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Drivers Of Vaccine Equity in Childhood Immunization Among Children Aged 12-23 Months in Plateau North Senatorial District, Plateau State, Nigeria: A Cross-Sectional Study

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ABSTRACT

Vaccine equity remains a major public health challenge in many low- and middle-income countries, where socioeconomic and spatial disparities continue to limit equitable access to childhood immunization services. Evidence regarding the independent drivers of vaccine equity in Plateau North Senatorial District, Nigeria, remains scarce. A cross-sectional study conducted in district among 400 mothers aged 15–49 years whose youngest child was aged 12–23 months. A multistage stratified sampling technique was used to select respondents across the six Local Government Areas of Plateau North Senatorial District. Data were collected using structured questionnaires and in-depth interviews. Descriptive statistics summarized respondents' characteristics, while Chi-square tests and binomial logistic regression analyses were used to identify factors associated with childhood immunization at a 5% significance level. Most respondents were aged 25–29 years (28.8%), tertiary education (51.0%), lived in rented accommodation (77.3%), resided in peri-urban communities (48.0%), travelled 3–4 km to access health facilities (58.5%) and 1–7 antenatal care visits (58.0%). Chi-square analysis showed that housing ownership status ($\chi^2 = 7.647$, $p = 0.022$) had significant associations with childhood immunization. Binomial logistic regression revealed that housing ownership status (AOR = 2.074; 95% CI: 1.315–3.270; $p = 0.002$) and settlement type (AOR = 0.730; 95% CI: 0.545–0.978; $p = 0.035$) were significant independent predictors of childhood immunization. Maternal age, maternal education, distance to health facilities, and means of transportation were not significantly associated with childhood immunization after adjustment. The study concludes that vaccine equity in Plateau North Senatorial District is primarily influenced by socioeconomic and spatial inequalities. Interventions aimed at improving childhood immunization should prioritize disadvantaged households and underserved settlements through targeted outreach programmes, equitable healthcare delivery, and policies that reduce financial and geographic barriers to vaccination.

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1.0 INTRODUCTION

Immunization is one of the most successful and cost-effective public health interventions, preventing an estimated 3.5 to 5 million deaths annually from vaccine-preventable diseases worldwide (WHO, 2025). Despite substantial progress in global immunization programmes, millions of children continue to miss essential vaccines due to inequities in access to health services (WHO & UNICEF, 2025). Vaccine equity seeks to ensure that every child has access to life-saving vaccines regardless of socioeconomic status, geographic location, or other barriers to healthcare (WHO, 2025). Vaccine equity guarantees that everyone in the world has equal access to vaccines (Brosig, 2021). Researchers and public health experts stressed the need of vaccination equity during the COVID-19 pandemic (Ye, Yang *et al.*, 2022), but it also applies to other illnesses and vaccines. Historically, global immunization campaigns have eliminated smallpox and considerably decreased polio, measles, TB, diphtheria, whooping cough, and tetanus (Van De Pas *et al.*, 2022). There are compelling reasons to implement procedures for global vaccine equity. Multiple variables contribute to the emergence and spread of pandemics, most notably people's ability to travel large distances and transfer viruses (Craven, 2021). A virus that is still in circulation somewhere in the world is likely to spread and resurface in other places. The broader and more diverse the population that a virus infects, the more likely it is to evolve more transmissible, virulent, and vaccination resistant variations (Brosig, 2021). Vaccine equity can be critical in stopping the spread and evolution of a disease. Ensuring that all populations have access to vaccines is a practical approach to improving global public health. Failure to do so raises the chance of subsequent waves of a disease (Tolbert *et al.*, 2021). Infectious diseases disproportionately afflict low- and middle-income neighborhoods and nations (LMICs), making vaccine equity a public health and foreign policy concern. Access to vital medications, such

as vaccinations, is intimately linked to the human right to health, which is widely established in international law (Bokat-Lindell *et al.*, 2021). Economically, vaccination inequities harm the global economy. To achieve vaccine fairness, inequities and obstacles in vaccine production, trade, and health-care delivery must be addressed (Gill *et al.*, 2022). The challenges include scaling up technology transfer and manufacturing, production costs, vaccination safety profiles, and anti-vaccine disinformation and hostility (Hotez *et al.*, 2022). The wealthy have better access to vaccines than the poor, both within and between countries. Within countries, vaccination uptake may be lower for racial and ethnic minorities, older adults, and people with impairments or chronic diseases. Vaccine distribution and accessibility vary significantly between urban and rural locations, particularly in low- and middle-income countries. Okwaraji *et al.*, (2012). Some countries have programs to address this inequality (CDC, 2021). Vaccine availability in some nations may be limited due to political, economic, social, or diplomatic concerns.

