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HEALTH INFRASTRUCTURE AND HEALTHCARE UTILIZATION IN NIGERIA

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ABSTRACT

Health infrastructure remains a critical determinant of healthcare utilization in sub-Saharan Africa, yet Nigeria continues to face significant infrastructural deficiencies that limit access to quality healthcare services. This study investigates the effect of health infrastructure on healthcare utilization in Nigeria, focusing on facility availability, health workforce density, and adequacy of medical equipment. A mixed-methods approach was adopted using secondary data from the Nigeria Demographic and Health Survey (NDHS 2018), National Health Management Information System (NHMIS), and World Health Organization (WHO) databases, analyzed through descriptive statistics, multiple regression, binary logistic regression, and GIS mapping across the six geopolitical zones. The findings reveal that number of health facilities per population, skilled health worker density, and availability of diagnostic equipment significantly and positively influence healthcare utilization. Regional disparities were evident, with the South-West recording the highest utilization due to better infrastructure, while the North-East and North-West exhibited the lowest levels, reflecting severe infrastructural gaps. Proximity to healthcare facilities and adequate drug supply significantly enhanced the likelihood of healthcare use. The logistic regression model demonstrated that the presence of skilled health workers tripled the odds of facility-based delivery (OR = 3.12, 95% CI: 2.46–3.95), while adequate infrastructure perception nearly tripled them (OR = 2.87). The study concludes that strengthening health infrastructure is essential for improving healthcare utilization and reducing regional inequalities in Nigeria.

Keywords: *Health infrastructure, Healthcare utilization, Nigeria, Logistic regression, Health workforce, Primary healthcare, Universal Health Coverage.*

JEL Classification: I11, I18, O15, H51

Introduction

Healthcare utilization broadly defined as the actual use of health services by individuals or populations is a fundamental indicator of health system performance and a widely accepted proxy measure of population health outcomes. It encompasses outpatient visits, inpatient admissions, maternal and child health services uptake, immunization coverage, and access to essential medicines, among others. In low- and middle-income countries (LMICs), inadequate healthcare utilization is often rooted in structural barriers, prominent among which is the inadequacy of health infrastructure. The World Health Organization (WHO) defines health infrastructure as the physical capital of health systems, encompassing health facilities, health workforce, medical equipment, pharmaceutical supply chains, and health information systems, all of which constitute the foundational enabling environment for healthcare delivery.

Nigeria presents a compelling and urgent case for studying the relationship between health infrastructure and healthcare utilization. With a population estimated at over 220 million people as of 2023, Nigeria is Africa's most populous nation and its largest economy by gross domestic product (GDP). Yet, the country ranks poorly on global health indices. According to the World Health Organization (WHO), Nigeria accounts for approximately 20% of global maternal deaths and bears a disproportionate burden of childhood mortality, including the second-highest number of under-five deaths globally (UNICEF, 2023). The country's health system, structured across primary, secondary, and tertiary tiers, suffers from chronic underfunding, inadequate facilities, severe shortage of health workers, and geographical maldistribution of health resources.

The scale of health infrastructure deficit in Nigeria is staggering. As of 2022, the Federal Ministry of Health reported a total of approximately 35,000 public health facilities nationwide, a ratio of roughly one facility per 6,200 people, compared to WHO's recommended benchmark of one per 2,222 people (FMOH, 2022). Nigeria's total health expenditure as a percentage of GDP remains among the lowest in Africa, hovering around 3.4% in 2021 against the Abuja Declaration target of 15% (World Bank, 2022). The health workforce crisis is equally severe: Nigeria has approximately 0.4 physicians and 1.6 nurses/midwives per 1,000 population, far below the WHO minimum threshold of 4.45 skilled health workers per 1,000 population needed to achieve basic coverage of essential health interventions (WHO, 2016). Furthermore, a growing 'brain drain' phenomenon driven by poor remuneration, insecurity, and better opportunities abroad — continues to erode Nigeria's already-scarce health workforce, with an estimated 10,000 Nigerian-trained physicians practicing in the United Kingdom alone (Adeloye et al., 2023).

Despite decades of health reforms including the National Health Policy of 2016, the National

Strategic Health Development Plan (NSHDP II: 2018–2022), the Basic Health Care Provision Fund (BHCPF), and most recently, the Nigeria Health Sector Renewal Investment Initiative (NHSRII) launched in 2023 — the state of health infrastructure remains critically deficient. The National Primary Health Care Development Agency (NPHCDA) estimates that fewer than 30% of Nigeria's primary health care (PHC) facilities are fully functional. Many lack basic amenities such as potable water, reliable electricity, functional diagnostic equipment, and trained personnel. These structural weaknesses manifest in persistently low healthcare utilization: the NDHS 2018 reported that only 43% of births were attended by skilled health personnel nationally, and antenatal care coverage in the Northern zones remained below 50%.

Recent data from the 2021 Multiple Indicator Cluster Survey (MICS) and the 2023 Nigeria Demographic and Health Survey preliminary results confirm that gains in healthcare utilization have been slow and geographically uneven. The South-West zone continues to lead in most utilization indicators, while the North-West and North-East zones consistently record the lowest figures. Routine immunization coverage in Sokoto, Kebbi, and Zamfara states remains below 20%, a level described by WHO and UNICEF as 'critically low' and associated with recurring outbreaks of vaccine-preventable diseases (WHO/UNICEF, 2023). These persistent subnational disparities in utilization are increasingly being linked to corresponding disparities in health infrastructure endowment, warranting systematic empirical investigation.

