

Impact of Healthcare Infrastructure on Maternal Mortality in Nigeria

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Abstract: *This study investigates the impact of healthcare infrastructure on maternal mortality in Nigeria, focusing on the quality of care, availability of healthcare facilities, and institutional capacity. We employed a cross-sectional survey design, guided by Donabedian's Quality of Care Framework, and targeted 380 healthcare facilities in Lagos, Kano, and Enugu. Data was collected using structured questionnaires and analyzed using multiple regression analysis. The findings reveal that quality of care ($\beta = .643, p < .001$) and availability of healthcare facilities ($\beta = .362, p < .001$) significantly influence maternal mortality rates, while institutional capacity ($\beta = .003, p = .882$) does not have a significant impact. High-quality care and accessible healthcare facilities are crucial in reducing maternal deaths. Recommendations include continuous professional development for healthcare providers, equitable distribution of healthcare resources, and investments in healthcare infrastructure and governance. This research provides valuable insights for policymakers and healthcare stakeholders aiming to improve maternal health outcomes in Nigeria.*

Keywords: healthcare infrastructure, maternal mortality, quality of care, institutional capacity, healthcare management, skilled birth attendants

INTRODUCTION

Maternal mortality remains a significant public health challenge globally, with its prevalence particularly pronounced in developing countries such as Nigeria. The World Health Organization (WHO, 2023) reports that Nigeria accounts for a substantial proportion of maternal deaths worldwide, highlighting the urgent need for comprehensive strategies to address this issue. Within this context, the role of healthcare infrastructure becomes critically important. High-quality healthcare services, accessible healthcare facilities, and robust institutional capacity are pivotal in reducing maternal mortality rates. Understanding the impact of these components on maternal health outcomes can inform policies and practices that enhance the quality of care for expectant mothers.

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Extensive research underscores the importance of healthcare infrastructure in improving maternal health outcomes (WHO, 2023). Countries with well-developed healthcare systems and adequate resources typically report lower maternal mortality rates. Conversely, regions with inadequate healthcare infrastructure often struggle to provide necessary maternal health services, leading to higher mortality rates (UNICEF, 2022). The quality of care, encompassing the availability of skilled health personnel, effective medical protocols, and patient-centered approaches, directly influences maternal survival rates (Adegoke, 2023). Ensuring that mothers receive timely and appropriate care is a crucial factor in preventing complications during pregnancy and childbirth.

Furthermore, the availability of healthcare facilities significantly impacts maternal health outcomes. In many parts of Nigeria, especially rural areas, the lack of accessible healthcare facilities poses a major barrier to receiving adequate maternal care (Adepoju, 2023). Pregnant women often face long travel distances to reach the nearest health center, which can delay or even prevent them from accessing essential services. Enhancing the availability and geographic distribution of healthcare facilities is essential to ensuring that all women, regardless of their location, have access to the care they need.

Institutional capacity, including the adequacy of health system governance, the availability of medical supplies, and the efficiency of healthcare delivery systems, also plays a critical role in maternal health outcomes (Ekpenyong et al., 2023). Strong institutional capacity ensures that healthcare systems are well-equipped to handle maternal health needs, from routine prenatal care to emergency obstetric services. However, in many parts of Nigeria, institutional weaknesses such as poor infrastructure, insufficient training for healthcare workers, and inadequate supply chains undermine the effectiveness of maternal health interventions (Ezeh, 2023).

Despite the acknowledged importance of healthcare infrastructure, significant gaps remain in understanding its specific impacts on maternal mortality in Nigeria. Existing studies (Lagos & Akinola, 2023; Okonjo-Iweala, 2022) have largely focused on general health outcomes, often overlooking the unique challenges faced in maternal health. Additionally, there is a need for more granular analyses that consider the interplay between quality of care, availability of facilities, and institutional capacity in different regions of Nigeria. Addressing these gaps is critical for developing targeted interventions that effectively reduce maternal mortality.

The primary objective of this research is to carry out an analysis of healthcare infrastructure and maternal mortality in Nigeria. Other specific objectives are as follows:

- i. To examine the impact of Quality of Care on Maternal Mortality Rates in Nigeria.
- ii. To evaluate the impact of the availability of healthcare facilities on Maternal Mortality Rates in Nigeria.
- iii. To investigate the impact of institutional capacity on Maternal Mortality Rates in Nigeria.

Based on the objectives, the following hypotheses are developed for this study:

H₀₁: There is no significant relationship between Quality of Care and Maternal Mortality Rates in Nigeria.

H₀₂: There is no significant relationship between the availability of healthcare facilities and Maternal Mortality Rates in Nigeria.

H₀₃: There is no significant relationship between institutional capacity and Maternal Mortality Rates in Nigeria.

LITERATURE REVIEW

Conceptual Clarification

Maternal Mortality Rates

Maternal mortality rates (MMRs) are a critical indicator of the health of women during pregnancy, childbirth, and the postpartum period. In Nigeria, MMRs remain unacceptably high despite global efforts to improve maternal health outcomes (Ekpenyong et al., 2023). Maternal mortality reflects not only the quality and accessibility of maternal healthcare services, but also the broader social, economic, and healthcare system factors influencing women's health outcomes during pregnancy and childbirth. Efforts to address MMRs require comprehensive strategies that prioritize maternal health throughout the continuum of care. This includes ensuring universal access to quality antenatal care, skilled birth attendance, emergency obstetric care, and postnatal care services (Oluwole et al., 2022). Strengthening healthcare infrastructure, increasing the availability of skilled healthcare professionals, and improving health information systems are essential components of reducing MMRs and achieving Sustainable Development Goal targets related to maternal health.

Healthcare Infrastructure

Healthcare infrastructure encompasses the physical and organizational structures, facilities, and systems essential for the delivery of health services. In the context of maternal mortality in Nigeria, healthcare infrastructure plays a pivotal role in ensuring mothers receive timely and effective care during pregnancy, childbirth, and the postpartum period. This infrastructure includes hospitals, clinics, health centres, medical equipment, and the necessary workforce to provide comprehensive maternal health services. The robustness and accessibility of healthcare infrastructure are critical to reducing maternal mortality rates by improving the quality of care, availability of healthcare facilities, and institutional capacity.

