LASU INTERNATIONAL JOURNAL OF MARKETING (LAIJOM)

ASSESSMENT OF MEDICAL INTERVENTIONS AND HEALTHCARE FACILITIES IN REDUCING UNDER-FIVE MORTALITY RATES IN NIGERIA

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ABSTRACT

The article explores the influence of medical interventions and healthcare facilities on under-five mortality rates in Nigeria, using data from 1991 to 2022 sourced from World Bank World Development Indicators database. Data were analysed using the Fully Modified Least Squares technique. The result shows that health personnel exerts an insignificant negative effect on under-five mortality rates while access to child healthcare shows a significant negative effect on under-five mortality rates. Finally, the result shows that public expenditure on health does not affect under-five mortality rates while out of pocket health expenditure shows a statistically significant negative effect on under-five mortality rates. It was submitted that access to child healthcare and out of pocket health expenditure reduce under-five mortality rates while availability of health personnel and public expenditure do not affect under-five mortality rates. Thus, there is the need to expand access to affordable and quality child healthcare services through UHC initiatives to reduce under-five mortality rates.

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Keywords: Fully Modified Least Squares, Health care infrastructure, Public health expenditure, Under five mortality rates, Universal Health Coverage

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1. Introduction

Reducing under-five mortality is a critical global health challenge, particularly in low- and middle-income countries (LMICs) like Nigeria. Despite global efforts, under-five mortality rates remain alarmingly high in many LMICs. Nigeria, with one of the highest under-five mortality ratios globally, exemplifies the stark disparities between developed and developing nations. These disparities are largely driven by inadequate medical care, a shortage of skilled medical professionals, and inadequate healthcare facilities (Fernandes et al., 2023; Souza et al., 2024).

Under-five mortality is influenced by a complex combination of clinical, social, political, and economic factors. In Nigeria, major causes of child death include pneumonia, diarrhea, malaria, neonatal conditions, and malnutrition , conditions that can often be prevented with timely, skilled medical intervention (Olawade et al., 2023). Access to essential healthcare facilities , such as hospitals, clinics, transportation, and emergency pediatric care facilities , is vital for improving child health outcomes (Das & Guha, 2023). However, rural areas in Nigeria face severe shortages of trained healthcare providers, compounded by financial constraints, political instability, and socio-cultural barriers (Arisukwu et al., 2021).

Social determinants such as poverty, education, and cultural practices further exacerbate child health outcomes. In rural areas, traditional beliefs and practices often discourage the use of formal healthcare services for sick children, increasing the risk of under-five mortality (Souza et al., 2024). Addressing under-five mortality therefore requires a comprehensive approach that addresses both healthcare facility deficiencies and socio-cultural challenges.

Child health in Nigeria remains a pressing issue, with the under-five mortality rate at 117 deaths per 1,000 live births , substantially higher than the global average of 38 per 1,000 (Souza et al., 2024). This disparity underscores the need for urgent improvements in child healthcare, particularly in rural areas such as Ugep in Cross River State, where access to skilled healthcare providers is limited. In contrast, high-income countries have significantly reduced under-five mortality through improved healthcare facilities, better access to skilled birth attendants, and timely medical interventions (Das & Guha, 2023). Other sub-Saharan African nations face similar challenges, where inadequate healthcare services and socio-economic disparities contribute to high under-five mortality rates (Souza et al., 2024). However, Rwanda's success in reducing under-five mortality , through community health worker training, expanding healthcare facilities, and strengthening community health programs , offers valuable lessons for Nigeria (Olawade et al., 2023).

Existing research such as Das & Guha, 2023 emphasizes the need for comprehensive strategies to address child health, focusing on both healthcare facility improvements and the training of medical personnel. Furthermore, studies like Arisukwu et al., 2021 stress the role of social and cultural factors, arguing that healthcare services alone cannot address the underlying causes of under-five mortality without community engagement and cultural transformation. Global organizations such as the World Health Organization (WHO) and the United Nations (UN) advocate for an integrated approach to child health, which includes medical care, women's empowerment through education, and cultural change (Souza et al., 2024). Despite initiatives like the Integrated Management of Childhood Illness (IMCI) and free child healthcare services in Nigeria, challenges such as poor implementation, lack of coordination, and limited funding have hindered their effectiveness (Olawade et al., 2023).

This study aims to contribute to the existing literature by exploring the role of medical interventions and healthcare facilities in reducing under-five mortality in Nigeria. It adopts a holistic approach, considering both healthcare access and cultural factors, to provide a deeper understanding of the persistence of high under-five mortality rates. Unlike previous studies that focus on isolated aspects, this research utilizes a multi-theoretical framework that integrates clinical, economic, and sociocultural perspectives. The study also evaluates the effectiveness of current child health policies and proposes new strategies based on the latest evidence and the current realities in Nigeria. The primary objective is to assess how healthcare interventions particularly those addressing healthcare facilities and cultural factors can effectively reduce under-five mortality in Nigeria. The specific objectives are to:

i. analyse how medical care variables affect under-five mortality; and

ii. investigate the effect of healthcare facilities on under-five mortality.

This study addresses critical gaps in under-five mortality reduction by investigating medical interventions, healthcare facilities, and cultural factors. It provides evidence-based insights for policymakers, health practitioners, and education advocates on effective strategies to reduce child deaths in Nigeria. The study's findings offer direct benefits to stakeholders, including government agencies, healthcare providers, and local communities, by informing policy reforms, improving healthcare access, and promoting maternal and child education.

2. Literature Review

Under-Five Mortality Rate (U5MR) serves as a critical health indicator, representing the number of children who die before reaching five years of age, per 1,000 live births within a defined period. This includes preventable deaths caused by direct causes such as pneumonia, diarrhea, malaria, measles, neonatal conditions (prematurity, birth asphyxia, sepsis), as well as indirect causes like malnutrition and poor environmental conditions.