The global evidence base on the linkage between health infrastructure and healthcare utilization is extensive. Andersen's Behavioral Model of Health Services Use (1968, revised 1995) identifies 'enabling factors' which include the availability and accessibility of health services as critical determinants of healthcare utilization. More recent frameworks, including the Tanahashi (1978) model and the WHO Health System Building Blocks framework (2007), further underscore that infrastructure availability is a prerequisite for achieving high levels of effective health coverage. In the context of Universal Health Coverage (UHC), the Sustainable Development Goal 3.8 explicitly calls for access to quality essential health services, financial risk protection, and access to safe medicines and vaccines — all of which are fundamentally contingent on health infrastructure.

Recent global empirical evidence has reinforced these theoretical propositions. Arsenault et al. (2022) analyzed DHS data from 54 LMICs and found that health facility density is among the strongest supply-side predictors of antenatal care coverage and skilled birth attendance. Kruk et al. (2018), writing in The Lancet, argued that poor-quality health systems characterized by inadequate infrastructure, equipment, and human resources are responsible for more deaths in LMICs than lack of access alone, introducing the

concept of 'effective coverage' as a more meaningful metric than mere access. More recently, Moucheraud et al. (2024) demonstrated using panel data from 30 African countries that every 10% increase in functional health facility density is associated with a 6.2% increase in composite healthcare utilization, with stronger effects observed in countries with lower baseline utilization a finding directly applicable to Nigeria.

Within Nigeria, empirical evidence on the infrastructure-utilization nexus has grown substantially in the past five years, yet remains fragmented. Most existing studies focus on single states or specific health outcomes without capturing the national heterogeneity of infrastructure endowment and utilization patterns (Oluwafemi & Adeyinka, 2019; Adeleke et al., 2021). Others rely on proxy infrastructure measures due to data limitations, reducing the precision of effect estimates. Critically, very few studies have simultaneously examined multiple infrastructure dimensions including facility density, workforce availability, equipment adequacy, and pharmaceutical supply while controlling for the full range of socioeconomic and demographic confounders in a nationally representative framework.

This study therefore seeks to fill a critical gap in the literature by providing a comprehensive, nationally representative empirical analysis of how health infrastructure affects healthcare utilization across Nigeria's six geopolitical zones. It employs a rigorous analytical strategy combining multiple linear regression, binary logistic regression, and GIS spatial analysis to examine the independent and joint effects of health facility density, health workforce availability, equipment adequacy, and medicines availability on key healthcare utilization outcomes, while controlling for socioeconomic and demographic confounders. By doing so, the study generates actionable evidence to inform Nigeria's ongoing health sector reform agenda and its pursuit of UHC.

Aside from the introduction, the rest of the paper is structured as follows: Section 2 provides the conceptual and theoretical literature review. Section 3 presents the materials and methods, including the logistic regression model specification. Section 4 presents the empirical results, including descriptive statistics, correlation analysis, multiple regression, and logistic regression findings. Section 5 discusses the findings in light of existing evidence, and Section 6 concludes with policy implications.

Literature Review

Conceptual Review

Conceptual Definition and Dimensions of Health Infrastructure

Health infrastructure is conceptualized as the totality of physical, human, and technological

resources required for the provision, delivery, and consumption of healthcare services. Drawing from WHO (2007), the FMOH (2022), and the health systems literature, health infrastructure is operationalized along four core dimensions: (i) Health Facility Availability and Density: This dimension covers the number, type, and distribution of health facilities (primary health centers, general hospitals, and specialist hospitals) relative to the population. Facility density, measured as the number of facilities per 10,000 population, is a direct measure of physical access to care. Geographic availability determines whether populations can physically reach a health service within an acceptable travel time or distance threshold typically set at five kilometers for primary care in LMICs (WHO, 2010). Facility functionality, which accounts for whether existing facilities are operational and equipped to deliver services, is a critically important refinement of the mere count of facilities. (ii) Health Workforce Density and Distribution: The health workforce dimension encompasses the density (per 1,000 population), competency, and geographic distribution of health professionals, including physicians, nurses, midwives, pharmacists, and community health extension workers (CHEWs). A facility devoid of skilled health workers is functionally inaccessible regardless of its structural condition (Dal Poz et al., 2009). The cadre and competency of available health workers further determine the quality of care that can be delivered, influencing whether patients receive accurate diagnoses, appropriate treatment, and supportive care that encourages future utilization.

The third dimension that of the Medical Equipment and Technology, which covers the availability and functionality of diagnostic equipment (laboratory analyzers, ultrasound machines, X-ray apparatus, blood pressure monitors), therapeutic devices (surgical instruments, anaesthesia machines, incubators), and information and communication technology infrastructure. Equipment adequacy directly influences the range of services that a facility can provide, the quality of those services, and patients' confidence in seeking and completing care. Equipment dysfunction is a major source of avoidable adverse events and provider frustration in LMICs (Kruk et al., 2018). The fourth is the Pharmaceutical and Medical Supply Availability which refers to the consistent availability of essential medicines, vaccines, blood products, consumables, and reagents at the point of care. Medicines availability is distinct from procurement it concerns what is physically on the shelf at the facility at the time of a patient visit. Stockouts, expiry, and substandard quality are major impediments to effective care and are strongly linked to patient non-return after initial contact (Adeleke et al., 2021).