In Plateau State, Rural Local Government Areas recorded significantly higher immunization coverage than urban Local Government Areas, highlighting the persistence of spatial inequalities in vaccine uptake and access to immunization services (Gyang *et al.*, 2024). Although previous studies have examined childhood immunization in Nigeria and other developing countries, most have focused primarily on vaccination coverage and individual socio-demographic determinants. Few studies have specifically investigated vaccine equity by simultaneously examining household wealth, settlement type, antenatal care attendance, maternal education, and geographical accessibility within Plateau North Senatorial District. This study therefore fills this gap by assessing the drivers of vaccine equity factors associated with influencing childhood immunization status among women of childbearing age in Plateau North Senatorial District, Plateau State, Nigeria.

Conceptual Framework

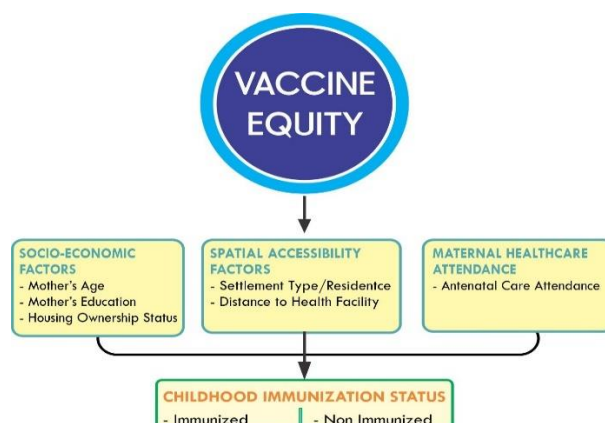


Figure 1: This framework was adapted from Andersen's Health Care Utilization Model and the WHO Social Determinants of Health Framework

The conceptual framework for this study was adapted from the Andersen Healthcare Utilization Model and the World Health Organization Social Determinants of Health Framework. The framework assumes that childhood immunization status is influenced by a combination of socio-economic, spatial accessibility, and maternal healthcare utilization factors. Educational attainment, household wealth status, settlement type, distance to health facilities, and antenatal care attendance may directly or indirectly affect access to and utilization of childhood immunization services. Variations in these factors ultimately contribute to vaccine equity among children in the study area.

2. EMPIRICAL REVIEW OF DRIVERS OF VACCINE EQUITY AND CHILDHOOD IMMUNIZATION

Maternal Education of Childhood Immunization

Maternal education is widely accepted as an important factor influencing childhood immunization. Educated mothers are generally more aware of vaccination schedules, the benefits of immunization and its consequences. According to Salako *et al.*, (2024), the mother's level of education was found to be strongly associated with the child's immunization status. Children of mothers with higher education levels were substantially more likely to receive full immunizations. Educated mothers are more aware of vaccination schedules, appreciate the

benefits of immunization, and are more proactive in seeking health care. This suggests that educational attainment contributes to improved decision-making regarding child health and completing recommended vaccination schedules. Although educational attainment is often associated with improved childhood immunization outcomes, the magnitude of its influence varies across settings. Differences in socioeconomic conditions, access to health services, and cultural practices may influence the extent to which maternal education affects immunization behaviours.

Maternal Healthcare Utilization

Antenatal care (ANC) and institutional delivery are crucial maternal healthcare services that have a major impact on regular immunization uptake and completion among Nigerian children. These are well-documented avenues for women to access health information, immunization advice, and prompt vaccine referrals for their children. Ariyibi *et al.*, (2023) did a cross-sectional study in Ilorin, North-Central Nigeria, and discovered that attendance at ANC and hospital delivery were substantial predictors of full regular immunization among children aged 12-23 months. Among the 456 mother-child couples evaluated, 80% of the children had been fully vaccinated, with early vaccines like BCG and Pentavalent receiving particularly high uptake. Statistical analysis found that mothers who attended ANC had considerably better probability of fully vaccinating their children and being vaccinated. Similarly, hospital delivery

was favorably associated with 100% vaccination coverage. These data indicate that health facility interaction during pregnancy and childbirth boosts a mother's exposure to immunization education and schedule reminders, as well as facilitates integration into postnatal immunization programs. This is consistent with prior research from other sections of Nigeria and Sub-Saharan Africa. For example, the 2018 Nigeria Demographic and Health Survey (DHS) found that children delivered in health facilities and whose mothers received ANC visits were considerably more likely to be immunized than those born at home or whose mothers did not receive prenatal care. ANC visits are frequently used as crucial touchpoints for vaccination advocacy, maternal motivation, and early immunization enrollment. The findings emphasize the necessity of improving prenatal and maternity services as a strategic strategy to increase children immunization coverage. Regular interaction with healthcare providers during pregnancy may enhance mothers' awareness of vaccination requirements and strengthen adherence to immunization schedules. Consequently, ANC utilization serves as an important mechanism for improving childhood immunization outcome.