The concept of under-five mortality has evolved through significant academic and institutional contributions. Fernandes et al. (2023) highlight that U5MR reveals persistent global disparities in child health, particularly in low- and middle-income countries (LMICs), where inadequate healthcare systems and limited access to skilled healthcare workers exacerbate child mortality risks. This underscores the systemic inequities contributing to high under-five mortality rates. In a similar vein, Mehta et al. (2024) emphasize the interplay between child health and social determinants of health (SDoH), framing U5MR not only as a clinical outcome but also as a manifestation of broader societal deficiencies. Factors such as education, income, and healthcare access shape child health outcomes, with marginalized communities disproportionately affected. This perspective aligns with Arisukwu et al. (2021), who identify socio-cultural and environmental barriers as key contributors to under-five mortality, particularly in rural Nigeria, highlighting the multifaceted nature of the issue.

Healthcare facilities encompass the physical, organizational, and human resources necessary for effective healthcare delivery. Scholars have focused on its multidimensional nature, which includes not only physical facilities and equipment but also human capital, policies, and technological systems that support healthcare systems. Das and Guha (2023) define healthcare facilities as comprising the physical, technological, and human resources needed for efficient healthcare operations, emphasizing its impact on public health outcomes and economic

development, particularly in resource-limited settings. Olawade et al. (2023) build on this by underscoring the importance of infrastructure in child health, identifying key components such as pediatric care facilities, skilled health workers, and emergency transportation systems as essential for reducing under-five mortality.

Arisukwu et al. (2021) offer a socio-cultural perspective, arguing that healthcare facilities include both formal and informal systems through which health services are accessed. They stress the role of trust in healthcare systems and the interplay between cultural beliefs and infrastructure use. Fernandes et al. (2023) link inadequate healthcare facilities to persistent health disparities globally, advocating for integrated approaches that address both physical infrastructure and the socio-economic determinants of health. Mehta et al. (2024) further explore how healthcare facilities affect cardiovascular health, revealing its crucial role in managing both chronic and acute conditions. Souza et al. (2024) provide a comprehensive view of healthcare facilities, placing it within the broader socio-economic and political contexts that influence healthcare access and quality.

The definition of medical interventions has evolved alongside advancements in medical and social sciences. Fernandes et al. (2023) describe medical interventions as care provided by skilled personnel to prevent, treat, or manage health conditions. Souza et al. (2024) underscore the systemic role of medical interventions in addressing socio-economic inequalities and ensuring equitable health outcomes. Das and Guha (2023) highlight that medical interventions are contingent on infrastructure and policy, encompassing aspects like workforce adequacy, financial accessibility, and institutional capacity. Arisukwu et al. (2021) integrate socio-cultural factors, noting the influence of traditional practices alongside formal healthcare services in shaping treatment outcomes.

This study utilizes the Health Belief Model (HBM) and Environmental Precedence Theory to analyze under-five mortality. The HBM, developed by Rosenstock (1974), posits that individuals are more likely to engage in health-promoting behaviors if they perceive themselves at risk, believe the consequences are severe, and recognize that taking action will reduce the risk. This model is particularly relevant to child healthcare, helping explain why caregivers may avoid seeking care despite known risks. Barriers such as cost, limited access, and fear of medical intervention may deter caregivers from seeking appropriate care for sick children (Geller et al., 2006). Research indicates that when caregivers perceive higher risks of child complications, they are more likely to seek timely medical care, thus improving health outcomes and reducing under-five mortality (Arisukwu et al., 2021). The Environmental Precedence Theory, proposed by Sallis et al. (2006), posits that environmental factors such as access to healthcare facilities, medical personnel, and infrastructure significantly influence health behaviors and outcomes. In child health, the theory emphasizes how inadequate access to quality healthcare creates barriers, preventing timely care and contributing to higher under-five mortality rates (Marmot, 2005; Arisukwu et al., 2021).

2.1 Empirical Review

Several studies provide valuable insights into the complex factors contributing to under-five mortality. Fernandes et al. (2023) examine global disparities in child mortality, focusing on the role of insufficient pediatric anesthesia services in LMICs. Their study reveals that a shortage of anesthesiologists exacerbates child morbidity and mortality, advocating for enhanced training programs and international partnerships. Mehta et al. (2024) explore the role of SDoH in child cardiovascular health and adverse pediatric outcomes, showing that cardiovascular

diseases contribute to child mortality, particularly among socio-economically disadvantaged families. Addressing SDoH is crucial for reducing under-five mortality risks and improving health outcomes.

Arisukwu et al. (2021) take a sociological approach, using national survey data to analyze under-five mortality in rural Nigeria. Applying the HBM, Environmental Precedence Theory, and Rational Choice Theory, they investigate how inadequate healthcare services, poor healthcare utilization, and cultural factors contribute to high under-five mortality rates. Their study highlights the impact of socio-cultural and infrastructural barriers on child health outcomes.

In a global study, Souza et al. (2024) examine child health through systematic reviews and data from international organizations like the UN and World Bank. They identify 23 conceptual frameworks linking child health to eco-social forces, individual characteristics, and healthcare systems, advocating for an integrated approach that addresses both biomedical causes of under-five mortality and the broader socio-economic determinants of health.

Das and Guha (2023) analyze healthcare facilities in India, exploring how economic factors influence healthcare provision. Their study finds that economically advanced states like Haryana and Maharashtra have inadequate healthcare facilities, while rural states offer relatively better services despite lower economic status. This highlights the need for increased public health spending to reduce under-five mortality.

Usman et al. (2021) examine the relationship between child health continuum of care (CoC) and neonatal and infant mortality in India. Their study shows that completing the full CoC , antenatal care, institutional delivery, postnatal care, and child immunization , significantly reduces neonatal and infant mortality.

Olawade et al. (2023) investigate community health workers' perceptions of the determinants of under-five mortality in South-Western Nigeria. They identify pneumonia, malaria, diarrhea, and malnutrition as primary causes of child deaths, emphasizing the importance of addressing socio-cultural issues like the stigma surrounding childhood vaccinations.