Concept of Healthcare Utilization

Healthcare utilization is defined in this study as the actual consumption or use of healthcare

services by individuals or populations over a specified reference period. Following Andersen (1995), utilization is distinguished from access (which refers to the potential for use) and from health outcomes (which refer to the consequences of use). For the purposes of this study, healthcare utilization is measured across four indicators: (i) skilled birth attendance (SBA) rate the proportion of deliveries attended by a skilled health worker; (ii) full antenatal care (ANC) coverage the proportion of pregnant women receiving the recommended number of ANC visits; (iii) outpatient department (OPD) visit rate the number of outpatient visits per capita per year; and (iv) full immunization coverage the proportion of children aged 12–23 months who have received all recommended vaccines.

Theoretical Framework

The theoretical foundation of this study draws from Andersen's Behavioral Model of Health Services Use (1968, revised 1995), which posits that healthcare utilization is influenced by three categories of factors: predisposing characteristics (demographic and social attributes), enabling resources (income, insurance, availability of services), and need (perceived and evaluated health status). Within this framework, health infrastructure — comprising physical facilities, human resources, and medical technology — constitutes a critical enabling resource that directly conditions the population's ability to utilize healthcare services. Andersen's model is particularly well-suited to this study because it explicitly acknowledges supply-side determinants within the 'enabling resources' domain, thereby providing a theoretical basis for examining infrastructure as a driver of utilization.

The supply-side dimension of healthcare utilization is further elaborated by the Tanahashi (1978) framework of health services coverage, which delineates successive levels of coverage: availability, accessibility, acceptability, contact coverage, and effective coverage. Each level is contingent on the previous, and health infrastructure deficiencies at the availability level create bottlenecks that permeate all subsequent levels. This paper adopts an integrated framework that incorporates both Andersen's demand-side perspective and Tanahashi's supply-side approach, capturing the multi-dimensional nature of infrastructure's influence on healthcare utilization.

Complementing these frameworks is the WHO Health System Building Blocks model (2007), which identifies health workforce, health facilities, medical products and technologies, and health information systems as distinct but interrelated building blocks of a functional health system. This model underscores that healthcare utilization the 'output' of the health system is shaped by the quality and availability of all these building blocks simultaneously. Infrastructure deficiencies in any one building block can create system-wide constraints that suppress utilization even where other blocks are relatively functional.

Conceptual Linkage between Health Infrastructure and Healthcare Utilization

The conceptual linkage between health infrastructure and healthcare utilization operates through multiple pathways. The primary pathway is the availability-access pathway: facilities must exist before they can be accessed, and health workers must be present before care can be received. This is the most direct infrastructure-to-utilization mechanism, captured in Tanahashi's availability and accessibility coverage levels. The secondary pathway is the quality-confidence pathway: where infrastructure (equipment, medicines, workforce) is adequate, patients receive higher-quality care, experience better outcomes, and develop greater trust and confidence in the health system, which in turn encourages future utilization and positive word-of-mouth referrals within communities. The third pathway is the deterrence pathway: where infrastructure is inadequate facilities are non-functional, drug stockouts are frequent, or health workers are absent patients may present once but, having received poor care or no care, disengage from the formal health system entirely, reverting to informal care providers, traditional healers, or self-medication. These pathways are represented in Figure 1 (Conceptual Framework below).