Geographic accessibility factors

Freeman *et al.*, (2023) conducted an international study utilizing geocoded administrative data to explore the relationship between geographic proximity to immunization providers and completion of the combined 7-vaccine series in Montana, USA, among children aged 0-24 months. The study included data from 26,085 children born from 2015 to 2017, with distances to the nearest immunization provider ranging from 0 to 81.0 miles (median = 1.7 miles). The authors used a multivariable log-linked binomial mixed model to examine factors impacting vaccine completion. Children who lived more than 10 miles from a provider were somewhat less likely to complete the full immunization series. Furthermore, children in rural areas were much less likely to finish immunizations than those in cities. The study revealed that, while distance in miles (km equivalent) had a minor impact, rural residency and service access restrictions were more significant impediments than travel distance alone. Getnet *et al.*, (2025)

used data from the most current Demographic and Health Survey (DHS) to undertake a multilevel and regional analysis of incomplete basic immunization among children aged 12-23 months in 48 resource-limited countries. The weighted sample had 202,029 children. Spatial clustering was analyzed with ArcGIS and SaTScan, and related factors were identified using multilevel logistic regression. A major finding regarding geographic access was the substantial relationship between caregiver-reported opinion of distance to health facility and inadequate immunization. Even after controlling for socioeconomic and health access characteristics, households that perceived distance as a major problem had a greater rate of incomplete immunization. While distance was evaluated in perception rather than exact kilometers, the study supports the spatial influence on vaccination gaps on a larger scale. In African, Goentzel *et al.*, (2022) employed empirical demand data and spatial distance to health facilities to create and use a mixed integer programming model to optimize the location of outreach sites and health centers for vaccine delivery in The Gambia. UNICEF was involved in the model's validation. The distance to health facilities was an endogenous variable in this study that had a substantial impact on vaccine uptake. By strategically placing outreach clinics closer to underserved groups, immunization coverage increased from 91.0% to 97.1% without raising the health budget. This highlights the importance of geographic access and closeness to the nearest PHC or outreach facilities in promoting vaccination equity.

Settlement type and Childhood Immunization

Settlement characteristics have been widely associated with variations in childhood immunization outcomes. Internationally, Noroozi *et al.*, (2024) used NHS vaccination data to undertake longitudinal machine learning research on predictors of childhood vaccine uptake in 150 districts in England from 2021 to 2024. The study used hierarchical clustering and a CatBoost classifier, interpreted using SHapley Additive Explanations (SHAP), to assess the role of regional, demographic, and socioeconomic characteristics. The findings found that rurality was a substantial positive predictor of increased immunization uptake, exceeding socioeconomic

characteristics. Urban areas with a large proportion of foreign-born citizens, weak English proficiency, and ethnic minorities were more likely to have lower vaccination uptake. This finding stresses the importance of settlement type, specifically rural versus urban environment, in determining vaccine coverage. *sresie et al.*, (2023) used nationally representative data from the 2019 mini-Demographic and Health Survey to conduct a multivariate decomposition analysis on urban-rural differences in complete immunization among Ethiopian children aged 12-23 months. The study included 996 weighted samples (299 urban and 697 rural). The results showed a full immunization rate of 64.6% in urban regions and 36.8% in rural areas, indicating a significant urban-rural divide. The disparity was mostly due to disparities in maternal health service utilization (e.g., ≥ 4 ANC visits: $\beta = 0.1212$, $p < 0.05$), place of delivery ($\beta = 0.1350$), and vaccination documentation via immunization cards ($\beta = 0.2666$). Interestingly, high wealth status ($\beta = -0.141$) and postnatal care ($\beta = -0.0697$) helped minimize the discrepancy. It emphasizes the critical role of targeted rural efforts in closing global vaccination gaps. *Magambo et al.*, (2020) studied how the geographic location of health institutions in Hoima District, Uganda affected immunization program performance. A mixed-methods, cross-sectional approach was used to collect data from 49 health institutions, HMIS records, and interviews with immunization workers. Results showed that 55.1% of health centers had poor immunization performance, with facilities closest to urban district headquarters being considerably more likely to perform poorly ($p < 0.05$). The study found that proximity to administrative centers does not guarantee better immunization outcomes, emphasizing the importance of targeting urban-based health facilities with context-specific outreach strategies. The study also identified factors such as inadequate outreach strategies and low community mobilization in urban areas.