2.2 Theoretical Review

The theoretical underpinnings of this study are anchored on three complementary frameworks: the Health Belief Model (HBM), Environmental Precedence Theory, and the Social Determinants of Health (SDoH) Framework. These theories collectively provide a robust analytical lens for understanding the complex interplay between medical interventions, healthcare facilities, and under-five mortality rates in Nigeria.

2.2.1 Health Belief Model (HBM)

The Health Belief Model, originally developed by Rosenstock (1974) and later refined by Becker and Maiman (1975), remains one of the most widely utilized theoretical frameworks for understanding health-seeking behaviors. The HBM posits that an individual's decision to engage in health-promoting behaviors is influenced by several key constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy.

In the context of child healthcare in Nigeria, the HBM offers valuable insights into why caregivers may or may not seek medical interventions for their children. Perceived susceptibility refers to a caregiver's belief about the likelihood that their child will contract a life-threatening illness. In many Nigerian communities, particularly in rural areas, there exists a fatalistic attitude towards child illness, where death is often viewed as an inevitable outcome rather than a preventable occurrence (Arisukwu et al., 2021). This low perceived susceptibility significantly undermines health-seeking behaviors.

Perceived severity, another critical construct, relates to the caregiver's assessment of the seriousness of a child's illness and its potential consequences. Research has demonstrated that when caregivers perceive childhood illnesses such as malaria, pneumonia, or diarrhea as severe, they are more likely to seek timely medical attention (Geller et al., 2006). However, cultural beliefs and traditional medicine practices often lead to underestimation of illness severity, resulting in delayed intervention and increased mortality risk.

The construct of perceived benefits examines whether caregivers believe that seeking formal healthcare will effectively prevent or treat childhood illnesses. This is particularly relevant in Nigeria, where past negative experiences with healthcare facilities, including medical negligence, drug shortages, and long waiting times, have eroded trust in the formal health system. When caregivers perceive limited benefits from seeking care, they are less likely to utilize available healthcare facilities, opting instead for traditional healers or self-medication (Souza et al., 2024).

Perceived barriers, perhaps the most influential construct in the Nigerian context, encompass the obstacles that prevent caregivers from accessing healthcare services. These include financial constraints, geographical distance, transportation difficulties, and cultural prohibitions. Studies have shown that out-of-pocket health expenditure serves as a significant barrier, particularly for impoverished households (Das & Guha, 2023). The HBM suggests that reducing these barriers through Universal Health Coverage initiatives and improved healthcare infrastructure would significantly increase healthcare utilization and reduce under-five mortality.

Cues to action, which can be internal (symptoms experienced by the child) or external (media campaigns, advice from community health workers), play a crucial role in triggering health-seeking behaviors. Community health programs and health education initiatives serve as important cues to action in Nigeria (Olawade et al., 2023). Finally, self-efficacy, the confidence in one's ability to successfully navigate the healthcare system and implement recommended health behaviors, is essential. Caregivers with higher self-efficacy are more likely to persist in seeking appropriate care, even in the face of initial obstacles.

2.2.2 Environmental Precedence Theory

The Environmental Precedence Theory, proposed by Sallis et al. (2006), provides a complementary framework for understanding how physical and social environments shape health behaviors and outcomes. This theory posits that environmental factors, including the availability, accessibility, and quality of healthcare facilities, significantly influence health-seeking behaviors and consequently, health outcomes.

The theory's core tenet is that environmental conditions precede and determine individual health behaviors. In the context of under-five mortality, Environmental Precedence Theory emphasizes that the physical healthcare infrastructure whether hospitals, health centers, equipment, or transportation networks creates the necessary conditions for healthcare utilization. When healthcare facilities are inadequate, poorly equipped, or geographically inaccessible, they present insurmountable barriers to care, even for caregivers who are motivated to seek treatment (Marmot, 2005).

In Nigeria, the environmental determinants of child health are starkly evident. The theory helps explain the disparities between urban and rural areas, where rural communities consistently lack essential healthcare infrastructure. A shortage of skilled health personnel, insufficient pediatric care facilities, lack of emergency transportation, and inadequate diagnostic equipment create an environment where child deaths are almost predetermined. The Environmental Precedence Theory suggests that without addressing these fundamental environmental deficiencies, behavioral interventions alone will not significantly reduce under-five mortality rates (Fernandes et al., 2023).

Furthermore, the theory considers the social environment as an integral component of the healthcare ecosystem. This includes community norms, cultural practices, and social support systems that either facilitate or hinder access to healthcare. In many Nigerian communities, traditional beliefs that illness results from spiritual causes rather than biomedical factors create a social environment that discourages the use of formal healthcare facilities (Arisukwu et al., 2021). Similarly, gender dynamics that subordinate women's decision-making authority often prevent mothers from seeking care for their children, as they require approval from male family members.

The Environmental Precedence Theory also emphasizes the importance of policy and governance environments. Public health policies, funding allocation, and healthcare regulations constitute the policy environment that determines the quality and availability of healthcare services. In Nigeria, inadequate public health expenditure and weak governance structures have created an environment of chronic healthcare underfunding, leading to persistent shortages of essential medicines, medical equipment, and trained personnel (Das & Guha, 2023).

2.2.3 Social Determinants of Health (SDoH) Framework

The Social Determinants of Health framework, as articulated by the World Health Organization (WHO) and expanded upon by Marmot and Wilkinson (2005), provides a comprehensive lens for understanding how social, economic, and political factors systematically shape health outcomes. The SDoH framework identifies several key determinants: income and social status, education, physical environment, social support networks, employment and working conditions, gender, culture, and access to healthcare services.

