and immunization status. Variables meeting the specified criterion for inclusion in the multivariable model were subsequently entered into a multivariable logistic regression analysis. Adjusted odds ratios (AORs) with corresponding 95% confidence intervals (CIs) were reported to determine the independent association between the explanatory variables and full immunization status. Statistical significance was assessed at a 5% level, with a *p*-value less than 0.05 considered statistically significant.

All analyses accounted for the complex sampling structure of the NDHS through the appropriate incorporation of sampling weights, clustering, and stratification. Statistical analysis was performed using Stata version 17.

3. Results

3.1. Level of Immunization Status among children aged 12–23 months by socio-demographic characteristics in rural Nigeria

Table 1 presents the distribution of full immunization status among children aged 12–23 months according to selected socio-demographic and household characteristics in rural Nigeria. Overall, 952 (32.99%) children were fully immunized, while 2,006 (67.01%) were not. The overall prevalence of full immunization was 32.99% (95% CI: 30.22–35.89).

Maternal age was significantly associated with immunization status ($\chi^2 = 3.303$; *p* = 0.039). Children of mothers aged 20–34 years had the highest prevalence of full immunization (34.20%; 95% CI: 31.01–37.54), followed by those aged 35–49 years (32.59%; 95% CI: 27.99–37.57), while children of adolescent mothers aged 15–19 years had the lowest prevalence (22.42%; 95% CI: 15.18–31.81). Maternal education was also significantly associated with immunization status ($\chi^2 = 18.501$; *p* < 0.001). The prevalence of full immunization increased with increasing maternal educational attainment, from 27.13% (95% CI: 23.72–30.85) among children whose mothers had no formal education to 37.42% (95% CI: 30.06–45.41) among those whose mothers had primary education, 42.40% (95% CI: 38.29–46.61) among those with secondary education, and 59.15% (95% CI: 49.82–67.87) among those with higher education. Maternal marital status showed a statistically significant association with immunization status ($\chi^2 = 2.354$; *p* = 0.044). The prevalence of full immunization was highest among children of widowed mothers (54.83%; 95% CI: 29.79–77.64), followed by those whose mothers were living together (50.87%; 95% CI: 39.48–62.17). The prevalence was 36.56% (95% CI: 22.30–53.65) among children of never-married mothers, 35.42% (95% CI: 14.14–64.62) among children of divorced mothers, 32.20% (95% CI: 29.34–35.19) among children of married mothers, and 31.72% (95% CI: 12.38–60.44) among children of separated mothers. Household wealth quantile was significantly associated with immunization status ($\chi^2 = 18.873$; *p* < 0.001). Children from rich households had the highest prevalence of full immunization (48.77%; 95% CI: 43.58–53.98), followed by those from middle-wealth households (38.42%; 95% CI: 32.33–44.89), while children from poor households had the lowest prevalence (28.39%; 95% CI: 25.23–31.78).

Place of delivery was significantly associated with full immunization ($\chi^2 = 62.653$; *p* < 0.001). Children delivered in a health facility had a higher prevalence of full immunization (46.13%; 95% CI: 42.08–50.24) than those delivered at home or another non-facility setting (27.41%; 95% CI: 24.39–30.66).

ANC attendance showed a strong and statistically significant association with immunization status ($\chi^2 = 158.305$; *p* < 0.001). The prevalence of full immunization was substantially higher among children whose mothers had attended at least one ANC visit (44.61%; 95% CI: 41.27–48.00) compared with those whose mothers had not attended ANC (12.43%; 95% CI: 9.82–15.61).

The number of living children was not significantly associated with immunization status ($\chi^2 = 1.749$; *p* = 0.176). Nevertheless, the prevalence of full immunization showed a slight increase across the categories, from 30.24% (95% CI: 25.80–35.09) among mothers with one child to 32.65% (95% CI: 29.14–36.37) among those with 2–4 children and 35.96% (95% CI: 31.49–40.68) among those with five or more children.

Similarly, birth order was not significantly associated with immunization status ($\chi^2 = 1.541$; *p* = 0.203). The prevalence of full immunization was 29.97% (95% CI: 25.78–34.54) among first births, 31.78% (95% CI: 27.44–36.45) among second- to third-born children, 34.19% (95% CI: 30.09–38.54) among fourth- to sixth-born children, and 37.10% (95% CI: 31.31–43.30) among children of seventh or higher birth order.

Child's sex was not significantly associated with immunization status ($\chi^2 = 0.663$; *p* = 0.416). The prevalence of full immunization was slightly higher among girls (33.89%; 95% CI: 30.44–37.52) than boys (32.13%; 95% CI: 28.70–35.76).