Jammeh et al., (2023) conducted a cross-sectional study to examine the full immunization status of children aged 0 to 23 months in urban slums in Kampala City and the rural region of Iganga, Uganda. The study included 1,016 children, with 544 from rural Iganga and 472 from the Kampala

slums. Stata was used to do logistic regression analysis on the data. The study found that children in slums were more likely to be fully vaccinated (48.9%) than their rural counterparts (43.2%), with an odds ratio of 1.456 ($p = 0.033$; 95% CI: 1.030-2.058).

Although BCG and early-stage vaccines had great coverage ($\geq 88\%$), dropout uptake for later-stage immunizations (Penta3, pneumococcal, and rotavirus) were up to 41%. Rural regions had significantly lower rotavirus vaccine coverage (7.5%) than slums (47.9%). The findings call into question the idea that urban slums are always disadvantaged and emphasize the complexities of residence-based vaccination inequities.

In Nigeria, *Odikeme et al.*, (2022) conducted a descriptive cross-sectional study in urban and rural communities in Bayelsa State to assess the timeliness and completeness of regular childhood immunization among children aged 12-23 months. A semi-structured questionnaire was administered to 427 respondents through a multistage sampling procedure. SPSS version 23 analysis showed that just 6% of urban and 9% of rural children were fully vaccinated, with significant disparities ($p < 0.001$). While urban areas had higher vaccine timeliness, rural children received immunizations later. *Omuemu et al.*, (2023) conducted a comparative cross-sectional study across urban and rural populations in Edo State, Nigeria, to assess Missed Opportunities for Vaccination (MOV) among children under five. A total of 644 mothers were selected using multistage sampling, and data were gathered using a modified WHO MOV assessment methodology. SPSS analysis revealed that MOV prevalence was 21.7% in urban and 22.1% in rural populations, with no significant difference ($p = 0.924$). The measles vaccine was the most usually missed. In both situations, short service hours were the most common reason for missed vaccinations. Poor maternal knowledge was a significant predictor in both settings, as was older child age and attendance at antenatal care in rural locations. Although urban and rural MOV uptake was similar, underlying contextual factors differed, implying that settlement type affects vaccination problems differently. The study reveals that while missed vaccination uptake may be similar across rural and urban contexts, the contributing reasons differ, demonstrating that

urban–rural immunization discrepancies are affected by both structural and behavioral characteristics.

In Plateau, Fulus (2025) conducted a cross-sectional survey in six chosen rural and urban local government areas to investigate inequities in healthcare access and utilization. A total of 384 respondents took part, and Fisher's Discriminant Analysis was used to uncover significant characteristics that differentiate healthcare access amongst settlement types. The study discovered that rural populations experienced much more problems, such as large travel distances to health facilities, poor transportation, financial constraints, and insufficient health insurance coverage. Maternal and child healthcare utilization was much lower in rural areas, which contributed to increased under-5 mortality uptake. Educational status and proximity to health services were identified as important predictors of healthcare access, with the model reaching a classification accuracy of 67.7%. These findings emphasize the importance of settlement type and geographic impediments to fair healthcare access in Plateau State. Gyang *et*

3. STUDY AREA

Locational and Size

Geography of the study area like other states in Nigeria is made up of three Senatorial Zones (Northern, Central and Southern Senatorial District). This study focuses on Northern Senatorial District of Plateau State, which is made up of six (6) LGAs namely; Jos North, Jos East, Jos South, Barkin Ladi, Riyom and Bassa. Northern Senatorial Zone of Plateau State lies between latitudes 8° 24' and 10° 30' North and The state contains a combination of public and private facilities. The public healthcare system is managed by the state government. It includes hospitals, clinics, and primary care centers. In recent years, the state government has made significant investments in the healthcare system. Jos University Teaching Hospital is Plateau State's largest and best-equipped hospital. It is a tertiary care hospital that offers specialized treatment for a variety of medical ailment. There are 1237 health institutions dispersed throughout 17 local government units in the state. The breakdown of these institutions shows that 615 government-operated Primary Health Care (PHC) facilities, while 542 are privately held.