The SDoH framework is particularly germane to understanding under-five mortality in Nigeria, as it moves beyond the narrow biomedical perspective to encompass the broader societal structures that create and perpetuate health inequities. Poverty, as the most powerful social determinant, exerts a pervasive influence on child health outcomes. Poor households lack the financial resources to afford quality healthcare, nutritious food, and safe living conditions, creating a vicious cycle of ill-health and impoverishment (Mehta et al., 2024).

Education, particularly maternal education, is another critical determinant. Studies have consistently demonstrated a negative correlation between maternal education and under-five mortality, as educated mothers are more likely to practice preventive health behaviors, recognize danger signs, and effectively navigate the healthcare system (Souza et al., 2024). In Nigeria, low female literacy rates, particularly in northern regions, contribute significantly to high child mortality.

The physical environment, including housing quality, water and sanitation infrastructure, and exposure to environmental hazards, is another important determinant. Poor water quality and inadequate sanitation contribute to the transmission of infectious diseases such as diarrhea, a leading cause of child death in Nigeria. Similarly, indoor air pollution from cooking with biomass fuels increases the risk of respiratory infections (Olawade et al., 2023).

Cultural factors, including norms, beliefs, and practices, constitute another significant social determinant. In many Nigerian communities, traditional medicine remains the preferred first line of treatment, while gender norms often restrict women's access to healthcare. The SDoH framework emphasizes that addressing these cultural factors is essential for reducing under-five mortality, as healthcare interventions alone cannot overcome deeply ingrained social and cultural barriers (Arisukwu et al., 2021).

2.2.4 Integration of Theoretical Frameworks

The integration of HBM, Environmental Precedence Theory, and the SDoH framework provides a comprehensive theoretical foundation for this study. These theories are not mutually exclusive but rather complementary, collectively illuminating the multiple pathways through which medical interventions and healthcare facilities influence under-five mortality.

The HBM explains the micro-level decision-making processes of caregivers, highlighting how perceptions of risk, benefits, and barriers shape health-seeking behaviors. The Environmental Precedence Theory provides the meso-level perspective, demonstrating how the healthcare environment predisposes or constrains these behaviors. The SDoH framework offers the macro-level analysis, revealing how broader social, economic, and political structures create the conditions within which both individual behaviors and healthcare environments operate.

This integrated theoretical framework suggests that reducing under-five mortality in Nigeria requires simultaneous action at multiple levels. At the individual level, health education and behavior change communication can modify perceptions of illness risk and enhance self-efficacy. At the community level, improving healthcare infrastructure and expanding access to affordable services can reduce environmental barriers to care. At the structural level, policies that address poverty, improve education, and promote gender equality can create conditions that facilitate improved child health outcomes.

Furthermore, the framework highlights the importance of Universal Health Coverage initiatives, which address multiple theoretical pathways simultaneously. By reducing financial barriers (perceived barriers in HBM), improving healthcare infrastructure (environmental factors in Environmental Precedence Theory), and addressing health inequities (social determinants in SDoH), UHC represents a comprehensive approach to reducing under-five mortality.

The theoretical review conducted in this section thus provides the conceptual foundation for understanding the complex relationships among medical interventions, healthcare facilities, and under-five mortality in Nigeria. It guides the empirical analysis and informs the policy recommendations that arise from this study, ensuring that the findings are grounded in robust theoretical reasoning that captures the multifaceted nature of child health outcomes.

3. Methodology

This study examines the effectiveness of medical interventions in reducing under-five mortality rates (U5MR) in Nigeria, using a retrospective longitudinal observational design. This approach enables the analysis of trends over time, offering critical insights into fluctuations in U5MR and the factors influencing these variations. The study focuses on children under five years of age in Nigeria, using data spanning from 1999 to 2022, sourced from the World Bank Development Indicators (WDI), covering a 31-year period from 1991 to 2022. Inspired by Ilboudo and Siri's (2023) research on the impact of free healthcare policies on maternal and child health in Burkina Faso, this study employs binary logistic regression to assess the relationship between under-five mortality rates and various predictor variables. These variables include medical factors such as healthcare personnel availability and access to child healthcare, as well as healthcare facility components like public and private health expenditures.

Two distinct models (1) and (2) below were developed to address the research questions. The first model evaluates the impact of medical factors on under-five mortality, with under-five mortality rate (U5MR) as the dependent variable. The independent variables in this model are healthcare personnel (HP) and access to child healthcare (ACH). The model is specified accordingly:

$$U5MR = \beta_0 + \beta_1 HP + \beta_2 ACH + \varepsilon U5MR = \beta_0 + \beta_1 HP + \beta_2 ACH + \varepsilon \quad (1)$$

This study examines the relationship between healthcare facilities and under-five mortality, with under-five mortality rate (U5MR) as the dependent variable. The analysis focuses on two key independent variables: public health expenditure (PHE) and out-of-pocket health expenditure (OUHE). By exploring these factors, the study aims to provide insights into the role of healthcare financing in shaping child health outcomes. The model is specified as follows:

$$U5MR = \beta_0 + \beta_1 PHE + \beta_2 OUHE + \varepsilon U5MR = \beta_0 + \beta_1 PHE + \beta_2 OUHE + \varepsilon \quad (2)$$

Data on under-five mortality rates, socio-economic factors, healthcare variables, and health infrastructure are sourced from World Bank World Development Indicators database spanning the period from 1999 to 2022. The relevant study variables and their measurements are presented as follows: The Under-Five Mortality Rate (U5MR) is measured as the number of children dying before age five per 1,000 live births. **Health Personnel (HP)** refers to the percentage of births attended by skilled health personnel (proxy for workforce availability). **Access to Child Healthcare (ACH)** is the percentage of children receiving full immunization coverage (DTP3/measles). **Public Expenditure on Health (PHE)** denotes domestic general government health expenditure as a percentage of GDP. Finally, **Out-of-Pocket Health Expenditure (OUHE)** is the percentage of current health expenditure derived from out-of-pocket spending.

The study utilizes the Fully Modified Ordinary Least Squares (FMOLS) multiple regression technique. Preliminary analyses consist of descriptive statistics, correlation analysis, and unit root tests. Data processing and analysis are performed using EViews 9 and Microsoft Excel.