Maternal media exposure was significantly associated with full immunization ($\chi^2 = 15.269$; *p* < 0.001). Children of mothers who were exposed to media had a higher prevalence of full immunization (37.80%; 95% CI: 34.23–41.51) than those whose mothers were not exposed (29.64%; 95% CI: 26.40–33.09).

Religion of the household head was statistically associated with immunization status ($\chi^2 = 7.132$; *p* < 0.001). The prevalence of full immunization was highest among children from households headed by other Christians (41.58%; 95% CI: 36.88–46.44), followed by

Catholic households (39.45%; 95% CI: 33.22–46.05) and Muslim households (30.50%; 95% CI: 27.06–34.16). The lowest prevalence was observed among children from traditionalist households (16.72%; 95% CI: 5.62–40.35).

Sex of the household head was not significantly associated with immunization status ($\chi^2 = 0.240$; $p = 0.624$). Children from male-headed households had a prevalence of full immunization of 33.13% (95% CI: 30.20–36.20), compared with 31.34% (95% CI: 25.14–38.27) among children from female-headed households. Education of the household head was significantly associated with immunization status ($\chi^2 = 14.497$; $p < 0.001$). The prevalence of full immunization increased from 24.74% (95% CI: 21.30–28.54) among children from households where the head had no formal education to 35.31% (95% CI: 28.50–42.77) among those whose household head had primary education, 41.70% (95% CI: 37.21–46.33) among those with secondary education, and 50.16% (95% CI: 42.80–57.51) among those with higher education. Children from households classified under other educational categories had a prevalence of 35.42% (95% CI: 20.09–54.46).

Region of residence was significantly associated with immunization status ($\chi^2 = 9.312$; $p < 0.001$). The highest prevalence of full immunization was observed among children residing in the South East (48.62%; 95% CI: 42.78–54.51), followed by the South-South (47.02%; 95% CI: 37.82–56.42) and North East (43.99%; 95% CI: 37.25–50.96). The prevalence was 31.20% (95% CI: 20.78–43.95) in the South West and 28.11% (95% CI: 24.10–32.50) in North Central, while the North West recorded the lowest prevalence (24.69%; 95% CI: 19.03–31.40).

3.2. Factors associated with Full Immunization Coverage among children aged 12–23 months in Rural Nigeria

The data in Table 2 below presents the unadjusted and adjusted logistic regression analysis of factors associated with full immunization among children aged 12–23 months in rural Nigeria. Several characteristics were associated with full immunization in the unadjusted analysis; however, after adjustment for potential confounding factors, only place of delivery, antenatal care attendance, number of children living in the household, and region of residence remained statistically significant.