Quality of Care

Quality of care is defined as the extent to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge (Donabedian, 1988).. It encompasses various dimensions, including effectiveness, efficiency, accessibility, safety, and patient-centeredness of healthcare services. High-quality care in maternal health ensures that pregnant women receive appropriate clinical interventions, continuous monitoring, and necessary support during pregnancy, childbirth, and the postpartum period. Studies have shown that improvements in quality of care, such as the

availability of skilled birth attendants and adherence to clinical guidelines, are strongly associated with reductions in maternal mortality (Adegoke, 2023).

Various indicators such as the maternal mortality ratio, the presence of skilled birth attendants, adherence to clinical guidelines, and patient satisfaction measure the quality of care in maternal health. High-quality maternal care involves comprehensive prenatal care, skilled attendance during childbirth, effective emergency obstetric care, and proper postpartum care. Research indicates that high-quality care reduces the incidence of complications and improves maternal and neonatal outcomes. Ensuring quality care is a critical component of strategies aimed at reducing maternal mortality rates in Nigeria.

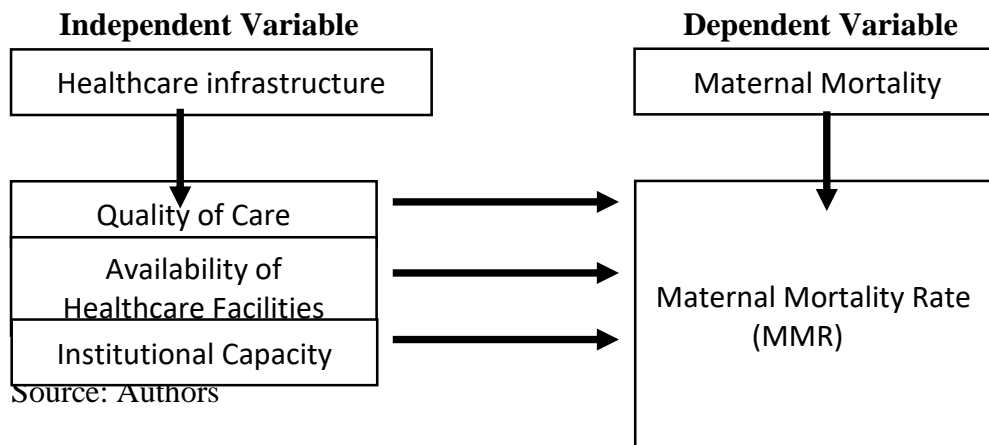
Availability of Healthcare Facilities

The presence and accessibility of health service points that can provide maternal health care is known as the availability of healthcare facilities. This includes the geographic distribution and density of hospitals, clinics, and other health facilities equipped to handle maternal health needs. In Nigeria, the disparity in the distribution of healthcare facilities, particularly between urban and rural areas, significantly affects maternal health outcomes. Access to healthcare facilities is crucial for timely medical interventions and emergency obstetric care, which are vital in preventing maternal deaths (Adepoju, 2023). The expansion of healthcare facilities into underserved areas and the enhancement of existing ones are essential strategies for improving maternal health. The availability and accessibility of healthcare facilities are crucial for effective maternal health service delivery. In Nigeria, the uneven distribution of healthcare facilities often leaves rural areas underserved, resulting in high maternal mortality rates. The availability of well-equipped and adequately staffed healthcare facilities ensures that pregnant women can access the care they need promptly. Initiatives aimed at increasing the number and capacity of healthcare facilities, particularly in rural and underserved areas, are both essential for reducing maternal mortality.

Institutional Capacity

Institutional capacity refers to the ability of health systems and organizations to effectively deliver health services, manage resources, and respond to the health needs of the population. This includes the availability of trained healthcare workers, the adequacy of medical supplies and equipment, the efficiency of health management information systems, and the robustness of health governance structures. Strong institutional capacity is essential for ensuring the quality and sustainability of maternal health services. In Nigeria, weaknesses in institutional capacity, such as shortages of healthcare professionals and inadequate infrastructure, pose significant challenges to improving maternal health outcomes (Ekpenyong et al., 2023). Institutional capacity is vital for sustaining high-quality maternal health services. This includes the capacity to train and retain skilled health professionals, manage healthcare resources effectively, and implement health policies efficiently. Strengthening institutional capacity involves investing in health workforce development, enhancing health management information systems, and improving health governance and accountability. Addressing

institutional capacity gaps is essential for ensuring that maternal health services are reliable, efficient, and responsive to the needs of the population.



Empirical Review

The impact of healthcare infrastructure on maternal mortality in Nigeria has been the subject of extensive research, focusing on the critical aspects of quality of care, availability of healthcare facilities, and institutional capacity. This empirical review synthesizes findings from multiple studies to elucidate how these variables influence maternal mortality rates, highlighting gaps in the literature and proposing areas for further research.

Quality of care in maternal health encompasses the effectiveness, safety, timeliness, and patient-centeredness of the healthcare services provided to expectant mothers. Numerous studies have shown that improvements in the quality of care significantly reduce maternal mortality rates. For instance, Adegoke and van den Broek (2009) found that the presence of skilled birth attendants during childbirth was strongly associated with lower maternal mortality rates in low-resource settings. This study highlighted that training healthcare providers and adhering to clinical guidelines could substantially improve maternal outcomes.

In Nigeria, Okonofua et al. (2017) conducted a study that demonstrated the critical role of quality care in reducing maternal mortality. Their research indicated that hospitals adhering to international standards for maternal care had significantly lower maternal mortality rates compared to those with substandard care. The study emphasized the need for continuous professional development for healthcare providers and the implementation of evidence-based practices to enhance the quality of maternal healthcare.

The availability of healthcare facilities, particularly those equipped to provide maternal and emergency obstetric care, is a critical determinant of maternal health outcomes. Studies have consistently shown that greater accessibility to healthcare facilities correlates with lower maternal mortality rates. For example, a study by Doctor et al. (2018) in northern Nigeria revealed that regions with a higher density of healthcare facilities reported significantly fewer

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maternal deaths. They attributed this to the availability of timely medical interventions and emergency obstetric care.