al., (2024) conducted a five-year retrospective analysis using secondary data on Penta 3 immunization coverage from all local government areas (LGAs) in Plateau State, Nigeria, between January 2018 and December 2022. The LGAs were classified as rural or urban based on official classification, and the data was analyzed using SPSS version 25 with statistical significance set at $p < 0.05$. The findings revealed a considerable decline in immunization coverage during the COVID-19 outbreak, followed by a partial recovery by 2022. The study found that rural LGAs had significantly greater immunization coverage uptake than urban LGAs, both before and after the pandemic ($p = 0.001$). The authors proposed stakeholder-driven solutions for increasing equity in vaccine availability and service delivery. This study provides compelling evidence that the type of settlement (urban vs. rural) continues to be a significant structural factor impacting regular childhood immunization coverage in Plateau State, with rural areas outperforming urban areas in post pandemic recovery.

longitudes 8° 32' and 10° 38' East GVP, (2021). Plateau North Senatorial District shares boundaries with Bauchi state to the North through Toro, Bogoro and Ningi LGAs and to Kaduna state to the West through Kaura, Jema'a and Zangon Kataf LGAs. It has a total land area of about 9,400 square kilometers within an average size of about 1,250 meters above mean sea level.

Health delivery system

There are 31 government secondary healthcare facilities and 44 private secondary healthcare facilities. The state is served by five tertiary healthcare facilities, three of which are privately owned (Bingham University Teaching, Vom Christian, and Our Lady of Apostles Hospitals) and two of which are government-operated (Jos University Teaching Hospital and Plateau Specialist Hospital), all located in the Plateau North Senatorial zone (Shaba *et al.*, 2023 and PSMH 2020). Plateau government primary health care facilities are distributed fairly throughout the state, with no fewer than 17 institutions in each local government. Barkin Ladi and Bassa in Plateau North Senatorial District have the most

government-owned primary facilities, with 56 and 51, respectively. Others: Jos South 42, Jos North 28, Barkin Ladi 56. Riyom has the fewest amenities. Because of the density of population in urban areas, these facilities are naturally clustered. The North senatorial district exhibits much of this clustering, with the highest concentration in and around the Jos-Bukuru city. This can also be ascribed to Jos' importance as the state's administrative hub (Shaba *et al.*, 2023).

4. MATERIALS AND METHODS

Research Design

This study adopted a cross-sectional survey design to assess drivers of vaccine equity in childhood immunization in Plateau North Senatorial District, Plateau State, Nigeria. The design was considered appropriate because it enabled the collection of data from a representative sample of women of childbearing age at a single point in time. The investigate the relationships between drivers of vaccine equity and childhood immunization.

Study Population

The target population comprised women of childbearing age (15–49 years) with only mothers whose youngest child was 12–23 months were eligible. According to the National Population Commission (NPC, 2024), the district had an estimated 504,972 women of childbearing age distributed across the six Local Government Areas of Barkin Ladi, Bassa, Jos East, Jos North, Jos South, and Riyom. Childhood immunization status was assessed using the youngest child aged 12–23 months. A child was classified as fully immunized if he/she had received all vaccines recommended under the Nigeria National Programme on immunization before the first birthday (BCG, OPV, Pentavalent, PCV, IPV and Measles vaccine). Immunization status was determined primarily from vaccination cards. Where vaccination cards were unavailable, maternal recall was used.

Data Collection

Primary data were collected using a structured questionnaire administered to women of childbearing age. The questionnaire contained drivers of vaccine equity factors influencing childhood immunization. In addition, in-depth interviews were conducted with community leaders, religious leaders, and selected mothers to obtain qualitative insights into drivers

influencing childhood immunization uptake. Interviews were recorded with participants' consent and subsequently transcribed for thematic analysis.

Data Analysis

Data were coded and analyzed using the Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics including frequencies and percentages were used to summarize respondents' characteristics. Chi-square (χ^2) tests were employed to examine associations between drivers of vaccine equity and childhood immunization and Binomial Logistic Regression was also used and Statistical significance was determined at a 5% level ($p < 0.05$).

1. Chi-Square Formula:

$$\chi^2 = \sum [(O - E)^2 / E]$$

Where: χ^2 = Chi-square statistic O = Observed frequency E = Expected frequency

2. Binomial Logistic Regression was employed to investigate the drivers of vaccine equity and childhood immunization because the dependent variable was binary.