Maternal age was significantly associated with full immunization in the unadjusted analysis. Compared with children of mothers aged 15–19 years, children of mothers aged 20–34 years had higher odds of being fully immunized (UOR = 1.80; 95% CI: 1.10–2.95; $p = 0.020$). However, the association was no longer statistically significant after adjustment (AOR = 1.36; 95% CI: 0.78–2.35; $p = 0.276$). Similarly, children of mothers aged 35–49 years had higher odds of full immunization in the unadjusted model (UOR = 1.67; 95% CI: 0.99–2.83; $p = 0.055$), but this association was not statistically significant after adjustment (AOR = 0.84; 95% CI: 0.43–1.62; $p = 0.596$). Maternal education was strongly associated with full immunization in the unadjusted analysis. Compared with children whose mothers had no formal education, the odds of full immunization were higher among children whose mothers had primary education (UOR = 1.61; 95% CI: 1.13–2.29; $p = 0.009$), secondary education (UOR = 1.98; 95% CI: 1.54–2.53; $p < 0.001$), and higher education (UOR = 3.89; 95% CI: 2.57–5.89; $p < 0.001$). However, none of these associations remained statistically significant after adjustment. The adjusted odds were 1.07 (95% CI: 0.73–1.57; $p = 0.720$) for primary education, 0.98 (95% CI: 0.67–1.44; $p = 0.933$) for secondary education, and 1.81 (95% CI: 0.94–3.45; $p = 0.074$) for higher education. Marital status was not significantly associated with full immunization in either the unadjusted or adjusted analysis. Compared with children of never-married mothers, children of married mothers had lower crude odds of full immunization (UOR = 0.82; 95% CI: 0.40–1.68; $p = 0.594$), but the direction changed after adjustment (AOR = 1.44; 95% CI: 0.63–3.28; $p = 0.390$). Children of mothers who were living together had higher odds in both the unadjusted (UOR = 1.80; 95% CI: 0.78–4.12; $p = 0.166$) and adjusted analyses (AOR = 1.61; 95% CI: 0.89–2.89; $p = 0.114$). Similarly, children of widowed mothers had higher odds in both the unadjusted (UOR = 2.11; 95% CI: 0.60–7.45; $p = 0.247$) and adjusted analyses (AOR = 1.67; 95% CI: 0.75–3.69; $p = 0.206$). However, the wide confidence intervals and non-significant p -values indicate insufficient evidence of an independent association between marital status and full immunization. Place of delivery remained significantly associated with full immunization after adjustment. Children delivered in a health facility had more than twice the crude odds of full immunization compared with those delivered at home (UOR = 2.27; 95% CI: 1.85–2.78; $p < 0.001$). Although the magnitude of the association was reduced after adjustment, health-facility delivery remained statistically significant (AOR = 1.37; 95% CI: 1.05–1.79; $p = 0.021$). Household wealth index was significantly associated with full immunization in the unadjusted analysis. Compared with children from poor households, those from middle-income households had higher odds of full immunization (UOR = 1.57; 95% CI: 1.17–2.11; $p = 0.003$), while those from rich households had even higher crude odds (UOR = 2.40; 95% CI: 1.85–3.12; $p < 0.001$). However, these associations were no longer statistically significant after adjustment. The adjusted odds were 1.00 (95% CI: 0.72–1.40; $p = 0.986$) for middle-income households and 1.24 (95% CI: 0.84–1.84; $p = 0.279$) for rich households. Antenatal care attendance was one of the strongest factors associated with full immunization in the model. Children whose mothers had attended at least one ANC visit had substantially higher odds of being fully immunized compared with those whose mothers had not attended ANC. The association was strong in both the unadjusted (UOR = 5.68; 95% CI: 4.25–7.58; $p < 0.001$) and adjusted models (AOR = 4.31; 95% CI: 3.16–5.89; $p < 0.001$). The number of children living was not statistically significant in the unadjusted analysis. Compared with mothers with one child, those with 2–4 children had slightly higher but non-significant crude odds of full immunization (UOR = 1.12; 95% CI: 0.88–1.42; $p = 0.352$), while those with five or more children also had higher but non-significant crude odds (UOR = 1.30; 95% CI: 0.96–1.75; $p = 0.094$). However, after adjustment, having five or more children became significantly associated with full immunization (AOR = 2.09; 95% CI: 1.38–3.16; $p = 0.001$), whereas the association among those with 2–4 children remained non-significant (AOR = 1.27; 95% CI: 0.95–1.70; $p = 0.106$).

Child's sex was not significantly associated with full immunization. Girls had slightly higher odds of being fully immunized than boys in both the unadjusted (UOR = 1.08; 95% CI: 0.89–1.31; $p = 0.416$) and adjusted analyses (AOR = 1.10; 95% CI: 0.89–1.37; $p = 0.368$). Since both confidence intervals included 1 and the p -values exceeded 0.05, the results do not provide evidence of an association between child's sex and full immunization in this population.

Maternal media exposure was significantly associated with full immunization in the unadjusted analysis. Children whose mothers were exposed to either form of media had higher odds of full immunization than those whose mothers were not exposed (UOR = 1.44; 95% CI: 1.20–1.74; $p < 0.001$). However, the association disappeared after adjustment (AOR = 1.01; 95% CI: 0.78–1.32; $p = 0.914$). Education of the household head was also significantly associated with full immunization in the unadjusted analysis. Compared with children from households where the head had no formal education, children from households where the head had primary education had higher odds of full immunization (UOR = 1.66; 95% CI: 1.19–2.32; $p = 0.003$), as did those with secondary education (UOR = 2.18; 95% CI: 1.68–2.82; $p < 0.001$) and higher education (UOR = 3.06; 95% CI: 2.15–4.36; $p < 0.001$). None of these associations remained statistically significant after adjustment. The AORs were 0.98 (95% CI: 0.65–1.47; $p = 0.918$), 1.38 (95% CI: 0.99–1.93; $p = 0.057$), and 1.37 (95% CI: 0.85–2.20;

Table 1: Level of Immunization Status among children aged 12–23 months by socio-demographic characteristics in rural Nigeria