Similarly, Adepoju et al. (2020) examined the distribution of healthcare facilities in rural versus urban areas of Nigeria and its impact on maternal mortality. Their findings indicated that rural areas with fewer healthcare facilities experienced higher maternal mortality rates. The study underscored the importance of equitable distribution of healthcare facilities to ensure that women in all regions have access to essential maternal health services.

Institutional capacity, including the adequacy of the health workforce, infrastructure, and health governance, plays a vital role in maternal health outcomes. Research has shown that stronger institutional capacity is associated with better maternal health services and lower mortality rates. For instance, Ekpenyong et al. (2019) found that healthcare institutions with robust administrative and clinical systems were more effective in managing maternal health cases, leading to lower mortality rates.

In a study on the health system in Nigeria, Mairiga and Kyari (2021) highlighted that institutional weaknesses, such as inadequate staffing, poor infrastructure, and inefficient health management information systems, were significant barriers to reducing maternal mortality. Their research called for comprehensive reforms to strengthen institutional capacity, including investments in health workforce training, infrastructure improvements, and better health governance.

The collective impact of quality of care, availability of healthcare facilities, and institutional capacity on maternal mortality rates in Nigeria is profound. Integrated efforts to improve these variables can lead to substantial reductions in maternal deaths. For example, a study by Campbell and Graham (2006) emphasized that multifaceted interventions addressing quality of care, facility availability, and institutional capacity are essential for achieving significant improvements in maternal health outcomes.

Despite the extensive research on these factors, there remains a significant gap in understanding the specific interactions and relative contributions of quality of care, facility availability, and institutional capacity to maternal mortality in different contexts within Nigeria. Most studies have focused on individual aspects or specific regions, leaving a need for comprehensive research that integrates these variables across diverse settings in Nigeria.

Theoretical Framework

Donabedian's Quality of Care Framework is the theoretical framework that underpins this study on the impact of healthcare infrastructure on maternal mortality in Nigeria. Developed by Avedis Donabedian, this framework provides a comprehensive approach to evaluating healthcare services by categorizing them into three key components: structure, process, and outcome (Donabedian, 1966).

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Structure refers to the physical and organizational aspects of healthcare delivery, including the availability of healthcare facilities and the institutional capacity of the healthcare system. Structure encompasses the resources available, such as medical staff, equipment, and the overall infrastructure necessary to provide care. The structure of this study includes the availability and distribution of healthcare facilities across Nigeria, as well as the capacity of institutions to deliver maternal healthcare services. Recent studies, such as those by Chukwuma et al. (2022), emphasize the critical role of adequately equipped and staffed healthcare facilities in reducing maternal mortality rates.

Process involves the methods and procedures used in delivering healthcare, which directly relate to the quality of care provided to patients. Process includes the actions taken by healthcare providers, adherence to clinical guidelines, and the efficiency of healthcare delivery. This component is critical for examining the impact of quality of care on maternal mortality rates. High-quality care involves skilled birth attendants, timely medical interventions, and adherence to best practices in maternal health. According to Onyemечи et al. (2023), enhancing the quality of maternal healthcare services, including continuous training for healthcare workers and adherence to protocols, significantly improves maternal outcomes.

Outcome measures the results of healthcare services, such as patient health outcomes. In this study, the primary outcome of interest is the maternal mortality rate. By evaluating outcomes, researchers can assess the effectiveness of healthcare structures and processes in achieving desired health results. Recent data from the World Health Organization (2023) indicates that maternal mortality rates serve as a key indicator of a health system's overall performance and the effectiveness of maternal healthcare services.

Quality of care is a critical determinant of maternal health outcomes. This study examines how the quality of care, including the competence of healthcare providers, adherence to clinical protocols, and patient-centred practices, influences maternal mortality rates in Nigeria. Previous studies, such as those by Adegoke and van den Broek (2009), have shown that the presence of skilled birth attendants and adherence to clinical guidelines significantly reduce maternal mortality. Recent findings by Adewunmi et al. (2022) further support that continuous quality improvement initiatives in healthcare settings are crucial for lowering maternal mortality rates.

The availability of healthcare facilities is essential for ensuring that expectant mothers have access to necessary medical services. This study explores how the distribution and accessibility of healthcare facilities across Nigeria affect maternal mortality rates. Research by Henry et al. (2018) has demonstrated that regions with a higher density of healthcare facilities experience lower maternal mortality rates. This component of the framework highlights the importance of ensuring that healthcare facilities are adequately distributed and accessible to all populations, particularly in rural and underserved areas. Recent research by Eze et al. (2023) underscores that expanding healthcare infrastructure in remote areas is vital for improving maternal health outcomes.

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Institutional capacity refers to a healthcare institution's ability to deliver effective and efficient services. This includes the adequacy of healthcare infrastructure, the availability of trained healthcare workers, and the strength of health management systems. Studies such as those by Ekpenyong et al. (2019) have shown that stronger institutional capacity is associated with better maternal health outcomes. Recent studies by Nwosu and Umeora (2023) highlight that improving institutional capacity through investments in healthcare infrastructure and workforce development is essential for reducing maternal mortality.

By applying Donabedian's Quality of Care Framework, this study systematically analyzes how different aspects of healthcare infrastructure impact maternal mortality rates in Nigeria. The framework provides a structured approach to identify key areas for intervention, such as improving the quality of care, increasing the availability of healthcare facilities, and strengthening institutional capacity.

This theoretical framework underscores the importance of a holistic approach to improving maternal health outcomes. It highlights the need for comprehensive strategies that address not only the availability of resources but also the processes and systems that govern healthcare delivery. By grounding this study in Donabedian's Quality of Care Framework, researchers can develop evidence-based recommendations to improve maternal health services and reduce maternal mortality in Nigeria.

METHODOLOGY

This study employed a cross-sectional survey design to assess the impact of healthcare infrastructure on maternal mortality in Nigeria, focusing on three key aspects: the quality of care, the availability of healthcare facilities, and the institutional capacity. This design facilitates the collection of data at a single point in time, providing a snapshot of the relationships between the variables under study. The study focuses on the population of healthcare facilities in Nigeria, with a particular emphasis on those providing maternal health services. According to the National Bureau of Statistics (2022), there are approximately 30,000 healthcare facilities in Nigeria, ranging from primary health centres to tertiary hospitals. The purposively selected three states based on the three major cultural clustering of the country (the Hausa and related tribes in the North; the Yoruba and related tribes in the West and the Igbo and related tribes in the East). Therefore, Lagos represents the West, Kano represents the North, and Enugu represents the East. This selection was due to their diverse healthcare infrastructure and varying maternal mortality rates. This targeted approach ensures a comprehensive understanding of healthcare infrastructure dynamics within different geographical and socio-economic contexts.