4. Results and Discussion

Table 2 presents the descriptive statistics of the dataset on all the variables in the study.

Table 2: Descriptive Statistics

	U5MR	**HP**	**PHE**	**OUHE**	**ACH**
Mean	117.0425	40.21250	0.636884	71.35144	62.22917
Median	116.2645	40.25000	0.532663	72.75694	63.10000
Maximum	131.2690	47.30000	1.202034	77.38787	67.00000
Minimum	105.0140	35.10000	0.445932	60.16207	54.10000
Std. Dev.	7.087317	3.714286	0.221848	4.851170	3.998530
Skewness	0.147745	0.155073	1.376934	-1.052062	-0.268011
Kurtosis	2.204145	2.164566	3.699890	3.123511	1.790166
Jarque-Bera	0.720699	0.794141	7.737236	4.257481	1.751018
Probability	0.697433	0.672287	0.020887	0.118987	0.416650
Observations	24	24	23	23	24

Key: U5MR = Under-Five Mortality Rate; HP = Health personnel; PHE = Public expenditure on health; OUHE = Out of pocket health expenditure; ACH = Access to child healthcare

Source: Authors Computation, 2025

The mean under-five mortality rate (U5MR) in Nigeria stands at 117.04 deaths per 1,000 live births, with a minimum of 105.01 and a maximum of 131.27, indicating a relatively high average number of child deaths per 1,000 live births. The minimum of 105.0140 shows that while the average U5MR is high, there is considerable variability in under-five mortality rates across different regions or time periods in Nigeria. This implies disparities in healthcare access or quality. The standard deviation of Under-Five Mortality Rate (U5MR) is higher at 7.087317, indicating considerable fluctuation in under-five mortality rates, possibly due to factors such as healthcare facilities, access, or socioeconomic disparities. However, the skewness of 0.15 indicates a slight rightward skew, implying a slightly heavier tail on the right side of the distribution. This skewness, combined with a kurtosis of 2.20, suggests that while the data is relatively normally distributed, there might be some outliers on the higher end of the U5MR spectrum. The low Jarque-Bera statistic with a high p-value for under-five mortality rate suggests that the variable is normally distributed.

The mean Health Personnel (HP) in Nigeria is 40.21, with a minimum of 35.10 and a maximum

of 47.30. This suggests a moderate average number of health personnel per unit of population. However, the range between the minimum and maximum values indicates variability in healthcare workforce distribution across different regions or settings within Nigeria. The standard deviation of Health Personnel (HP) is 3.71, indicating some degree of variability in the number of health personnel across time or regions. The skewness of Health Personnel (HP) is 0.16, suggesting a slight rightward skew in the distribution. This implies that there may be relatively fewer regions or settings with exceptionally high numbers of health personnel compared to those with lower numbers. Additionally, the kurtosis of 2.16 indicates a moderately peaked distribution, implying that most regions or settings have a similar level of health personnel, with some outliers on either end of the distribution. The Jarque-Bera statistic for Health Personnel (HP) is 0.79 with a p-value of 0.67, indicating that the variable is likely normally distributed. This suggests that, overall, the distribution of health personnel across different regions or settings in Nigeria follows a relatively normal pattern, with the majority of areas having a similar number of health personnel.

The mean Public Expenditure on Health (PHE) in Nigeria is 0.64, with a minimum of 0.45 and a maximum of 1.20. This indicates the average proportion of the country's GDP spent on healthcare. The wide range between the minimum and maximum values suggests significant variability in healthcare spending across different regions or time periods. The standard deviation of Public Expenditure on Health (PHE) is 0.22, indicating relatively low variability in healthcare spending over time or across regions. The skewness of Public Expenditure on Health (PHE) is 1.38, indicating a rightward skew in the distribution. This suggests that there may be relatively more regions or time periods with lower levels of healthcare spending compared to those with higher levels. Additionally, the kurtosis of 3.70 suggests a moderately peaked distribution, with some regions or time periods having significantly higher healthcare expenditure compared to others. The Jarque-Bera statistic for Public Expenditure on Health (PHE) is 7.74 with a p-value of 0.02, indicating that the variable is not normally distributed. This departure from normality suggests that healthcare spending in Nigeria may be influenced by non-standard factors or events, such as healthcare emergencies, political changes, or economic fluctuations.

The mean Out of Pocket Health Expenditure (OUHE) in Nigeria is 71.35, with a minimum of 60.16 and a maximum of 77.39. This indicates the average amount individuals pay directly for healthcare services. The relatively high mean suggests a significant financial burden on individuals, particularly those with limited access to health insurance or social protection schemes. The wide range between the minimum and maximum values reflects variability in healthcare affordability across different socioeconomic groups or regions. The standard deviation of Out of Pocket Health Expenditure (OUHE) is 4.85, indicating moderate variability in healthcare spending by individuals over time or across regions. The skewness of Out of Pocket Health Expenditure (OUHE) is -1.05, indicating a leftward skew in the distribution. This suggests that there may be relatively more individuals or households with lower out-of-pocket healthcare expenditures compared to those with higher expenditures. Additionally, the kurtosis of 3.12 suggests a moderately peaked distribution, with most individuals or households clustered around the mean expenditure level, but with some outliers on either end of the distribution. The Jarque-Bera statistic for Out of Pocket Health Expenditure (OUHE) is 4.26 with a p-value of 0.12, indicating that the variable is not normally distributed. This departure from normality suggests that healthcare spending patterns by individuals in Nigeria may be influenced by non-standard factors or events, such as sudden health emergencies or unexpected healthcare costs.