Variable	Fully immunized n (%)	Not fully immunized n (%)	χ^2 statistic	p-value	95% CI for full immunization
Overall	952 (32.99%)	2,006 (67.01%)			30.22–35.89
Maternal age			3.303	0.039	
15–19 years	22.42%	77.58%			15.18–31.81
20–34 years	34.20%	65.80%			31.01–37.54
35–49 years	32.59%	67.41%			27.99–37.57
Maternal education			18.501	<0.001	
No education	27.13%	72.87%			23.72–30.85
Primary	37.42%	62.58%			30.06–45.41
Secondary	42.40%	57.60%			38.29–46.61
Higher	59.15%	40.85%			49.82–67.87
Maternal marital status			2.354	0.044	
Never married	36.56%	63.44%			22.30–53.65
Married	32.20%	67.80%			29.34–35.19
Living together	50.87%	49.13%			39.48–62.17
Widowed	54.83%	45.17%			29.79–77.64
Divorced	35.42%	64.58%			14.14–64.62
Separated	31.72%	68.28%			12.38–60.44
Wealth tertile			18.873	<0.001	
Poor	28.39%	71.61%			25.23–31.78
Middle	38.42%	61.58%			32.33–44.89
Rich	48.77%	51.23%			43.58–53.98
Place of delivery			62.653	<0.001	
Home/non-facility	27.41%	72.59%			24.39–30.66
Health facility	46.13%	53.87%			42.08–50.24
ANC visit			158.305	<0.001	
No ANC visit	12.43%	87.57%			9.82–15.61
At least one ANC visit	44.61%	55.39%			41.27–48.00
Number of living children			1.749	0.176	
1 child	30.24%	69.76%			25.80–35.09
2–4 children	32.65%	67.35%			29.14–36.37
5 or more children	35.96%	64.04%			31.49–40.68
Birth order			1.541	0.203	
First birth	29.97%	70.03%			25.78–34.54
2nd–3rd birth	31.78%	68.22%			27.44–36.45
4th–6th birth	34.19%	65.81%			30.09–38.54
7th or higher	37.10%	62.90%			31.31–43.30
Child sex			0.663	0.416	
Male	32.13%	67.87%			28.70–35.76
Female	33.89%	66.11%			30.44–37.52
Media exposure			15.269	<0.001	
Not exposed	29.64%	70.36%			26.40–33.09
Exposed	37.80%	62.20%			34.23–41.51
Religion of household head			7.132	<0.001	
Catholic	39.45%	60.55%			33.22–46.05
Other christian	41.58%	58.42%			36.88–46.44
Islam	30.50%	69.50%			27.06–34.16
Traditionalist	16.72%	83.28%			5.62–40.35
Sex of household head			0.240	0.624	
Male	33.13%	66.87%			30.20–36.20
Female	31.34%	68.66%			25.14–38.27
Education of household head			14.497	<0.001	
No education	24.74%	75.26%			21.30–28.54
Primary	35.31%	64.69%			28.50–42.77
Secondary	41.70%	58.30%			37.21–46.33
Higher	50.16%	49.84%			42.80–57.51
Other	35.42%	64.58%			20.09–54.46
Region of residence			9.312	<0.001	
North Central	28.11%	71.89%			24.10–32.50
North East	43.99%	56.01%			37.25–50.96
North West	24.69%	75.31%			19.03–31.40
South East	48.62%	51.38%			42.78–54.51
South South	47.02%	52.98%			37.82–56.42
South West	31.20%	68.80%			20.78–43.95

$p = 0.190$), respectively. Region of residence showed important differences in full immunization. Using the North Central region as the reference category, children residing in the North East had higher odds of full immunization in both the unadjusted (UOR = 2.01; 95% CI: 1.42–2.85; $p < 0.001$) and adjusted analyses (AOR = 1.51; 95% CI: 1.08–2.12; $p = 0.016$). Thus, the association with the North East remained statistically significant after adjustment.

In contrast, children residing in the North West had lower adjusted odds of full immunization than those in the North Central region (AOR = 0.61; 95% CI: 0.39–0.94; $p = 0.024$), although the crude association was not statistically significant (UOR = 0.84; 95% CI: 0.57–1.24; $p = 0.379$). Children residing in the South East and South-South had significantly higher crude odds of full immunization compared with those in the North Central region, with UORs of 2.42 (95% CI: 1.77–3.31; $p < 0.001$) and 2.27 (95% CI: 1.47–3.49; $p < 0.001$), respectively. However, these associations were no longer statistically significant after adjustment in the South East (AOR = 0.96; 95% CI: 0.62–1.49; $p = 0.869$) or South-South (AOR = 1.39; 95% CI: 0.81–2.38; $p = 0.226$). Similarly, residence in the South West was not significantly associated with full immunization in either the unadjusted (UOR = 1.16; 95% CI: 0.65–2.08; $p = 0.619$) or adjusted model (AOR = 1.06; 95% CI: 0.28–4.10; $p = 0.927$).