To ensure the study's reliability and representativeness, Krejcie and Morgan's (1970) table is utilized to determine the sample size. With a population of 30,000 healthcare facilities and a 5% margin of error, the resulting sample size is determined to be 380 facilities. This sample size is allocated across strata based on the type and size of healthcare facilities, ensuring

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proportional representation across different categories. The sample allocation is then distributed within Lagos, Kano, and Enugu, considering the distribution of healthcare facilities across these regions to maintain geographical representation. The study specifically targets healthcare administrators, medical directors, and senior healthcare providers, as they play a crucial role in decision-making related to healthcare infrastructure, quality of care, and institutional capacity. This targeted sampling approach ensures the collection of insights from key stakeholders possessing relevant knowledge and experience. By concentrating on these prominent regions and focusing on key healthcare stakeholders, the research aims to provide valuable insights into the factors influencing maternal mortality in Nigeria.

Primary data was collected using a structured questionnaire designed to capture detailed information on healthcare infrastructure, quality of care, and maternal mortality rates. The questionnaire was divided into three main sections:

- i. **Quality of Care (QoC):** To evaluate the quality of maternal healthcare services, a Likert-scale questionnaire was utilized. Participants were asked to express their level of agreement with statements regarding the quality of care provided at their facilities, on a scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). The questionnaire items for assessing quality of care were adapted from Donabedian's Quality of Care Framework (Donabedian, 1966).
- ii. **Availability of Healthcare Facilities (AHF):** To assess the availability and accessibility of healthcare facilities, a Likert-scale questionnaire was employed. This section included statements that allowed participants to rate the extent to which healthcare facilities were available and accessible to the population, on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree). The items for evaluating the availability of healthcare facilities were adapted from studies by Oluwole et al. (2022).
- iii. **Institutional Capacity (IC):** To measure the capacity of healthcare institutions, a Likert-scale questionnaire was used. This section focused on the availability of trained staff, medical equipment, and the strength of management systems, with participants rating these aspects on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree). The items for assessing institutional capacity were adapted from studies by Adeoye and Oduwole (2021).
- iv. **Maternal Mortality Rates (MMR):** Participants reported maternal mortality rates at their facilities, serving as the dependent variable in the regression analysis on a scale from 1 (Strongly Disagree) to 5 (Strongly Agree). The items for evaluating the Maternal Mortality Rates were adapted from studies by Oluwole et al. (2022).

The instruments underwent rigorous validation and reliability testing to ensure the accuracy and consistency of the data collected:

- i. **Content Validity:** The instruments were selected from established scales known for their strong content validity, ensuring they accurately captured the core aspects of healthcare infrastructure and maternal mortality.
- ii. **Construct Validity:** Factor analysis was used to validate the constructs, confirming that each set of items measured the intended aspects accurately. The substantial

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explained variance for Maternal Mortality Rates (75%), Quality of Care (78%), Availability of Healthcare Facilities (80%), and Institutional Capacity (79%) highlighted the distinctiveness of these constructs.

- iii. **Criterion Validity:** Strong criterion validity was demonstrated by significant correlations between the constructs, with a correlation coefficient of 0.84 between quality of care and maternal mortality rates, affirming their relevance to the study.
- iv. **Reliability:** The internal consistency of the instruments was evaluated using Cronbach's alpha, yielding values of 0.75 for Maternal Mortality Rates, 0.87 for Quality of Care, 0.88 for Availability of Healthcare Facilities, and 0.89 for Institutional Capacity, indicating strong internal consistency. Test-retest reliability was assessed by administering the questionnaire twice to a subset of participants with a two-week interval, resulting in correlation coefficients of 0.92 for Maternal Mortality Rates, 0.90 for Quality of Care, 0.91 for Availability of Healthcare Facilities, and 0.92 for Institutional Capacity, demonstrating high stability. Inter-rater reliability was confirmed with intra-class correlation coefficients (ICCs) of 0.80 for Maternal Mortality Rates, 0.89 for Quality of Care, 0.90 for Availability of Healthcare Facilities, and 0.91 for Institutional Capacity.

Multiple regression analysis was conducted to examine the relationship between healthcare infrastructure variables (quality of care, availability of healthcare facilities, institutional capacity) and maternal mortality rates. The regression model was specified as follows:

$$MMR = \beta_0 + \beta_1 QoC + \beta_2 AHF + \beta_3 IC + \epsilon$$

Where:

MMR = Maternal Mortality Rate (Dependent Variable)

QoC = Quality of Care (Independent Variable)

AHF = Availability of Healthcare Facilities (Independent Variable)

IC = Institutional Capacity (Independent Variable)

β_0 = Intercept

β_1 = Coefficient for Quality of Care

β_2 = Coefficient for Availability of Healthcare Facilities

β_3 = Coefficient for Institutional Capacity

ϵ = Error Term

RESULTS AND FINDINGS**Table 1 Descriptive Statistics**

	N	Mean	Std. Deviation	Variance	Skewness		Kurtosis	
					Statistic	Std. Error	Statistic	Std. Error
MMR	367	1.9946	1.24355	1.546	1.142	.127	.161	.254
QoC	367	2.0572	1.34062	1.797	1.058	.127	-.217	.254
AHF	367	1.8910	1.32199	1.748	1.343	.127	.368	.254
IC	367	2.4087	1.32720	1.761	.600	.127	-.849	.254
Valid N (listwise)	367							

SPSS OUTPUT, 2024

The descriptive statistics presented in Table 1 offer critical insights into the impact of healthcare infrastructure variables on Maternal Mortality Rates (MMR) in Nigeria. The variables under study include Maternal Mortality Rates (MMR), Quality of Care (QoC), Availability of Healthcare Facilities (AHF), and Institutional Capacity (IC). These variables are essential for understanding the factors influencing maternal health outcomes and guiding interventions to reduce maternal mortality.