Logistic Regression Model:

$$\ln \frac{p}{1-p} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n$$

Where:

p = probability of childhood Immunization

β_0 = intercept

$\beta_1 \dots \beta_n$ = regression coefficients

$X_1 \dots X_n$ = Drivers of vaccine equity

Sampling Procedure

A multistage stratified random sampling technique was employed for the study. At the first stage, Plateau North Senatorial District were stratified into six on the bases of local government areas, thus, Barkin Ladi, Bassa, Jos East, Jos North, Jos south and Riyom LGAs. At the second stage, wards were then clustered and randomly selected to give a representation across the study area. Furthermore, at the third stage polling units were then selected by simple random sampling. Fourthly, the 400 women of childbearing age (15–49 years) were distributed across the selected polling units proportionately to size. For the qualitative component, interview was conducted among women to gain their opinion about immunization in the area.

Sample Size Determination

The sample size for the quantitative survey was determined using the Yamane Taro (1967) formula:

$$n = \frac{N}{1 + Ne^2}$$

Where

n= Sample size

N= Population size: 504,972 (women of childbearing age 15-49 years))

e= Level of Precision or Sampling of Error which is $\pm 5\%$

$$n = \frac{504,972}{1 + 504,972 (0.05)^2}$$

$$n = \frac{504972}{1,262.43} = 400$$

Ethical clearance

Ethical approval for this study on drivers of vaccine equity and childhood immunization was obtained from the Plateau State Ministry of Health. Informed consent was secured from all respondents, and confidentiality and anonymity were strictly maintained. Participation was voluntary and data collected were used solely for academic purposes.

RESULT AND DISCUSSION

Table 1: Drivers of Vaccine equity in the study area

Vaccine equity factors	Frequency	Percentage (%)
Mother's Age		
15-19	60	15.00
20-24	87	21.75
25-29	115	28.80
30-34	38	9.50
35-39	34	8.50
40-44	30	7.50
45-49	36	9.00
Total	400	100
Mother's Education		
No Formal Edu.	18	4.5
Primary Edu.	76	19.0
Secondary Edu.	102	25.5
Tertiary Edu.	204	51.0
Total	400	100
Housing Ownership Status		
Rent	309	77.3
Own	84	21.0
Mortgage	7	1.8
Total	400	100
Settlement type		
Rural/Village	69	17.3
Peri-urban	192	48.0
Urban Center	139	34.8
Total	400	100
Distance to Health Facility (Km)		
1-2 km	64	16.0
3-4 km	234	58.5
>4 km	102	25.5
Total	400	100
Antenatal care visits		
0 visits	65	16.3
1-7 visits	232	58.0

8 visits (WHO Recommended)	103	25.8
Total	400	100

Source: Author's Field Survey, 2025

The age distribution shows that the majority of respondents were within the age group of 25–29 years, accounting for 115 respondents (28.8%), followed by those aged 20–24 years with 87 respondents (21.8%). Respondents aged 15–19 years constituted 15.0%, while older age 15 categories such as 40–44 years and 45–49 years represented smaller proportions. This finding indicates that most women in the study area are within the active reproductive age bracket, which is associated with high fertility and increased maternal and child healthcare needs. The dominance of women aged agrees with Adebawale *et al.*, (2022) in Northern Nigeria found that women aged 20–29 years were the most represented among mothers accessing maternal and child healthcare services. The educational attainment of mothers indicates relatively high literacy levels among respondents. Women with tertiary education constituted the highest proportion with 204 respondents (51.0%), followed by those with secondary education at 25.5%, primary education at 19.0%, and only 4.5% having no formal education. This finding suggests improved educational access among women in the study area. Higher educational attainment among mothers is significant because education influences maternal health awareness, child nutrition, healthcare-seeking behavior, and household decision-making. The result corroborates the findings of Akinyemi *et al.*, (2022), who reported that maternal education significantly improves maternal and child health outcomes in Nigeria. Furthermore, the United Nations Children's Fund (UNICEF, 2023) emphasized that educated mothers are more likely to adopt preventive healthcare practices and ensure adequate nutrition for their children. In terms of housing ownership status, the bulk of respondents (77.3%) came from poor households, showing that surveyed households faced significant economic disadvantage. Housing ownership status is a significant predictor of healthcare utilization because financially disadvantaged households may have difficulty getting vaccination services. In addition, 21.0% identified as middle class, with only 1.8%

claiming to be wealthy. This finding is consistent with the findings of Oladimeji *et al.*, (2022), who found that home ownership among low-income women in Nigeria is relatively low due to limited financial capacity and lack of access to mortgage facilities. Similarly, UN-Habitat (2023) stated that urban housing in developing nations such as Nigeria is predominantly dominated by rental housing due to affordability issues.