Table 2: Factors associated with Full Immunization Coverage among children aged 12–23 months in Rural Nigeria

Characteristics	UOR (95% CI)	P-value	AOR (95% CI)	P-value
Maternal Age				
15–19 (Ref. Cat.)	1.00	—	1.00	—
20–34	1.80 (1.10–2.95)	0.020*	1.36 (0.78–2.35)	0.276
35–49	1.67 (0.99–2.83)	0.055	0.84 (0.43–1.62)	0.596
Maternal Education				
No Education (Ref. Cat.)	1.00	—	1.00	—
Primary	1.61 (1.13–2.29)	0.009**	1.07 (0.73–1.57)	0.720
Secondary	1.98 (1.54–2.53)	<0.001***	0.98 (0.67–1.44)	0.933
Higher	3.89 (2.57–5.89)	<0.001***	1.81 (0.94–3.45)	0.074
Marital Status				
Never married (Ref. Cat.)	1.00	—	1.00	—
Married	0.82 (0.40–1.68)	0.594	1.44 (0.63–3.28)	0.390
Living together	1.80 (0.78–4.12)	0.166	1.61 (0.89–2.89)	0.114
Widowed	2.11 (0.60–7.45)	0.247	1.67 (0.75–3.69)	0.206
Place of Delivery				
Home (Ref. Cat.)	1.00	—	1.00	—
Health facility	2.27 (1.85–2.78)	<0.001***	1.37 (1.05–1.79)	0.021*
Wealth Index				
Poor (Ref. Cat.)	1.00	—	1.00	—
Middle	1.57 (1.17–2.11)	0.003**	1.00 (0.72–1.40)	0.986
Rich	2.40 (1.85–3.12)	<0.001***	1.24 (0.84–1.84)	0.279
ANC Visit				
No ANC (Ref. Cat.)	1.00	—	1.00	—
At least one ANC visit	5.68 (4.25–7.58)	<0.001***	4.31 (3.16–5.89)	<0.001***
Number of Children Living				
1 (Ref. Cat.)	1.00	—	1.00	—
2–4	1.12 (0.88–1.42)	0.352	1.27 (0.95–1.70)	0.106
5 or more	1.30 (0.96–1.75)	0.094	2.09 (1.38–3.16)	0.001**
Child Sex				
Boy (Ref. Cat.)	1.00	—	1.00	—
Girl	1.08 (0.89–1.31)	0.416	1.10 (0.89–1.37)	0.368
Media Exposure				
Not Exposed (Ref. Cat.)	1.00	—	1.00	—
Exposed to either media	1.44 (1.20–1.74)	<0.001***	1.01 (0.78–1.32)	0.914
Education of Household Head				
No Education (Ref. Cat.)	1.00	—	1.00	—
Primary	1.66 (1.19–2.32)	0.003**	0.98 (0.65–1.47)	0.918
Secondary	2.18 (1.68–2.82)	<0.001***	1.38 (0.99–1.93)	0.057
Higher	3.06 (2.15–4.36)	<0.001***	1.37 (0.85–2.20)	0.190
Region of Residence				
North Central (Ref. Cat.)	1.00	—	1.00	—
North East	2.01 (1.42–2.85)	<0.001***	1.51 (1.08–2.12)	0.016*
North West	0.84 (0.57–1.24)	0.379	0.61 (0.39–0.94)	0.024*
South East	2.42 (1.77–3.31)	<0.001***	0.96 (0.62–1.49)	0.869
South South	2.27 (1.47–3.49)	<0.001***	1.39 (0.81–2.38)	0.226
South West	1.16 (0.65–2.08)	0.619	1.06 (0.28–4.10)	0.927

Note: UOR = unadjusted odds ratio; AOR = adjusted odds ratio; CI = confidence interval.

Estimates are from survey-weighted logistic regression (svy: logistic). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

4. Discussion

4.1. Level of Immunization Status among Children Aged 12–23 Months and Distribution by Socio-Demographic Characteristics in Rural Nigeria

The present study revealed a relatively low level of full immunization coverage among children aged 12–23 months in rural Nigeria. This finding is consistent with several nationally representative studies, such as the 2018 Nigeria Demographic and Health Survey (NDHS) [32], in southwest Ethiopia [33], in Iganga District in Uganda [34], and in Madagascar, which have consistently reported lower immunization coverage, especially among rural populations. Similarly, analyses from WHO have repeatedly shown substantial gaps in rural immunization coverage in Nigeria and across sub-Saharan Africa [4]. The low level of coverage observed in the present study suggests that achieving complete childhood immunization remains a challenge in rural communities, where access to services and other social and economic factors may continue to affect vaccination uptake.

The analysis of childhood immunization coverage in rural Nigeria showed that maternal age was significantly associated with vaccination rates. Children of mothers in the middle reproductive age group had better immunization coverage, while those of adolescent mothers had the lowest coverage. This finding is consistent with evidence from sub-Saharan Africa, where younger mothers may experience greater challenges in accessing and utilizing child health services [35] in Ethiopia [36] in Northern Nigeria. Earlier Nigerian studies using DHS data also indicated that adolescent mothers were less likely to have fully immunized children, a gap linked to limited knowledge, confidence, and autonomy [13]. The lower immunization coverage among children of adolescent mothers in the present study may therefore reflect the social, economic, and informational challenges that often accompany early motherhood.