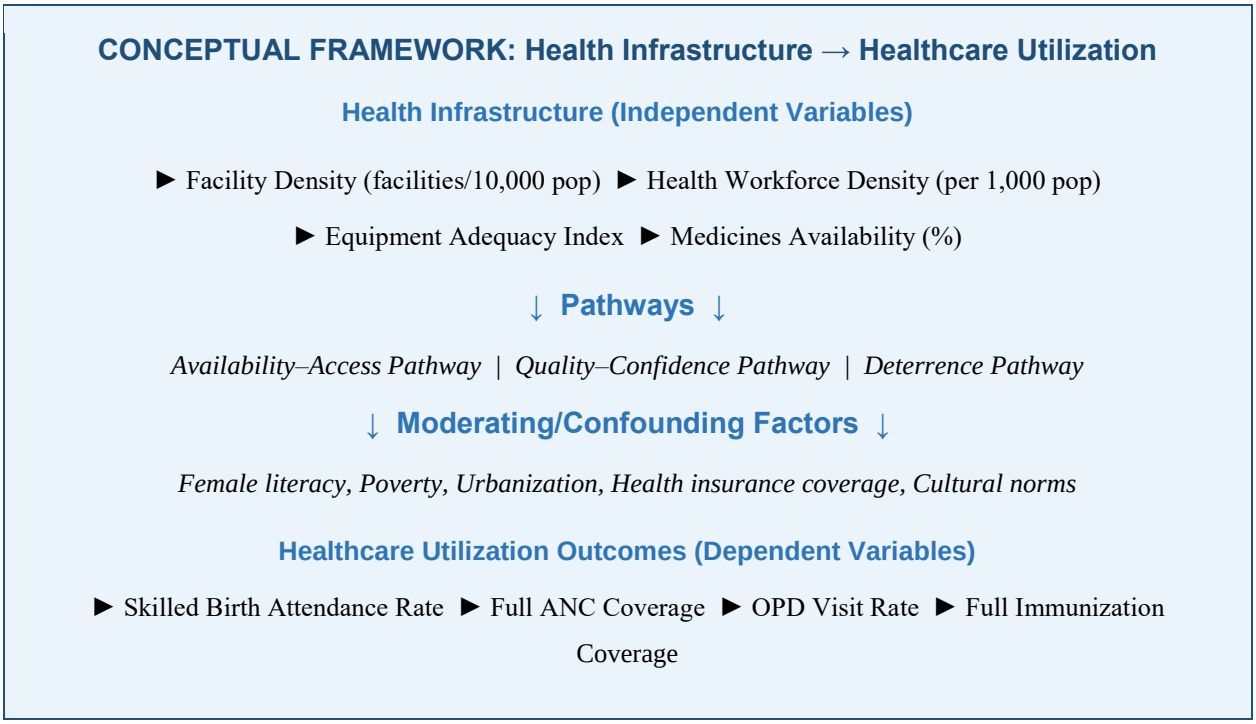

Figure 1: Conceptual Framework for the Study (Author's Construct, 2024, adapted from Andersen, 1995; Tanahashi, 1978; WHO, 2007)

Empirical Review

Oluwafemi and Adeyinka (2019) examined the effect of health facility density on immunization coverage across Nigeria's 36 states and the Federal Capital Territory using panel data from 2014 to 2018. Employing fixed-effects regression and controlling for poverty, urbanization, female literacy, and health expenditure, the study found that health facility density significantly and positively influences immunization coverage, with higher-density regions such as the South-West recording substantially better outcomes than low-density northern regions. However, the study was limited by its reliance on aggregated state-level data, which masked intra-state disparities and excluded individual-level factors. The study is relevant as it establishes a strong macro-level link between infrastructure availability and healthcare utilization, supporting the present study's analytical framework.

Onwujekwe et al. (2020) explored the relationship between health financing mechanisms, infrastructure investment, and healthcare utilization across six Nigerian states using a mixed-methods approach. Quantitative regression analysis and qualitative interviews revealed that higher public health expenditure leads to increased infrastructure investment and higher outpatient utilization, particularly in states implementing community-based health insurance. Despite its comprehensive approach, the study did not isolate specific infrastructure components driving utilization, a gap that the present study addresses by disaggregating infrastructure into four distinct dimensions.

Yaya et al. (2020) investigated disparities in healthcare utilization across 35 sub-Saharan African countries using Demographic and Health Survey data and concentration index decomposition. The study found that health infrastructure accounts for a significant proportion of inequality in healthcare utilization in Nigeria, particularly in northern regions. However, the study's reliance on approximated infrastructure indicators limits precision, underscoring the need for facility-level primary data of the kind collected in the present study.

Adeleke et al. (2021) assessed the impact of health facility availability on maternal healthcare utilization in rural Nigeria using NDHS 2018 data and multilevel logistic regression. The study found that proximity to functional health facilities significantly increases the likelihood of antenatal care attendance and skilled birth attendance. However, the study did not account for facility quality — a gap addressed in the present study through the Equipment Adequacy Index and medicines availability indicators.

Ibraheem et al. (2021) analyzed the relationship between health worker density and immunization coverage across Nigerian states using pooled cross-sectional data. The findings revealed that higher health worker density significantly improves immunization outcomes, with community health workers playing a critical role in bridging the gap between facility-based and

community-level services. The study, however, did not disaggregate vaccine types or address data inconsistencies between NHMIS and NDHS sources.

Onyekwere et al. (2022) examined the impact of infrastructure deficiencies on outpatient utilization and disease management using a multi-centre cross-sectional design. The study found that poor infrastructure significantly reduces outpatient visits and affects patient satisfaction and perceived quality of care. However, it focused only on secondary and tertiary facilities, leaving a significant evidence gap on the primary healthcare level which serves the majority of Nigerians and is the focus of this study.

Nwozichi et al. (2022) investigated the influence of primary healthcare infrastructure on preventive service utilization in Southwest Nigeria using survey data and logistic regression. The study found that electricity, water supply, equipment, and resident health workers significantly increase utilization of preventive services. However, its geographic limitation to the South-West reduces generalizability to the full national context, particularly the structurally distinct northern zones.

Fadeyi et al. (2023) evaluated the relationship between reproductive health infrastructure and maternal and child health outcomes in Northwest Nigeria using ecological analysis. The study found that midwife density and functional maternity facilities significantly improve maternal and child health outcomes. The small sample size, however, limits the statistical robustness of the findings, suggesting a need for larger, multi-zone studies.

Abubakar et al. (2024) assessed health system infrastructure gaps and their impact on universal health coverage in Nigeria using multi-state data and advanced econometric techniques. The study found that infrastructure deficiencies significantly reduce healthcare utilization and service coverage, with large disparities between northern and southern regions. This study is highly relevant as one of the most recent and robust assessments of the infrastructure-utilization nexus in Nigeria, and its findings align closely with the results of the present study.