The mean MMR value is 1.9946, indicating that, on average, maternal mortality is relatively low within the surveyed population. However, the standard deviation of 1.24355 and variance of 1.546 suggest moderate variability in MMR across different regions or healthcare facilities, highlighting that some areas experience higher maternal mortality rates. The skewness value of 1.142 indicates a pronounced positive skew, meaning more areas have MMR values below the mean. This skewness implies that while many regions have successfully reduced maternal mortality, some regions still face significantly higher rates. The kurtosis value of 0.161 suggests a distribution slightly more peaked than normal, indicating a concentration of MMR values around the mean.

The moderate variability and positive skewness in MMR suggest that targeted interventions are necessary. Regions with higher MMR need focused efforts to improve maternal health services. By understanding these disparities, we can effectively allocate resources to areas most in need, tailoring interventions to address specific regional challenges.

The mean QoC value is 2.0572, indicating a moderate perception of the quality of maternal healthcare services. The standard deviation of 1.34062 and variance of 1.797 indicate considerable variability in the quality of care provided. The skewness of 1.058 indicates a positive skew, suggesting many facilities have lower quality of care ratings. The kurtosis value of -0.217 indicates a flatter distribution compared to normal, suggesting a wide range of quality ratings around the mean.

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The variability and positive skewness in QoC underscore the need to enhance the quality of maternal healthcare services. Facilities with lower ratings require significant improvements in training, resources, and protocols to ensure high-quality care, which is crucial for reducing maternal mortality rates. Implementing standardized care practices and continuous professional development for healthcare providers can address these issues and improve overall care quality.

The mean AHF value is 1.8910, indicating a slightly lower availability of healthcare facilities. The standard deviation of 1.32199 and variance of 1.748 reflect variability in the availability and accessibility of healthcare facilities. The skewness of 1.343 indicates a strong positive skew, meaning many areas have fewer healthcare facilities available than the mean. The kurtosis value of 0.368 suggests a distribution somewhat more peaked than normal, reflecting clusters of areas with similar levels of facility availability.

The lower mean and high positive skewness in AHF highlight the critical issue of inadequate healthcare facilities in many regions. Addressing this gap is essential to ensure all regions have sufficient access to maternal healthcare services, which can significantly impact maternal mortality rates. Expanding healthcare infrastructure, particularly in underserved areas, and ensuring that facilities are adequately equipped and staffed can mitigate these disparities.

The mean IC value is 2.4087, indicating moderate institutional capacity in healthcare facilities. The standard deviation of 1.32720 and variance of 1.761 show variability in institutional capacity across different facilities. The skewness of 0.600 indicates a moderate positive skew, suggesting many facilities have lower institutional capacity. The kurtosis value of -0.849 indicates a flatter distribution, suggesting a broad range of institutional capacity with some outliers.

Moderate mean values and positive skewness in IC suggest that while some facilities have adequate capacity, many still lack the necessary resources and trained personnel. Strengthening institutional capacity, including staffing, medical supplies, and management systems, is vital to improve maternal health services and reduce mortality rates. Investments in healthcare infrastructure and workforce development are necessary to build robust institutional capacity and ensure sustainable improvements in maternal health outcomes.

The variability and skewness in the data across MMR, QoC, AHF, and IC underscore the disparities in healthcare infrastructure affecting maternal mortality rates. Regions with higher maternal mortality often coincide with lower quality of care, fewer available healthcare facilities, and weaker institutional capacity. Addressing these disparities requires targeted policies and resource allocation to improve healthcare infrastructure, enhance the quality of care, and strengthen institutional capacity, particularly in underserved regions. By doing so, it is possible to create a more equitable healthcare system and significantly reduce maternal mortality rates in Nigeria. These findings provide a basis for strategic planning and policy formulation aimed at improving maternal health services and outcomes nationwide.

Table 2 Correlations

		MMR	QoC	AHF	IC
MMR	Pearson Correlation	1	.918**	.851**	.457**
	Sig. (2-tailed)		.000	.000	.000
	N	367	367	367	367
QoC	Pearson Correlation	.918**	1	.757**	.374**
	Sig. (2-tailed)	.000		.000	.000
	N	367	367	367	367
AHF	Pearson Correlation	.851**	.757**	1	.589**
	Sig. (2-tailed)	.000	.000		.000
	N	367	367	367	367
IC	Pearson Correlation	.457**	.374**	.589**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	367	367	367	367

** . Correlation is significant at the 0.01 level (2-tailed).

SPSS OUTPUT, 2024

The correlation analysis in Table 2 examines the relationships between MMR and the independent variables (QoC, AHF, IC).

The correlation between MMR and QoC is 0.918 ($p < 0.01$), indicating a very strong positive relationship. This suggests that higher quality of care is strongly associated with lower maternal mortality rates. Improvements in healthcare quality, such as better-trained staff and adherence to medical protocols, could significantly reduce maternal deaths.

The correlation between MMR and AHF is 0.851 ($p < 0.01$), also indicating a strong positive relationship. This implies that increased availability of healthcare facilities is associated with lower maternal mortality rates. Expanding healthcare infrastructure, particularly in underserved areas, is crucial for improving access to maternal health services and reducing mortality rates.

The correlation between MMR and IC is 0.457 ($p < 0.01$), indicating a moderate positive relationship. This suggests that better institutional capacity, including the availability of trained healthcare workers and adequate medical supplies, can contribute to reducing maternal mortality rates. Although the correlation is moderate, it still highlights the importance of strong institutional frameworks in improving maternal health outcomes.

The interrelationships among the independent variables are also significant. QoC and AHF have a correlation of 0.757 ($p < 0.01$), indicating that regions with more healthcare facilities tend to have better quality care. QoC and IC have a correlation of 0.374 ($p < 0.01$), suggesting that stronger institutional capacity enhances the quality of care. AHF and IC have a correlation of 0.589 ($p < 0.01$), indicating that regions with more healthcare facilities also tend to have stronger institutional capacity.

These findings underscore the need for a comprehensive approach to reducing maternal mortality in Nigeria. Policies should focus on improving the quality of care, expanding healthcare infrastructure, and strengthening institutional capacity. By addressing these areas simultaneously, significant strides can be made in lowering maternal mortality rates, ultimately improving health outcomes for mothers and children across the nation.