Maternal education showed a statistically significant difference, with immunization coverage increasing as maternal educational attainment increased. This finding supports the well-established evidence that maternal education is one of the strongest predictors of vaccine uptake. Most of these studies have shown that mothers with at least secondary education were more than twice as likely to have fully immunized children compared to those without education [37–40]. Education may improve mothers' understanding of the benefits of vaccination, knowledge of immunization schedules, and ability to make decisions about child health services. The finding also suggests that improving access to education may have wider benefits for childhood preventive healthcare in rural communities.

Marital status also revealed a statistically significant difference. The pattern observed across the different marital groups suggests that family and household circumstances may influence childhood immunization. This aligns with previous studies, which suggest that spousal support, shared financial resources, and household stability promote health service utilization [41–43]. However, the differences observed among some of the marital groups should be interpreted carefully because some groups may have relatively small numbers of respondents. Other analyses have shown that the effect of marital status diminishes once socioeconomic characteristics are controlled for [44], suggesting that marital status may partly reflect other household and social conditions.

Household wealth also showed a statistically significant difference, with immunization coverage increasing across wealth categories. This finding aligns with previous studies showing that immunization coverage generally improves with higher socioeconomic status [30, 45, 46]. Lower coverage among children from poorer households may reflect the difficulties these families face in meeting the direct and indirect costs of accessing health services. Even when vaccination is provided without charge, transportation costs, distance to health facilities, and time away from work may still create barriers for poorer households.

Further, antenatal care attendance was strongly associated with childhood immunization. Children of mothers who attended ANC had better immunization coverage than those whose mothers did not attend ANC. This finding agrees with previous literature identifying ANC as an important opportunity for health education and counselling on child health services [45]. Mothers who attend ANC have more opportunities to interact with health workers and receive information about the importance and timing of childhood vaccination. ANC attendance may also indicate greater contact with the formal healthcare system, which can support continued use of preventive services after childbirth.

A similar reversal was observed in relation to household wealth, which showed a statistically significant difference at $p < 0.05$. Whereas prior studies consistently demonstrate that immunization coverage improves with increasing socioeconomic status [46, 47], the present study found that children in poorer households had immunization rates comparable to, or even exceeding, those from wealthier families. This may reflect the deliberate targeting of immunization campaigns to deprived populations, which has been reported to narrow or even invert wealth-based inequalities.

The analysis also showed that the number of living children was not significantly associated with immunization status. Although some differences were observed across family-size categories, the overall pattern did not suggest a meaningful relationship between the number of living children and full immunization. This finding differs from earlier research, which suggested that higher-order births are less likely to be immunized due to resource dilution. Further contradictions were evident with antenatal and postnatal care. While previous literature identifies ANC and PNC visits as important entry points for immunization counseling [44, 45], this study found that children of mothers who did not attend ANC were more likely to be immunized, and PNC showed no significant effect. These unusual patterns may be due to the reliance on campaign-based immunization strategies that bypass formal maternal healthcare pathways, combined with possible biases in self-reported survey data.

The absence of a significant association in the present study may suggest that other factors, such as maternal education, household wealth, and access to health services, are more important in determining immunization among rural children.

Child sex did not show a significant difference in immunization status. Although girls had slightly better coverage than boys, the difference was not statistically meaningful. This finding suggests that male and female children in the study population generally had similar opportunities to receive routine childhood immunization. It also indicates that sex of the child may not be an important source of inequality in immunization coverage in the rural communities studied.

Children of mothers who were exposed to media had better immunization coverage than those whose mothers were not exposed to media, and the association was statistically significant. This finding agrees with [48, 49], who linked media access to higher immunization rates. Exposure to media may improve mothers' access to information about vaccination, immunization schedules, and the importance of completing childhood vaccines. In rural communities where access to health information may be limited, radio, television, and other media platforms may therefore play an important role in promoting immunization.

Religious affiliation also showed a statistically significant relationship with immunization status. The differences observed across religious groups suggest that religious and cultural factors may influence the acceptance and use of childhood vaccination. The finding is consistent with [50], who highlighted religious or patriarchal constraints as possible barriers to immunization. Differences between religious groups may be related to beliefs about vaccination, trust in health services, access to health information, and community attitudes towards childhood immunization. However, religion may also be influenced by other social and economic characteristics, which should be considered when examining its independent effect on immunization.

The education of the household head was also associated with childhood immunization. Immunization coverage increased with higher educational attainment of the household head. This finding supports previous evidence linking education with better health service utilization [38, 50–52]. An educated household head may have greater awareness of the importance of preventive healthcare and may also be more supportive of decisions concerning childhood vaccination. The finding further suggests that education within the household may influence child health practices beyond the educational characteristics of the mother.