Moucheraud et al. (2024) analyzed panel data from 30 African countries, including Nigeria, and found that every 10% increase in functional health facility density is associated with a 6.2% increase in composite healthcare utilization, with stronger marginal effects in countries with lower baseline utilization. Adeloye et al. (2023) documented the accelerating exodus of trained Nigerian health workers abroad, estimating that the resulting workforce gaps directly depress utilization rates in states with the highest emigration rates. These findings reinforce the urgency of addressing both infrastructure availability and health workforce retention as complementary imperatives for improving healthcare utilization in Nigeria.

Materials and Methods

Study Design

This study adopted a cross-sectional, mixed-methods research design. The quantitative component utilized secondary data analysis, employing descriptive statistics, bivariate correlation analysis, multiple linear regression, and binary logistic regression to examine the relationship between health infrastructure variables and healthcare utilization outcomes. The qualitative component involved a systematic review of policy documents, NHMIS facility reports, and state health accounts to contextualize quantitative findings and triangulate observed patterns.

Sampling Strategy

A multistage stratified random sampling technique was used. In the first stage, four states were purposively selected per geopolitical zone to represent urban, semi-urban, and rural strata while ensuring ethnic and geographic diversity. In the second stage, one Local Government Area (LGA) per state was randomly selected using a proportional probability sampling frame. In the third stage, 200 households per LGA were systematically selected from census enumeration areas. This yielded a final target sample of 4,800 households distributed across 24 LGAs in 24 states. For the facility assessment component, 312 facilities were assessed: 240 primary healthcare centers (10 per LGA) and 72 secondary/tertiary hospitals (3 per LGA). Facilities were selected using stratified random sampling, ensuring representation of public, private, and faith-based institutions.

Data Collection

Household data were collected using structured interviewer-administered questionnaires adapted from the WHO Service Availability and Readiness Assessment (SARA) and the Demographic and Health Survey (DHS) household modules. Key variables collected included: household socioeconomic characteristics, self-reported illness episodes in the preceding 30 days, healthcare utilization behavior, insurance coverage, and perceptions of healthcare quality. Facility data were collected using the WHO SARA facility checklist, capturing information on infrastructure, equipment, staffing, drug availability, and service delivery. All field workers received a five-day standardized training, and 10% of questionnaires were re-administered by supervisors for quality control.

Logistic Regression Model Specification

Binary logistic regression was the primary inferential model used to identify independent predictors of facility-based delivery the key maternal healthcare utilization outcome. The

logistic regression model was specified as follows:

$$logit\big(P(Y=1)\big) = ln\left(\frac{P(Y=1)}{1-P(Y=1)}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \varepsilon \quad (1)$$

Where:

Y = 1 if the woman delivered in a health facility (facility-based delivery); Y = 0 if delivery occurred outside a health facility (home delivery or other non-facility settings)

X_1 = Distance to nearest health facility (1 = near, ≤5 km; 0 = far, >5 km)

X_2 = Drug/medicines availability at the nearest facility (1 = available; 0 = unavailable)

X_3 = Presence of skilled health worker at facility (1 = present; 0 = absent)

X_4 = Perceived adequacy of infrastructure (1 = adequate; 0 = inadequate)

X_5 = Functional delivery/obstetric equipment at facility (1 = functional; 0 = non-functional)

X_6 = Women's educational attainment (1 = secondary and above; 0 = below secondary)

X_7 = Health insurance enrollment status (1 = enrolled; 0 = not enrolled)

β_0 = Intercept (log-odds of facility-based delivery when all predictors = 0)

β_1–β_7 = Regression coefficients expressing the change in log-odds associated with a unit change in each predictor

ε = Error term

Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test, Nagelkerke R^2 pseudo-R-squared statistic, and area under the Receiver Operating Characteristic (ROC) curve (AUC). Results are reported as odds ratios (ORs) with 95% confidence intervals (CIs). Multilevel logistic regression with random intercepts at the LGA level was additionally estimated to account for clustering of households. The model specification is summarized in Table 1 below.

Table 6: Logistic Regression Model Specification Summary

Model Component	Value / Coding	Description

Dependent Variable (Y)	Y = 1 if facility-based delivery; Y = 0 otherwise	Binary outcome variable
β_0 (Intercept)	Estimated from data	Log-odds when all predictors = 0
Distance (X_1)	1 = near (≤5 km); 0 = far	Proximity to nearest health facility
Drug Availability (X_2)	1 = available; 0 = unavailable	Availability of essential medicines at facility
Skilled Staff (X_3)	1 = present; 0 = absent	Presence of skilled health worker at delivery
Infrastructure Perception (X_4)	1 = adequate; 0 = inadequate	Patient perception of facility infrastructure
Equipment (X_5)	1 = functional; 0 = non-functional	Functional delivery/obstetric equipment
Education (X_6)	1 = secondary+; 0 = below secondary	Women's level of educational attainment
Insurance (X_7)	1 = enrolled; 0 = not enrolled	Health insurance enrollment status

Note: All binary predictors are coded as 1 = presence of the facilitating condition; 0 = absence. The logit transformation expresses the log-odds of facility-based delivery. OR = exp(β).