The mean Access to Child Healthcare (ACH) in Nigeria is 62.23, with a minimum of 54.10 and a maximum of 67.00. This indicates the average level of access children have to child healthcare services, which encompasses immunization coverage, treatment for common childhood illnesses, and nutritional support. The relatively high mean suggests a moderate level of access to child healthcare services across the population. However, the range between the minimum and maximum values implies variability in access levels, reflecting disparities in healthcare facilities, geographical accessibility, and socioeconomic factors. The standard deviation of Access to Child Healthcare (ACH) is 3.99, indicating moderate variability in access levels over time or across different regions. This variability may be influenced by factors such as healthcare facility availability, transportation infrastructure, cultural norms, and educational attainment. Policymakers should prioritize interventions to improve access to child healthcare services, particularly in underserved areas or among marginalized populations, to reduce under-five mortality and improve child health outcomes. The skewness of Access to Child Healthcare (ACH) is -0.27, indicating a slight leftward skew in the distribution. This suggests that there may be relatively more areas or populations with lower levels of access to child healthcare compared to those with higher access levels. Additionally, the kurtosis of 1.79 suggests a moderately peaked distribution, with most areas or populations clustered around the mean access level, but with some outliers on either end of the distribution. The Jarque-Bera statistic for Access to Child Healthcare (ACH) is 1.75 with a p-value of 0.42, indicating that the variable is likely normally distributed. This suggests that access to child healthcare services in Nigeria follows a relatively normal pattern, with the majority of areas or populations having similar access levels.

Table 3 presents the results of the unit root test using the Augmented Dickey-Fuller (ADF) approach for each variable in the dataset. It includes the t-statistic values, corresponding p-values, the order of integration, and the critical values at different significance levels.

Table 3: Augmented Dickey-Fuller Unit Root Test Statistic

Variables	**Level t-Statistic**	**Level Prob.**	**First Difference t-Statistic**	**First Difference Prob.**	**Order of Integration**
U5MR	-2.128962	0.23589	-5.395761	0.00029	I(1)
HP	-2.140868	0.23169	-4.206752	0.00399	I(1)
PHE	-1.715930	0.40989	-5.427683	0.00029	I(1)
OUHE	-3.051360	0.04629	-5.086200	0.00059	I(0)
ACH	-1.866501	0.34109	-4.634582	0.00159	I(1)

Key: U5MR = Under-Five Mortality Rate; HP = Health personnel; PHE = Public expenditure on health; OUHE = Out of pocket health expenditure; ACH = Access to child healthcare.

Source: Authors Computation, 2025

The Augmented Dickey-Fuller Unit root test explores the stationarity of time series data. Under-Five Mortality Rate (U5MR): The test statistics for U5MR at both the level and first

difference are -2.13 and -5.40, respectively, with probability values of 0.24 and 0.0003. These results indicate that U5MR is integrated of order 1 (I(1)), suggesting that the series exhibits a unit root and requires differencing to achieve stationarity. The implication of this unit root is that under-five mortality rates exhibit long-term trends or structural changes over time.

The test statistics for Health Personnel (HP) indicate that it is also integrated of order 1 (I(1)), with t-statistics of -2.14 and -4.21, and probability values of 0.23 and 0.004 for the level and first difference, respectively. This implies that the availability of health personnel exhibits a unit root and requires differencing for stationarity. The results suggest that the number of health personnel in Nigeria's healthcare system experiences long-term fluctuations or structural changes, which may impact healthcare delivery, patient outcomes, and overall health system performance.

The test statistics for Public Expenditure on Health (PHE) indicate integration of order 1 (I(1)), with t-statistics of -1.72 and -5.43, and probability values of 0.41 and 0.0003 for the level and first difference, respectively. This suggests that public expenditure on health is characterized by a unit root. The findings imply that public health spending experiences long-term trends or structural changes, influenced by fiscal policies, healthcare financing mechanisms, and health system priorities.

The test statistics for Out of Pocket Health Expenditure (OUHE) reveal integration of order 0 (I(0)) at the level and order 1 (I(1)) at the first difference, with t-statistics of -3.05 and -5.09, and probability values of 0.0463 and 0.0006, respectively. This suggests that while OUHE is stationary in its levels, indicating the presence of a unit root. This implies that out-of-pocket health expenditure experiences short-term fluctuations but may exhibit long-term trends or structural changes over time. High levels of OUHE can pose financial barriers to healthcare access, leading to inequities in healthcare utilization and adverse health outcomes, especially for vulnerable populations.

The test statistics for Access to Child Healthcare (ACH) indicate integration of order 1 (I(1)), with t-statistics of -1.87 and -4.63, and probability values of 0.34 and 0.0016 for the level and first difference, respectively. This suggests that access to child healthcare is characterized by a unit root. The results imply that access to child healthcare services experiences long-term trends or structural changes, influenced by factors such as geographic accessibility, healthcare facilities, and socio-economic determinants.

In Figure 1, the trend of Under-Five Mortality rate as measured by deaths per 1,000 live births is displayed.