4.2. Factors associated with Full Immunization Coverage among children aged 12–23 months in Rural Nigeria

The factors associated with full immunization coverage among children aged 12–23 months in Rural Nigeria showed that maternal age was not significantly associated with full immunization after adjusting for confounders. This suggests that the observed differences in immunization across maternal age groups may be explained by other socioeconomic and health-related factors. Similar results were reported by [35] in Ethiopia, where maternal age lost significance after multivariate adjustment. However, some Nigerian studies using DHS data have shown that younger mothers, especially adolescents, are less likely to fully immunize their children due to limited autonomy and lower awareness [36, 50, 51], which differs from the present study. The finding suggests that maternal age alone may not independently determine whether a child completes the recommended immunization schedule in rural Nigeria.

Although maternal education showed a positive association with full immunization in the crude analysis, this relationship was no longer significant after adjustment. This implies that the apparent advantage associated with maternal education may be related to other factors that influence immunization uptake. This finding contrasts with several studies in Nigeria and other developing countries, where maternal education consistently emerged as a strong predictor of full immunization [48, 53]. For example, a multi-country DHS analysis showed that higher maternal education increases the likelihood of complete vaccination [54, 55]. The absence of an independent association in this study may be due to the rural setting, where barriers to accessing immunization services may affect mothers regardless of their educational background.

Marital status did not significantly influence immunization uptake after adjustment. This finding aligns with [56] and [57], who found no independent effect of marital status after controlling for socioeconomic variables. However, some studies [58] suggested that single or formerly married women face more constraints in child healthcare utilization, which differs from the present results. The finding suggests that differences in marital circumstances may not independently determine childhood immunization when other relevant factors are considered. Children delivered at health facilities were more likely to be fully immunized even after adjustment. This suggests that contact with health facilities around the time of delivery may provide an important opportunity for mothers to receive information about childhood immunization and to begin using child health services. This finding agrees with previous studies in Nigeria and sub-Saharan Africa [59, 60], which have consistently found a positive association between facility delivery and childhood immunization. The finding also highlights the importance of strengthening the link between maternity services and subsequent child immunization.

Although household wealth showed significant associations in the crude analysis, these relationships were no longer significant after adjustment. This finding indicates that the apparent influence of household wealth may be explained by other factors included in the model, particularly access to maternal and child health services. This differs from several studies, including [18, 61], which showed household wealth as a consistent determinant of immunization in rural Nigeria. The finding suggests that improving access to immunization services may help reduce the direct influence of household economic differences on vaccination uptake.

ANC attendance remained a strong predictor of full immunization after adjustment. Children whose mothers attended ANC were more likely to be fully immunized than those whose mothers did not attend ANC. This finding corroborates studies in Nigeria [36, 48] and other developing countries [62], which emphasize ANC as a critical entry point for maternal and child health interventions, including immunization counselling. Regular contact with health workers during pregnancy may provide mothers with information about childhood vaccination and encourage continued contact with health services after delivery. The finding therefore reinforces the importance of integrating immunization messages into ANC services.

The number of living children was not significantly associated with full immunization among mothers with two to four children after adjustment. However, children of mothers with five or more children were more likely to be fully immunized after adjustment. This finding differs from the expectation that children from larger families may have lower access to preventive health services because household resources are spread across more children. It also differs from findings by [63], who observed lower immunization among children from larger households due to resource dilution. The finding is, however, consistent with the possibility that mothers with larger families may have greater experience with maternal and child health services and may therefore be more familiar with immunization practices. It also differs from the findings of [64], which reported no significant relationship between parity and immunization.

Child sex was not significantly associated with full immunization after adjustment. Although girls had slightly higher odds of being fully immunized, the difference was not maintained after other factors were considered. This finding aligns with [65], who reported no sex preference in immunization in Nigeria, but contrasts with studies from South Asia [66], where boys were more likely to be fully immunized due to cultural gender bias. The finding suggests that gender of the child may not be an important source of inequality in childhood immunization in the study population.

Media exposure showed a significant association with full immunization in the crude analysis but lost significance after adjustment. This suggests that the influence of media exposure may be related to other characteristics, such as maternal education, socioeconomic circumstances, or access to health services. This contrasts with findings from Nigeria [67] and Bangladesh [53], where exposure to mass media remained a strong independent determinant. The finding does not necessarily reduce the importance of media in immunization promotion, but suggests that media exposure alone may not be sufficient to explain differences in full immunization after other factors are taken into account.