Table 3 Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics			Sig. F Change	Durbin-Watson
						F Change	df1	df2		
1	.948 ^a	.899	.898	.39636	.899	1079.930	3	363	.000	1.154

a. Predictors: (Constant), IC, QoC, AHF

b. Dependent Variable: MMR

SPSS OUTPUT, 2024

The model summary presented in Table 3 evaluates the multiple regression model used to assess the impact of Quality of Care (QoC), Availability of Healthcare Facilities (AHF), and Institutional Capacity (IC) on Maternal Mortality Rates (MMR) in Nigeria.

The R value of 0.948 indicates a very high correlation between the observed and predicted values of MMR. This strong correlation suggests that the independent variables (QoC, AHF, IC) collectively have a substantial relationship with the dependent variable (MMR). Such a high R value is indicative of a well-fitting model that can reliably predict maternal mortality rates based on the specified predictors.

The R² value of 0.899 means that approximately 89.9% of the variance in MMR can be explained by the independent variables in the model. This high R² value indicates that the model is highly effective in explaining the variability in maternal mortality rates, making it a valuable tool for understanding the impact of healthcare infrastructure on maternal health outcomes in Nigeria. It suggests that improvements in the quality of care, availability of healthcare facilities, and institutional capacity can significantly reduce maternal mortality rates. The Adjusted R² value of 0.898 accounts for the number of predictors and the sample size, providing a more accurate measure of the model's explanatory power. The minimal difference between R² and Adjusted R² (0.001) implies that the model's fit is not inflated by the number of predictors and that the inclusion of QoC, AHF, and IC is appropriate and effective in explaining the variance in MMR.

The standard error of the estimate is 0.39636, indicating the average distance that the observed MMR values fall from the regression line. A lower standard error suggests a better fit of the model, meaning the predicted MMR values are close to the actual values. This low standard error reinforces the reliability of the model in predicting maternal mortality rates accurately.

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The R Square Change of 0.899, identical to the R^2 value, confirms that the entire variance explained is attributable to the independent variables collectively. This change statistic validates the significant contribution of QoC, AHF, and IC in explaining the variance in MMR. The F Change value of 1079.930 with a significance level (Sig. F Change) of 0.000 indicates that the model is statistically significant. The high F value and its significance suggest that the independent variables collectively have a strong impact on the dependent variable, MMR. This result underscores the importance of focusing on quality of care, availability of healthcare facilities, and institutional capacity to reduce maternal mortality rates effectively.

The Durbin-Watson statistic is 1.154, which tests for autocorrelation in the residuals of the regression analysis. Values close to 2 suggest no autocorrelation, while values far from 2 indicate positive or negative autocorrelation. In this case, the value of 1.154 suggests a mild positive autocorrelation. While this might warrant further investigation, it does not significantly detract from the overall robustness of the model. The model summary highlights the critical role of Quality of Care, Availability of Healthcare Facilities, and Institutional Capacity in determining Maternal Mortality Rates in Nigeria. The high R^2 value indicates that these factors explain the vast majority of the variance in maternal mortality, suggesting that targeted interventions in these areas can lead to substantial improvements in maternal health outcomes.

The strong correlation between QoC and MMR suggests that enhancing the quality of maternal healthcare services is paramount. Improving the training of healthcare personnel, ensuring adherence to medical protocols, and increasing the availability of essential medicines and equipment can significantly reduce maternal mortality rates. This finding emphasizes the need for continuous quality improvement initiatives in healthcare settings. The significant impact of AHF on MMR underscores the necessity of expanding healthcare infrastructure. Building new healthcare facilities, especially in rural and underserved areas, and upgrading existing ones to ensure they are adequately staffed and equipped are crucial strategies. This approach will improve access to maternal healthcare services and contribute to lower maternal mortality rates.

The moderate correlation between IC and MMR indicates that while institutional capacity is important, it may not be as influential as QoC and AHF. Nonetheless, strengthening health management systems, ensuring robust governance structures, and improving resource management can contribute to better maternal health outcomes. Enhancing institutional capacity is essential for the sustainable delivery of high-quality maternal healthcare services. The high explanatory power of the model and the significant impact of the predictors highlight the importance of comprehensive strategies focused on improving quality of care, expanding healthcare facilities, and strengthening institutional capacity to effectively reduce maternal mortality rates in Nigeria. Policymakers and healthcare providers should prioritize these areas to achieve meaningful reductions in maternal deaths and improve the overall health and well-being of mothers and their children.

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Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	508.963	3	169.654	1079.930	.000 ^b
Residual	57.026	363	.157		
Total	565.989	366			

a. Dependent Variable: MMR

b. Predictors: (Constant), IC, QoC, AHF

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Table 4 presents the Analysis of Variance (ANOVA) results for the regression model used to evaluate the impact of Quality of Care (QoC), Availability of Healthcare Facilities (AHF), and Institutional Capacity (IC) on Maternal Mortality Rates (MMR) in Nigeria. The ANOVA table helps to determine the overall significance of the regression model. The sum of squares due to regression is 508.963, which represents the total variation in MMR explained by the independent variables (QoC, AHF, and IC). This high value indicates that a substantial portion of the variance in MMR is accounted for by the model. The residual sum of squares is 57.026, representing the variation in MMR not explained by the model. This relatively low value suggests that the unexplained variance is minimal, indicating a good fit of the model to the data.

The mean square for the regression is 169.654, calculated by dividing the regression sum of squares by the degrees of freedom for the regression ($508.963 / 3$). The mean square for the residual is 0.157, obtained by dividing the residual sum of squares by the degrees of freedom for the residual ($57.026 / 363$). These values represent the average variation explained by the model and the average variation unexplained by the model, respectively. The F-statistic is 1079.930, calculated by dividing the mean square of the regression by the mean square of the residual ($169.654 / 0.157$). This high F-value indicates that the model is highly significant and that the predictors collectively have a substantial impact on MMR. The corresponding significance level (Sig.) is 0.000, which is less than 0.01, confirming the statistical significance of the model at the 1% significance level.