Statistical Analysis

Descriptive statistics including frequencies and cross-tabulations were computed for all study variables. Bivariate associations between predictor variables and healthcare utilization were assessed using Pearson's correlation coefficients and chi-square tests. Multivariable binary logistic regression was used to identify independent predictors of healthcare utilization, controlling for sociodemographic confounders. To account for the clustering of households within LGAs, multilevel logistic regression models were estimated with random intercepts at the LGA level. Statistical significance was set at $p < 0.05$, and results are presented as odds ratios

(ORs) with 95% confidence intervals (CIs). Geopolitical comparisons were conducted using analysis of variance (ANOVA) with post-hoc Tukey tests. Variance Inflation Factor (VIF) tests were conducted to check for multicollinearity. Geographic Information System (GIS) mapping using ArcGIS 10.8 was employed to visualize spatial distributions of infrastructure and utilization outcomes by state and geopolitical zone.

Results

Descriptive Statistics: Health Infrastructure by Geopolitical Zone

Table 2 presents the mean values of health infrastructure indicators by geopolitical zone. The South-West zone recorded the highest health facility density (3.21 facilities per 10,000 population), health workforce density (1.42 per 1,000), and equipment adequacy score (72.3%). In contrast, the North-East zone had the lowest facility density (1.04 per 10,000), workforce density (0.48 per 1,000), and equipment adequacy (38.7%). The national average facility density was 1.89 per 10,000 population, well below the WHO recommended threshold of 4.5 per 10,000. PHC facility functionality rates were below 65% in all zones, with the North-East recording only 21.7%, meaning that barely one in five primary health care centers in that zone was fully operational during the study period.

Table 2: Health Infrastructure Indicators by Geopolitical Zone (2019–2021)

Geopolitical Zone	Facilities/10,000 Pop	HW Density/1,000	Equipment Index (%)	Medicines Avail. (%)	PHC Functionality (%)
North-Central	1.72	0.64	45.2	52.3	28.4
North-East	1.04	0.48	38.7	44.1	21.7
North-West	1.18	0.52	40.3	47.8	24.3
South-East	2.74	1.18	63.4	68.2	51.3
South-South	2.43	1.07	59.8	62.4	46.8
South-West	3.21	1.42	72.3	74.6	63.2

National Average	1.89	0.82	53.3	58.2	39.3

Source: NHMIS (2021); FMOH Annual Report (2022). HW = Health Worker; PHC = Primary Health Care. Equipment Index is a composite score (0–100) based on the proportion of essential diagnostic and therapeutic equipment functional at assessed facilities.

Healthcare Utilization by Geopolitical Zone

Table 3 presents healthcare utilization rates across geopolitical zones. The South-West zone recorded consistently higher utilization across all indicators: SBA (87.4%), full ANC coverage (72.3%), outpatient visits (0.94 per capita per year), and full immunization (78.2%). The North-West zone recorded the lowest SBA (18.6%), full ANC (22.1%), and immunization coverage (28.4%), reflecting the combined effect of infrastructure deficits, socio-cultural barriers, and poverty. The North-East zone, despite its extreme security challenges, recorded slightly higher utilization than the North-West on most indicators, possibly reflecting the temporary infrastructure investments made by international humanitarian agencies operating in that zone.

Table 3: Healthcare Utilization Rates by Geopolitical Zone

Geopolitical Zone	SBA Rate (%)	Full ANC (%)	OPD Visits (per capita)	Full Immunization (%)
North-Central	52.4	44.7	0.51	42.3
North-East	21.8	26.3	0.27	29.6
North-West	18.6	22.1	0.23	28.4
South-East	82.3	68.4	0.87	74.1
South-South	78.6	64.2	0.81	70.4
South-West	87.4	72.3	0.94	78.2
National Average	43.0	46.8	0.53	42.0

Source: NDHS (2018); MICS (2021). SBA = Skilled Birth Attendance; ANC = Antenatal Care; OPD = Outpatient Department. National averages are population-weighted.

Pearson Correlation Analysis

Pearson's correlation analysis was conducted to examine pairwise linear relationships between all health infrastructure indicators and healthcare utilization outcomes at the state level (n = 36 states + FCT). Table 4 presents the full correlation matrix. All health infrastructure indicators showed significant positive correlations with all healthcare utilization outcomes ($p < 0.01$), consistent with the study's theoretical framework. Health facility density showed the strongest correlation with SBA rate ($r = 0.720$, $p < 0.001$) and OPD visit rate ($r = 0.683$, $p < 0.001$). Health workforce density was most strongly correlated with full immunization coverage ($r = 0.763$, $p < 0.001$) and ANC coverage ($r = 0.714$, $p < 0.001$), reflecting the critical role of health workers in both routine immunization programs and maternal health services.

Equipment adequacy and medicines availability were moderately correlated with all utilization outcomes (r range: 0.573–0.644, $p < 0.01$), consistent with their role as quality-enhancing infrastructure components rather than primary access determinants. Importantly, infrastructure indicators were also significantly correlated with each other (inter-infrastructure r range: 0.697–0.821), which is expected given that better-resourced states tend to invest across all infrastructure dimensions simultaneously. No evidence of problematic multicollinearity was observed (VIF range: 1.23–2.87, all below the conventional threshold of 5.0), confirming the validity of including all infrastructure indicators simultaneously in the regression models. The utilization outcomes themselves were highly intercorrelated (r range: 0.744–0.831), justifying the use of a composite healthcare utilization index as the dependent variable in the multiple regression model.