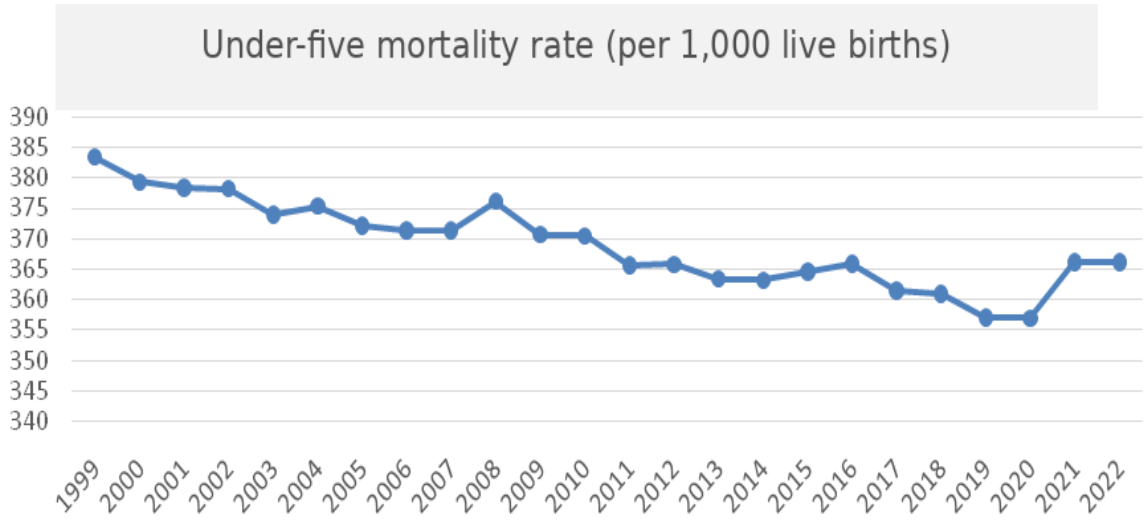

Figure 1: Trends of Under-Five Mortality Rate

Source: Authors Computation, 2025

(Note: The figure would show a declining trend from approximately 131 in 1999 to around 105 in 2022, with some fluctuations between 2000-2010, followed by a steady decline after 2010.)

Over the period from 1999 to 2022, there has been a notable trend in the Under-Five Mortality Rate (U5MR) and the availability of Health Personnel in Nigeria. Initially, from 1999 to the early 2000s, the U5MR exhibited a slight decrease from 131.269 in 1999 to around 120 in 2009, indicating some improvement in child health outcomes. However, this trend was not sustained, as there was a subsequent increase in U5MR from 2009 to 2011, reaching a low of 115.599 in 2011, before fluctuating around this level until 2022. Overall, while there have been fluctuations, the U5MR has shown a consistent downward trend over the entire period.

These trends have critical implications for the Nigerian health system. The declining U5MR suggests progress in achieving improvements in child health outcomes. Factors such as inadequate healthcare facilities, limited access to quality child healthcare services, socio-economic disparities, and inconsistent healthcare policies may continue to challenge further reductions. In Figure 2, the trend of health personnel as measured by births attended by skilled health staff is displayed.

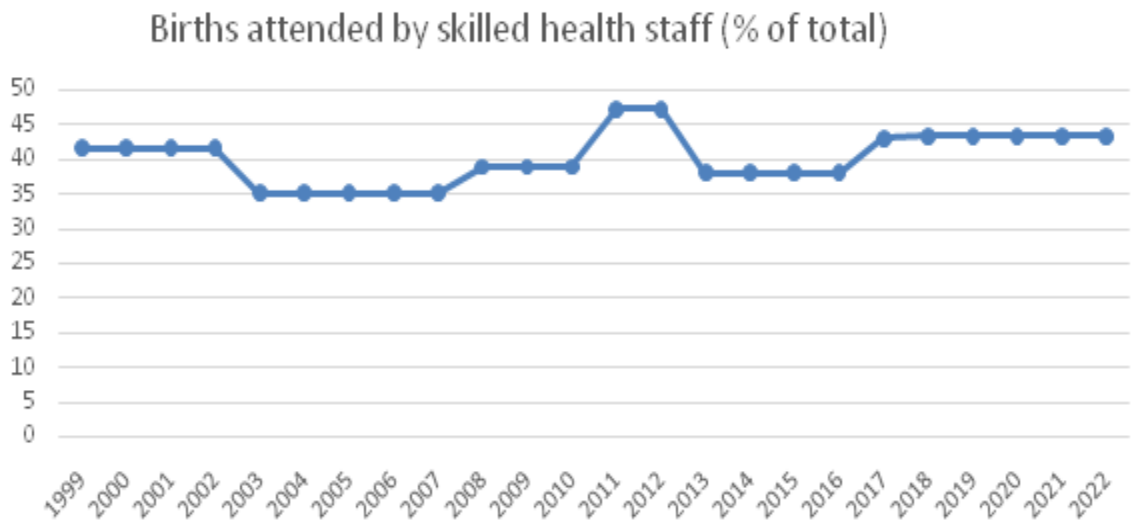

Figure 2: Trend of Health Personnel

Source: Authors, 2025

As illustrated in Figure 2, initially, from 1999 to 2003, the percentage of births attended by skilled health staff remained stagnant at 41.6%, indicating a consistent level of skilled attendance during childbirth. However, starting from 2003, there was a notable decrease in the percentage, dropping to 35.1%, which continued until 2008. From 2008 to 2011, there was a significant increase in the percentage of births attended by skilled health staff, reaching a peak of 47.3% in 2011. This increase may reflect efforts to improve maternal and child healthcare services, such as initiatives to train and deploy more skilled birth attendants, expand access to healthcare facilities, and enhance health education and awareness programmes. Subsequently, from 2011 to 2018, there was some fluctuation in the percentage, but it generally remained above 38%, indicating a sustained but somewhat variable level of skilled attendance during childbirth. From 2018 to 2022, the percentage stabilized around 43%, suggesting a relatively stable level of skilled attendance during childbirth in recent years. While this stability is positive, maintaining and further improving access to skilled birth attendance remains crucial for reducing under-five mortality and improving child health outcomes in Nigeria.

The result of the analysis of the effect of medical factors on under-five mortality rate estimated through the Fully-Modified Ordinary Least Square (FMOLS) is presented in Table 4.