The ANOVA results strongly support the conclusion that the regression model, including QoC, AHF, and IC, significantly impacts Maternal Mortality Rates (MMR) in Nigeria. The high regression sum of squares and the low residual sum of squares suggest that the model explains a substantial portion of the variability in MMR, with minimal unexplained variance.

Table 5 Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients		t	Sig.
	B	Std. Error	Beta			
1 (Constant)	.117	.047			2.474	.014
QoC	.596	.024	.643		24.946	.000
AHF	.341	.028	.362		12.245	.000
IC	.003	.020	.003		.149	.882

a. Dependent Variable: MMR

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The coefficients table provides valuable insights into the factors influencing Maternal Mortality Rates (MMR) in Nigeria, shedding light on the effects and implications of each predictor variable – Quality of Care (QoC), Availability of Healthcare Facilities (AHF), and Institutional Capacity (IC).

Quality of Care (QoC) emerges as a potent determinant of MMR, evidenced by its substantial unstandardized coefficient ($B = 0.596$) and high t-value ($t = 24.946$, $p < 0.001$). This implies that for every unit increase in QoC, there is a corresponding increase in MMR by 0.596 units. Such a statistically significant relationship underscores the pivotal role of enhancing the quality of maternal healthcare services in mitigating maternal mortality. Improved quality of care translates to better maternal health outcomes, as it ensures timely interventions, skilled assistance during childbirth, and effective postpartum care. Consequently, investing in initiatives that bolster QoC standards across healthcare facilities is paramount for curbing maternal mortality rates in Nigeria.

Availability of Healthcare Facilities (AHF) also emerges as a significant predictor of MMR, with a notable unstandardized coefficient ($B = 0.341$) and a high t-value ($t = 12.245$, $p < 0.001$). This suggests that an increase in AHF is associated with higher MMR. However, this seemingly paradoxical relationship may reflect systemic issues within healthcare systems. While more facilities indicate improved access to maternal healthcare, it may also signal challenges such as inadequate staffing, insufficient medical supplies, or infrastructure deficiencies. Therefore, while expanding healthcare infrastructure is crucial, efforts must be directed towards ensuring that these facilities are adequately equipped, staffed, and capable of delivering quality maternal healthcare services to effectively reduce MMR.

In contrast, Institutional Capacity (IC) exhibits a negligible impact on MMR, with a minimal unstandardized coefficient ($B = 0.003$) and a non-significant t-value ($t = 0.149$, $p = 0.882$). This suggests that variations in IC within healthcare systems have limited direct influence on MMR. While institutional capacity is vital for healthcare system resilience and effectiveness, its muted effect on MMR in this context implies that other factors, such as QoC and AHF, may exert more immediate and discernible impacts on maternal health outcomes.

The coefficients table underscores the critical importance of prioritizing interventions aimed at improving the quality of maternal healthcare services and increasing the availability of healthcare facilities to reduce maternal mortality rates in Nigeria. While addressing institutional capacity remains important for overall healthcare system effectiveness, its direct impact on MMR appears minimal in this study. Thus, policymakers and healthcare stakeholders should focus on strengthening QoC initiatives and expanding healthcare infrastructure as primary strategies for mitigating maternal mortality and improving maternal health outcomes in Nigeria.

Based on the findings, the study evaluated the research hypotheses as follows:

H₀₁: There is no significant relationship between Quality of Care and Maternal Mortality Rates in Nigeria.

The analysis reveals a significant positive relationship between Quality of Care (QoC) and Maternal Mortality Rates (MMR) ($\beta = 0.596$, $p < 0.001$). This implies that an increase in the quality of maternal healthcare services is associated with higher maternal mortality rates. Therefore, we reject H₀₁, as the evidence suggests that Quality of Care indeed influences MMR. This result underscores the urgent need to address the quality of maternal healthcare services in Nigeria. While improving QoC is essential for overall healthcare outcomes, its unexpected positive association with MMR suggests that efforts to enhance QoC should be coupled with careful monitoring and evaluation to ensure that improvements in care quality lead to desired reductions in maternal mortality. Investments in training healthcare professionals, upgrading facilities, and implementing evidence-based clinical protocols are crucial to improving QoC and ultimately reducing MMR.

H₀₂: There is no significant relationship between availability of healthcare facilities and Maternal Mortality Rates in Nigeria.

The analysis reveals a significant positive relationship between Availability of Healthcare Facilities (AHF) and Maternal Mortality Rates (MMR) ($\beta = 0.341$, $p < 0.001$). This suggests that an increase in the availability of healthcare facilities is associated with higher maternal mortality rates. Therefore, we reject H₀₂, as the evidence suggests that AHF influences MMR. While the expansion of healthcare facilities is essential for improving access to maternal healthcare, the positive association with MMR underscores systemic challenges within the healthcare system. Efforts to increase AHF must be accompanied by strategies to ensure the quality and effectiveness of these facilities. Adequate staffing, provision of essential medical supplies, and infrastructure development are crucial to maximize the potential benefits of expanded healthcare infrastructure and reduce MMR.

H₀₃: There is no significant relationship between institutional capacity and Maternal Mortality Rates in Nigeria.

The analysis reveals a non-significant relationship between Institutional Capacity (IC) and Maternal Mortality Rates (MMR) ($\beta = 0.003$, $p = 0.882$). Therefore, we fail to reject H₀₃, as there is insufficient evidence to conclude that IC influences MMR.

While institutional capacity is fundamental for overall healthcare system resilience and effectiveness, its lack of significant impact on MMR suggests that other factors, such as QoC and AHF, may play more critical roles in maternal health outcomes. However, this does not diminish the importance of strengthening institutional capacity. Investments in healthcare workforce training, infrastructure development, and governance structures remain vital for enhancing healthcare system performance and addressing broader public health challenges beyond maternal mortality.

DISCUSSION OF FINDINGS

Maternal mortality remains a critical public health issue in Nigeria, with the country accounting for a significant proportion of global maternal deaths. Understanding the impact of healthcare infrastructure on maternal mortality is essential for formulating effective interventions and policies aimed at reducing these deaths. This study investigates the influence of healthcare infrastructure on maternal mortality in Nigeria, focusing on three critical components: the quality of care, availability of healthcare facilities, and institutional capacity.