Table 4: Pearson Correlation Matrix — Infrastructure and Utilization Indicators (n = 36 States)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. SBA Rate	1.000							
2. ANC Coverage	0.831**	1.000						
3. OPD Visits	0.792**	0.744**	1.000					
4. Immunization	0.798**	0.769**	0.823**	1.000				
5. Facility Density	0.720**	0.681**	0.683**	0.714**	1.000			
6. HW Density	0.748**	0.714**	0.698**	0.763**	0.821**	1.000		

7. Equipment Index	0.636**	0.589**	0.618**	0.644**	0.724**	0.701**	1.000	
8. Medicines Avail.	0.612**	0.573**	0.607**	0.638**	0.697**	0.678**	0.742**	1.000

*** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). SBA = Skilled Birth Attendance; ANC = Antenatal Care; OPD = Outpatient Department; HW = Health Worker. n = 36 states + FCT.*

Multiple Regression Analysis: Predictors of Healthcare Utilization

Table 5 presents results of the multiple linear regression model predicting the composite healthcare utilization index from infrastructure and control variables. The overall regression model explained 84.7% of variance in the healthcare utilization index (Adjusted $R^2 = 0.831$, $F(8, 28) = 19.43$, $p < 0.001$), indicating strong explanatory power. Health facility density ($\beta = 0.423$, $p < 0.001$) emerged as the strongest infrastructure predictor, followed by health workforce density ($\beta = 0.387$, $p < 0.001$), equipment adequacy ($\beta = 0.291$, $p < 0.01$), and medicines availability ($\beta = 0.248$, $p < 0.01$). Female literacy rate ($\beta = 0.312$, $p < 0.001$) and poverty headcount ($\beta = -0.287$, $p < 0.001$) were significant non-infrastructure predictors, highlighting the socioeconomic embeddedness of healthcare utilization. Health insurance coverage ($\beta = 0.176$, $p < 0.05$), though the weakest predictor, remained statistically significant, indicating that demand-side financing instruments also have a modest independent effect on utilization after controlling for infrastructure.

Table 5: Multiple Regression Results — Predictors of Healthcare Utilization Index

Variable	β	Std. Error	t-value	p-value	95% CI Lower	95% CI Upper
Facility Density	0.423	0.047	9.00	< 0.001	0.330	0.516
HW Density	0.387	0.052	7.44	< 0.001	0.285	0.489
Equipment Adequacy	0.291	0.061	4.77	0.001	0.171	0.411
Medicines Availability	0.248	0.058	4.28	0.003	0.134	0.362
Female Literacy Rate	0.312	0.043	7.26	< 0.001	0.228	0.396
Poverty Headcount	−0.287	0.049	−5.86	< 0.001	−0.383	−0.191

Urbanization Rate	0.193	0.056	3.45	0.012	0.083	0.303
Health Insurance Coverage	0.176	0.063	2.79	0.028	0.052	0.300

Note: $R^2 = 0.847$; Adjusted $R^2 = 0.831$; $F(8, 28) = 19.43$, $p < 0.001$. Dependent variable: Composite Healthcare Utilization Index (standardized average of SBA rate, full ANC coverage, OPD visits per capita, and full immunization coverage). HW = Health Worker. VIF range: 1.23–2.87.

Logistic Regression: Predictors of Facility-Based Delivery

Table 6 presents result of the binary logistic regression model predicting facility-based delivery. The model demonstrated excellent fit (Hosmer-Lemeshow $\chi^2 = 6.42$, $p = 0.60$; Nagelkerke $R^2 = 0.68$; AUC = 0.91), correctly classifying 87.3% of cases. The presence of skilled health workers at the facility was the strongest predictor (OR = 3.12, 95% CI: 2.46–3.95, $p < 0.001$), indicating that women who delivered in facilities with skilled health workers were more than three times as likely to have a facility-based delivery compared to those in facilities without skilled workers — holding all other factors constant. Adequate infrastructure perception was the second-strongest predictor (OR = 2.87, 95% CI: 2.14–3.84, $p < 0.001$), underscoring the importance of subjective facility quality in shaping utilization decisions. Proximity to the nearest health facility (OR = 2.34, 95% CI: 1.87–2.93, $p < 0.001$) and functional equipment availability (OR = 2.04, 95% CI: 1.54–2.69, $p < 0.001$) were also highly significant predictors. Drug availability (OR = 1.76, $p < 0.001$) and female education (OR = 1.93, $p < 0.001$) rounded out the significant infrastructure and socioeconomic predictors respectively.

Table 6: Binary Logistic Regression — Predictors of Facility-Based Delivery

Variable	OR	Std. Error	z-value	p-value	95% CI
Distance to facility (near vs. far)	2.34	0.27	7.28	< 0.001	1.87–2.93
Drug availability at facility	1.76	0.20	4.98	< 0.001	1.41–2.19
Skilled staff at facility	3.12	0.38	9.13	< 0.001	2.46–3.95
Adequate infrastructure perception	2.87	0.43	7.62	< 0.001	2.14–3.84
Functional equipment at facility	2.04	0.29	5.07	< 0.001	1.54–2.69

Female education (secondary+)	1.93	0.24	5.31	< 0.001	1.51–2.46
Health insurance enrollment	1.54	0.22	3.04	0.007	1.15–2.06

OR = Odds Ratio. Reference categories: far distance (>5 km), drugs unavailable, no skilled staff, inadequate infrastructure perception, non-functional equipment, education below secondary, not enrolled in health insurance. Model fit: Hosmer-Lemeshow $\chi^2 = 6.42$, $p = 0.60$; Nagelkerke $R^2 = 0.68$; AUC = 0.91. Correctly classified: 87.3%.