In an interview conducted to respondents 77.3% living as poor participated, it was asserted that:

"As a poor person, I have to make hard-hitting financial conclusions. With the hard times of feeding my family, it is always thought-provoking to ensure my child obtains all the necessary vaccinations. If I am financially buoyant, I'd have more peace of mind to attends to all my child's vaccinations." (IDI, Gabia, Bassa LGC, 2024).

The settlement type results suggest that 48% of respondents live in peri-urban areas, 17.3% in rural/villages, and 34.8% in urban centers.

In an interview with respondents who live with their children in rural settlements, it was asserted that:

"As we live in a rural settlement some health facilities no accessible from our homes. Combined with certain other challenges such as transport money, it becomes difficult for us to take our children for routine immunization, this make my son to missed a vaccines". (IDI, Danto, Riyom LGC, 2024).

The table results contradict Allan *et al.* (2021) study, which found that children living in urban areas had a 26% lower chance of being fully vaccinated than those living in rural areas in Kenya. It concluded that systematic obstacles in urban settings, such as informal settlements and fragmented healthcare services, could stymie immunization attempts in Kenya. The table also shows the various attitudes of respondents regarding the distance to their health institution. 16% indicated 1-2km to reach their health institution, 58.5% indicated 3-4km (more than half), and 25.5% (more than a quarter) said >4km. This result is consistent with that of Rahman *et al.*, (2021), who found that proximity to health facilities greatly improved the likelihood of being

immunized in research using DHS data from Sub-Saharan nations. Antenatal care visits reveal that 16.3% of respondents never visited ANC, which would encourage them to vaccinate their

children, while 58% (more than half) visited 1-3 times and 25.8% visited 4 or more times (as recommended by WHO) in the study area.

Table 2: Distributions of drivers of vaccine equity and childhood immunization in the study area.

	Immunized		Non-Immunized		Total		Chi-square (χ^2) /Df/P-value
Age							
15–19	30	7.50	30	7.50	60	15.00	χ^2 :11.822 (6) p=0.066
20-24	45	11.25	42	10.50	87	21.75	
25-29	47	11.75	68	17.00	115	28.80	
30-34	17	4.25	21	5.25	38	9.50	
35-39	21	5.25	13	3.25	34	8.50	
40-44	8	2.00	22	5.50	30	7.50	
45-49	20	5.00	16	4.00	36	9.00	χ^2 :3.414 (3) p=0.33
Total	188	47.00	212	53.00	400	100	
Mother's Education							
No Formal Edu.	12	3.00	6	1.50	18	4.5	
Primary Edu.	34	8.50	42	10.50	76	19.00	
Secondary Edu.	50	12.50	52	13.00	102	25.50	
Tertiary Edu.	92	23.00	112	28.00	204	51.00	
Total	188	47.00	212	53.00	400	100	
Housing Ownership Status							
Rent	134	33.50	175	43.75	309	77.3	χ^2 :7.647(2) p=0.022
Own	49	12.25	35	8.75	84	21.0	
Mortgaged	5	1.25	2	0.50	7	1.8	
Total	188	47.00	212	53.00	400	100	
Settlement type							
Rural/Village	39	9.75	30	7.50	69	17.3	χ^2 :4.58(2) p=0.101
Peri-urban	92	23.00	100	25.00	192	48.0	
Urban Center	57	14.25	82	20.50	139	34.8	
Total	188	47.00	212	53.00	400	100	
Distance to Health Facility (Km)							
1–2 km	37	9.25	27	6.75	64	16.0	χ^2 :4.554(2) p=0.103
3–4 km	101	25.25	133	33.25	234	58.5	
>4 km	50	12.50	52	13.00	102	25.5	
Total	188	47.00	212	53.00	400	100	
Antenatal care visits							
0 visits	33	8.25	32	8.00	65	16.3	

1-7 visits	109	27.25	123	30.75	232	58.0	$\chi^2:0.60(2)$ $p=0.620$
8 visits (WHO Recommended)	46	11.50	57	14.25	103	25.8	
Total	188	47.00	212	53.00	400	100	

Source: Author's Field Survey, 2025

The study found a statistically significant association between housing ownership status and childhood immunization ($\chi^2 = 7.647$, $p = 0.022$). Children from wealthy homes were more likely to receive immunizations than those from disadvantaged households. This data implies that economic resources play a key role in increasing access to immunization programs. Although normal childhood immunizations are supplied free of charge in Nigeria, indirect costs such as transportation, lost work time, and other

healthcare-related charges may discourage low-income families from following vaccination regimens. This finding is consistent with the Nigeria Demographic and Health Survey (NPC & ICF, 2024), which found higher immunization coverage among children from affluent households than those from poorer households. The findings reinforce the premise that vaccine equity cannot be achieved without addressing larger socioeconomic disparities that influence healthcare consumption.