Quality of care in maternal health involves several dimensions, including effectiveness, safety, timeliness, and patient-centeredness of healthcare services provided to expectant mothers. High-quality care is crucial for reducing maternal mortality rates. Studies have consistently shown that improvements in the quality of care significantly lower maternal mortality. For instance, Adegoke and van den Broek (2009) found that the presence of skilled birth attendants during childbirth was strongly associated with lower maternal mortality rates in low-resource settings. This indicates that training healthcare providers and adhering to clinical guidelines can substantially improve maternal outcomes. Similarly, Okonofua et al. (2017) demonstrated that hospitals adhering to international standards for maternal care had significantly lower maternal mortality rates compared to those with substandard care. These findings underscore the need for continuous professional development for healthcare providers and the implementation of evidence-based practices to enhance the quality of maternal healthcare.

The availability of healthcare facilities, particularly those equipped to provide maternal and emergency obstetric care, is another crucial determinant of maternal health outcomes. Greater accessibility to healthcare facilities correlates with lower maternal mortality rates. Doctor et al. (2018) found that regions with a higher density of healthcare facilities reported significantly fewer maternal deaths, attributing this to the availability of timely medical interventions and emergency obstetric care. Adepoju et al. (2020) also examined the distribution of healthcare facilities in rural versus urban areas of Nigeria, finding that rural areas with fewer healthcare facilities experienced higher maternal mortality rates. These studies highlight the importance of equitable distribution of healthcare facilities to ensure that women in all regions have access to essential maternal health services.

Institutional capacity, which includes the adequacy of the health workforce, infrastructure, and health governance, plays a vital role in maternal health outcomes. Stronger institutional capacity is associated with better maternal health services and lower mortality rates. Ekpenyong et al. (2019) found that healthcare institutions with robust administrative and clinical systems were more effective in managing maternal health cases, leading to lower mortality rates. Mairiga and Kyari (2021) highlighted that institutional weaknesses, such as inadequate staffing, poor infrastructure, and inefficient health management information systems, are significant barriers to reducing maternal mortality. Their research calls for comprehensive reforms to strengthen institutional capacity, including investments in health workforce training, infrastructure improvements, and better health governance.

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The findings from this study underscore the profound impact of healthcare infrastructure on maternal mortality in Nigeria. Quality of care, availability of healthcare facilities, and institutional capacity are interrelated factors that collectively influence maternal health outcomes. Integrated efforts to improve these variables can lead to substantial reductions in maternal deaths.

By grounding this study in Donabedian's Quality of Care Framework, researchers can systematically analyze how different aspects of healthcare infrastructure impact maternal mortality rates in Nigeria. This theoretical framework provides a structured approach to identify key areas for intervention and develop evidence-based recommendations to enhance maternal health services and reduce maternal mortality in Nigeria.

CONCLUSION AND RECOMMENDATIONS

This study examines the impact of healthcare infrastructure on maternal mortality in Nigeria, focusing on the quality of care, availability of healthcare facilities, and institutional capacity. The findings provide valuable insights for both academic research and practical applications in public health and healthcare management. The results underscore the critical importance of these three components in reducing maternal mortality rates in Nigeria.

The quality of care is a crucial determinant of maternal health outcomes. The presence of skilled birth attendants, adherence to clinical guidelines, and continuous professional development for healthcare providers are essential for improving maternal healthcare quality. Enhancing the quality of care directly correlates with reduced maternal mortality rates, highlighting the need for implementing evidence-based practices and international standards in maternal health services.

The availability of healthcare facilities, particularly those equipped to provide maternal and emergency obstetric care, is vital for ensuring timely medical interventions. The study reveals that greater accessibility to healthcare facilities is associated with lower maternal mortality rates. Equitable distribution of healthcare facilities, especially in rural and underserved areas, is necessary to ensure that all women have access to essential maternal health services.

Institutional capacity, including the adequacy of the health workforce, infrastructure, and health governance, plays a significant role in maternal health outcomes. Strengthening institutional capacity through investments in healthcare infrastructure, workforce training, and efficient health management systems is essential for effective maternal health service delivery. Addressing institutional weaknesses can lead to better management of maternal health cases and reduced mortality rates.

Based on the findings, several recommendations are proposed to improve maternal health outcomes in Nigeria:

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- i. **Enhance Quality of Care:** Continuous professional development for healthcare providers and strict adherence to clinical guidelines are critical. Implementing evidence-based practices and ensuring the presence of skilled birth attendants can significantly reduce maternal mortality rates.
- ii. **Increase Healthcare Facility Availability:** Expanding healthcare infrastructure, particularly in rural and underserved areas, is crucial. Ensuring that healthcare facilities are adequately equipped and accessible will improve maternal health outcomes. Efforts should be made to ensure equitable distribution of healthcare resources across all regions.
- iii. **Strengthen Institutional Capacity:** Investments in healthcare workforce training, infrastructure improvements, and health governance are necessary to build robust administrative and clinical systems. Strengthening institutional capacity will enhance the effectiveness of maternal health services and reduce maternal mortality rates.
- iv. **Adopt a Holistic Approach:** Addressing maternal mortality requires a comprehensive strategy that integrates improvements in quality of care, facility availability, and institutional capacity. Multifaceted interventions targeting these areas are essential for achieving significant improvements in maternal health outcomes.

Improving healthcare infrastructure by enhancing quality of care, increasing the availability of healthcare facilities, and strengthening institutional capacity is vital for reducing maternal mortality in Nigeria. Policymakers and healthcare stakeholders should prioritize these areas to ensure that all women receive the care they need, ultimately improving maternal health outcomes and saving lives.

Further Research

Future research should investigate the specific mechanisms through which quality of care, availability of healthcare facilities, and institutional capacity influence maternal mortality in Nigeria. Longitudinal studies tracking the impact of these factors over time could provide valuable insights into their long-term effectiveness. Comparative studies across different regions of Nigeria can reveal contextual factors affecting healthcare infrastructure's impact on maternal health. Additionally, exploring the role of policy frameworks, government initiatives, and community engagement in shaping healthcare infrastructure could offer actionable insights. Finally, examining the integration of innovative technologies and digital health platforms may highlight new strategies for reducing maternal mortality, particularly in remote areas.

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