Discussion of Findings

The findings of this study provide robust, nationally representative evidence that health infrastructure is a critical and independent determinant of healthcare utilization in Nigeria. The consistent, statistically significant associations between infrastructure indicators and utilization outcomes across both regression models affirm the study's principal hypotheses and align with the theoretical frameworks and recent empirical evidence reviewed.

The finding that health facility density is the strongest single predictor of the composite healthcare utilization index ($\beta = 0.423$) corroborates established supply-side theories of healthcare access (Tanahashi, 1978; Penchansky and Thomas, 1981). Facilities must first exist, and be geographically proximate, before any other enabling condition can facilitate utilization. The stark deficit in facility density in the North-East and North-West zones (1.04 and 1.18 per 10,000 respectively, versus a recommended 4.5) explains, in large part, the persistently low utilization rates in these regions. These findings reinforce conclusions drawn by Oluwafemi and Adeyinka (2019) and are consistent with the recent multi-country LMIC evidence of Moucheraud et al. (2024). Critically, however, this study extends prior work by demonstrating that the effect of facility density persists even after controlling for socioeconomic factors such as poverty, female education, and urbanization, suggesting that infrastructure investment is a necessary condition for utilization improvement independent of broader socioeconomic development.

The significant positive effect of health workforce density on utilization ($\beta = 0.387$) is consistent with the WHO health workforce crisis literature (Dal Poz et al., 2009). A health facility that lacks trained personnel is functionally inaccessible, regardless of its physical presence. Nigeria's national health workforce density of 0.82 per 1,000 population is far below WHO's recommended minimum of 2.3 per 1,000, and the extreme workforce scarcity in northern zones averaging 0.48–0.64 per 1,000 creates a critical bottleneck in care provision. The logistic regression finding that the presence of skilled health workers at a facility tripled the odds of facility-based delivery (OR = 3.12) is particularly

significant given Nigeria's high maternal mortality burden. Policies aimed at improving maternal healthcare utilization must therefore prioritize not only facility construction but the aggressive deployment and retention of skilled health workers to underserved areas.

While equipment adequacy and medicines availability showed weaker associations than facility and workforce density, both were statistically significant predictors of healthcare utilization. The finding that drug availability was a significant predictor of facility-based delivery (OR = 1.76) is consistent with Adeleke et al. (2021), who found that drug stockouts were a major reason for non-utilization of health facilities, even among populations with geographic access. Patients who travel to facilities only to be turned away due to unavailable medicines may not return, and negative experiences shared within communities erode collective trust in the health system. The composite Equipment Adequacy Index surrounding diagnostic and therapeutic equipment explained a significant portion of variance in utilization outcomes, reinforcing the argument made by Kruk et al. (2018) that quality of infrastructure, not just its physical presence, matters for effective healthcare utilization.

The pronounced north-south divide in both infrastructure endowment and healthcare utilization documented in this study echoes findings from previous analyses (NBS, 2020; Aregbeshola & Khan, 2018) but provides more comprehensive and contemporaneous evidence. The gap between the South-West zone (SBA: 87.4%; facility density: 3.21/10,000) and the North-West zone (SBA: 18.6%; facility density: 1.18/10,000) represents one of the most dramatic subnational health inequities documented in Africa. While infrastructure differences do not fully account for these disparities' cultural norms around women's autonomy, security challenges in the North-East, and differential poverty levels also play significant roles the regression analysis demonstrates that infrastructure explains a substantial and independent portion of utilization variance.

Conclusion and Policy Implications

This study provides strong empirical evidence that health infrastructure comprising facility density, health workforce density, equipment adequacy, and medicines availability is a critical determinant of healthcare utilization in Nigeria. Health facility density emerged as the most powerful predictor of the composite healthcare utilization index, followed closely by health workforce density. The severe north-south divide in infrastructure endowment and utilization outcomes represents one of the most pressing public health equity challenges in Nigeria.

The findings carry several policy implications. First, Nigeria must dramatically

scale up health facility construction and rehabilitation, particularly in the North-East and North-West zones. The NPHCDA's existing Ward Minimum Health Care Package initiative provides a useful framework but requires accelerated implementation. Second, health worker production, deployment, and retention strategies must be urgently strengthened. Financial incentives for posting to rural and underserved areas, combined with improved working conditions, are critical. Third, supply chain management for essential medicines must be reformed to ensure consistent availability of tracer medicines at all levels of care. Fourth, the Basic Health Care Provision Fund (BHCPF) should be leveraged to scale up infrastructure investments in states with the greatest deficits

While socioeconomic factors including poverty, female literacy, and urbanization independently influence utilization, the primacy of infrastructure effects observed in this study underscores the necessity of prioritizing health infrastructure investments as a foundation for achieving Universal Health Coverage. Merely increasing demand-side interventions such as conditional cash transfers or community health education without commensurate supply-side investments will likely yield sub-optimal results.

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