Binomial Regression Analysis

Table 3: Result of Binomial regression analysis of Drivers of vaccine equity on childhood immunization in Plateau North Senatorial District.

	B	S.E.	Wald	df	Sig.	AOR	95% C.I.	
							Lower	Upper
Age	-.053	.058	.835	1	.361	.948	.846	1.063
Mothers education	-.136	.118	1.328	1	.249	.873	.693	1.100
Housing ownership status	.729	.232	9.850	1	.002	2.074	1.315	3.270
Settlement Type	-.315	.149	4.445	1	.035	.730	.545	.978
Distance to reach your health facility	-.085	.161	.280	1	.597	.918	.669	1.260
Antenatal care visits	-.065	.163	.160	1	.689	.937	.680	1.290
Constant	.586	.668	.771	1	.380	1.797		

The binomial logistic regression analysis demonstrated that housing ownership status was a significant predictor of childhood immunization (AOR = 2.074; 95% CI: 1.315–3.270; $p = 0.002$). Children from households with better housing ownership status were approximately twice as likely to receive complete immunization compared with those from poorer households. This finding indicates that socioeconomic position remains a critical determinant of vaccine equity. Although routine childhood immunization is provided free of charge in Nigeria, indirect costs such as transportation expenses, loss of productive time, and other household financial constraints may reduce caregivers' ability to complete recommended vaccination schedules. This finding is consistent with the Nigeria Demographic and Health Survey

(NPC & ICF, 2024), which reported substantially higher immunization coverage among children from wealthier households than among children from poorer households. Similar findings have also been reported across several low- and middle-income countries where household wealth consistently predicts childhood vaccination uptake. Settlement type also emerged as a significant predictor of childhood immunization (AOR = 0.730; 95% CI: 0.545–0.978; $p = 0.035$). This finding suggests that disparities in immunization coverage persist across rural, peri-urban, and urban settlements, reflecting inequalities in access to healthcare services, availability of immunization facilities, transportation infrastructure, and community outreach activities. The result agrees with Gyang *et al.*, (2024), who reported significant spatial

differences in childhood immunization coverage across rural and urban Local Government Areas in Plateau State. It is also consistent with Asresie *et al.*, (2023), who documented significant urban–rural disparities in childhood immunization among Ethiopian children. These findings reinforce the importance of incorporating spatial equity considerations into immunization programmes to ensure that underserved communities receive adequate vaccination services. In contrast, maternal age, maternal education, distance to the nearest health facility, and means of transportation were not statistically significant predictors after adjustment for other variables. Although these variables have been associated with childhood immunization in previous studies, the present findings suggest that their effects may be mediated through broader socioeconomic and geographical conditions. This highlights the importance of addressing structural inequalities that influence vaccine access rather than relying solely on individual demographic characteristics. Overall, the regression findings indicate that socioeconomic and spatial determinants remain the principal drivers of vaccine equity in Plateau North Senatorial District. Policies aimed at improving childhood immunization should therefore prioritize disadvantaged households and underserved settlements to reduce inequities in vaccine uptake.

CONCLUSION

This study examined the drivers of vaccine equity influencing childhood immunization among children aged 12–23 months in Plateau North Senatorial District, Plateau State, Nigeria. The binomial logistic regression analysis identified housing ownership status and settlement type as the only significant independent predictors of childhood immunization after controlling for the other explanatory variables. Children from households with better housing ownership status had significantly higher odds of being fully immunized, while differences in settlement type also significantly influenced childhood immunization uptake. These findings demonstrate that vaccine equity is shaped primarily by underlying socioeconomic and spatial inequalities rather than by maternal age, maternal education, distance to health facilities, or means of transportation alone. The findings

suggest that although childhood vaccines are provided free of charge in Nigeria, indirect socioeconomic constraints and geographical disparities continue to influence access to and utilization of immunization services. Consequently, achieving equitable childhood immunization requires interventions that extend beyond vaccine availability to include strategies that reduce socioeconomic disadvantage and address location-specific barriers to immunization services. The study therefore concludes that improving vaccine equity in Plateau North Senatorial District will require targeted interventions focusing on economically disadvantaged households and underserved settlements. Strengthening community-based outreach services, expanding equitable access to primary healthcare, and implementing policies that reduce financial and geographic barriers to immunization are essential for improving childhood vaccination coverage and reducing inequities in the study area.

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