The education of the household head was also not independently associated with full immunization after adjustment. Although children from households with more educated heads had higher odds of full immunization in the crude analysis, the association was not sustained in the adjusted model. This corroborates findings from [68] but contrasts with reports by [69], which suggested that paternal education influences decision-making in immunization uptake. The finding suggests that the effect of household head education may operate through other household and maternal characteristics rather than directly influencing immunization uptake.

Regional variations in full immunization were evident after adjustment. Children in the North East were more likely to be fully immunized compared with those in the North Central, while children in the North West were less likely to be fully immunized. The differences observed in the South East and South South in the crude analysis were not maintained after adjustment. This finding corroborates evidence from the 2018 Nigeria DHS, which reported substantial subnational disparities in immunization coverage. However, the regional pattern in the present study differs from some earlier studies [13, 70], suggesting that the factors associated with immunization may vary across regions and over time. Differences in health system performance, access to services, community-level practices, security conditions, and implementation of immunization programmes may contribute to these regional differences.

5. Conclusion

This study concludes that full immunization coverage among children aged 12–23 months in rural Nigeria remains suboptimal, with important variations across maternal, socioeconomic, health-service, and geographic characteristics. Although overall immunization coverage provides an indication of progress, the observed differences between population groups and regions suggest that improvements in coverage do not necessarily translate into equitable immunization access for all children living in rural communities. Maternal education and household wealth were associated with full immunization at the descriptive level, but neither remained independently associated with immunization in the overall adjusted analysis. The role of maternal education also differed by region, as it remained independently associated with full immunization in the Southern region but not in the Northern region.

Maternal utilisation of health services emerged as an important determinant of full immunization. Antenatal care attendance remained independently associated with full immunization in both the Northern and Southern regions, highlighting the importance of antenatal care as an opportunity for immunization education, counselling, and linkage to routine childhood vaccination services. Place of delivery was independently associated with immunization in the Northern region, indicating the potential importance of contact with health facilities during childbirth for subsequent vaccination uptake.

The study further demonstrates that the determinants of full immunization differ between rural regions of Nigeria. In the Northern region, facility delivery and the number of children living in the household were independently associated with full immunization, whereas these factors were not independently associated with immunization in the Southern region. Conversely, maternal education remained an independent determinant in the Southern region. These regional differences indicate that a uniform approach to improving childhood immunization may not adequately address the different factors influencing vaccination uptake across rural Nigeria.

Recommendations

Routine immunization programmes in rural Nigeria should strengthen the integration of immunization counselling and referral into ANC services, using antenatal contacts to educate expectant mothers about the childhood immunization schedule and the importance of completing all recommended doses. Community-based immunization outreach and defaulter-tracking should also be strengthened to improve access and continuity of vaccination, particularly in underserved rural communities. Immunization communication should be tailored to mothers and households with lower educational attainment and delivered through simple, culturally appropriate messages. Health authorities should routinely use disaggregated immunization data to identify communities and population groups with persistent coverage gaps. Further qualitative and longitudinal research is recommended to clarify the mechanisms through which maternal education, ANC utilisation, and household educational characteristics influence childhood immunization uptake.

Study Limitations

This study has some limitations. First, the cross-sectional design and use of secondary NDHS data limit the ability to establish causal relationships between the identified factors and full immunization. The analysis was also restricted to variables available in the NDHS dataset; therefore, potentially relevant factors such as distance to immunization facilities, vaccine availability, service quality, health-worker counselling, and community-level influences could not be adequately assessed. Secondly, immunization status was based on vaccination cards and/or maternal or caregiver reports, which may have introduced recall or reporting bias where vaccination cards were unavailable. In addition, the findings are limited to rural children aged 12–23 months and may not be generalisable to urban populations or other age groups. Finally, the use of an existing national dataset meant that the researchers had no control over the original questionnaire, variable definitions, or data collection procedures.

Article Information

Ethical Approval: This study used secondary data from the Nigeria Demographic and Health Survey (NDHS). Ethical approval for the original NDHS was obtained from the relevant national and institutional ethics review committees before data collection.

Informed Consent: Written informed consent was obtained from all participants before their inclusion in the study.

Consent for Publication: Not applicable.

Data Availability: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Clinical Trial Registration: Not Applicable.

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Authors Contribution: B.J.F. - Conceptualization, Methodology, Investigation, Data Curation, Writing – Original Draft, Writing – Review & editing, Project Administration, Resources; C.K.E. - Conceptualization, Methodology, Writing – Review & editing; O.M.N. - Investigation, Data Curation, Formal Analysis, Writing – Original Draft, Writing – Review & editing, Supervision, Resources; S.A.I. - Investigation, Data Curation, Writing – Review & editing, Project Administration; R.I.B. - Investigation, Data Curation, Writing – Review & editing, Project Administration; A.I.W. - Conceptualization, Methodology, Formal Analysis, Writing – Review & editing, Supervision, Resources.

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