Table 4: Fully-Modified OLS Estimates of Model 1

Dependent Variable: LOG(U5MR)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
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DLOG(HP)	0.002150	0.050139	0.043058	0.9661
LOG(ACH)	-0.169597	0.060384	-2.807997	0.0112
C	6.608044	0.249223	26.51350	0.0000
R-squared	0.346495			
Adjusted R-squared	0.277705			
S.E. of regression	0.014450			
Long-run variance	0.000327			
Post tests				
Histogram Normality test:				
Jarque-Bera (Prob)	2.925774 (0.231567)			
Wald Test:				
F-Statistic (Prob)	255.9636 (0.0000)			

Key: U5MR = Under-Five Mortality Rate; HP = Health personnel; ACH = Access to child healthcare

Source: Authors Computation, 2025

The Fully-Modified Ordinary Least Squares (OLS) estimates relationship between medical factors and under-five mortality rates in Nigeria from 1999 to 2023. The estimated coefficient for the change in Health Personnel (HP) is positive but statistically insignificant (β = 0.002160; t = 0.043068; Pr(0.05) = 0.9661). The lack of statistical significance suggests that the marginal increase in the number of health personnel does not have a discernible impact on under-five mortality rates in Nigeria over the observed period. This finding underscores the complexity of addressing child health challenges solely through healthcare workforce augmentation. It highlights potential inefficiencies or inadequacies in the healthcare delivery system that might render increases in health personnel insufficient to tackle under-five mortality effectively. The coefficient for Access to Child Healthcare (ACH) is negative and statistically significant (β = -0.169587; t = -2.807987; Pr(0.05) = 0.0112). The negative coefficient indicates that an increase in access to child healthcare is associated with a significant decrease in under-five mortality rates. This underscores the critical role of improving access to child healthcare services in reducing under-five mortality in Nigeria. This result suggests that healthcare accessibility initiatives, immunization programmes, and community-based healthcare programmes aimed at enhancing access to child healthcare can be pivotal in achieving sustainable reductions in under-five mortality rates. The constant term is positive and highly statistically significant (β = 6.608054; t = 26.51351; Pr(0.05) = 0.0000). The significance of the constant term implies that factors beyond health personnel and access to child healthcare have a significant influence in determining under-five mortality rates. These factors may

include broader socio-economic determinants of health, such as poverty, education, cultural practices, and healthcare facility disparities.

In the post-estimation tests, the Jarque-Bera statistic (2.925774) with a p-value of 0.231567 suggests that the residuals from the regression model are normally distributed. The normality of residuals enhances the reliability of the Fully-Modified OLS estimates, indicating that the model's assumptions are not violated and the estimated coefficients are robust. The Wald Test F-Statistic (255.9636) with a p-value of 0.0000 indicates that the overall model is statistically significant at the 5% level. The significant F-statistic implies that the combined effect of health personnel and access to child healthcare on under-five mortality rates is statistically significant. It underscores the relevance and validity of the regression model in explaining variations in under-five mortality rates in Nigeria.

The result of the analysis of the effect of health infrastructure on under-five mortality rate estimated through the Fully-Modified Ordinary Least Square (FMOLS) is presented in Table 5.

Table 5: Fully-Modified OLS Estimates of Model 2

Dependent Variable: LOG(U5MR)				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
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PHE	8.678796	7.002728	1.239345	0.2303
OUHE	-0.837500	0.370007	-2.263470	0.0355
C	421.7960	29.71863	14.19298	0.0000
R-squared	0.416057			
Adjusted R-squared	0.354589			
S.E. of regression	5.024594			
Long-run variance	30.56002			
Post tests				
Histogram Normality test:				
Jarque-Bera (Prob)	0.132154 (0.936059)			
Wald Test:				

F-Statistic (Prob)	241.3142 (0.0000)

Key: U5MR = Under-Five Mortality Rate; PHE = Public expenditure on health; OUHE = Out of pocket health expenditure

Source: Authors Computation, 2025

The Fully-Modified Ordinary Least Squares (OLS) estimates demonstrate the relationship between healthcare facility factors and under-five mortality rates in Nigeria. The coefficient estimate for Public Expenditure on Health (PHE) is positive but statistically insignificant (β = 8.678796; t = 1.239345; Pr (0.05) = 0.2303). The statistical insignificant coefficient of public expenditure on health suggests that changes in public expenditure on health do not have a discernible impact on under-five mortality rates in Nigeria during the observed period. This indicates that increases in healthcare spending alone may not effectively reduce under-five mortality rates. The coefficient estimate for Out of Pocket Health Expenditure (OUHE) is negative and statistically significant (β = -0.837500; t = -2.263470; Pr(0.05) = 0.0355). The negative coefficient implies that an increase in out-of-pocket health expenditure is associated with a significant decrease in under-five mortality rates. This finding suggests that individuals spending more out-of-pocket on healthcare services might have better access to quality child healthcare, leading to improved child health outcomes. However, it also raises concerns about financial barriers to healthcare access for vulnerable populations who may struggle to afford out-of-pocket expenses. The constant term is positive and highly statistically significant (β = 421.7960; t = 14.19298; Pr (0.05) = 0.0000). The significant constant term suggests that factors beyond public and out-of-pocket health expenditures have a substantial influence on under-five mortality rates in Nigeria. It underscores the multifaceted nature of child health challenges and the need for comprehensive healthcare system reforms.

In the post tests, the Jarque-Bera statistic (0.132154) with a p-value of 0.936059 suggests that the residuals from the regression model are normally distributed. This indicates that the model's assumptions regarding the normality of residuals are not violated, enhancing the reliability of the estimates. The Wald Test F-Statistic (241.3142) with a p-value of 0.0000 indicates that the overall model is statistically significant at the 5% level. This implies that the combined effect of public and out-of-pocket health expenditures on under-five mortality rates is statistically significant. It underscores the relevance and validity of the regression model in explaining variations in under-five mortality rates in Nigeria.

5. Conclusion and Recommendations

This study analyses the effectiveness of medical interventions and healthcare facilities in reducing under-five mortality rates in Nigeria over the period of 1999 to 2023. The analysis covers medical treatment related factors and healthcare facilities. The analysis of the research objectives one revealed that change in Health Personnel (HP) (β = 0.002160; t = 0.043068; Pr(0.05) = 0.9661) exerts an insignificant negative effect on under-five mortality rates in Nigeria over the observed period. The result suggests that a health personnel does not have a discernible impact on under-five mortality rates in Nigeria over the observed period. This finding highlights potential inefficiencies or inadequacies in the healthcare delivery system that might render increases in health personnel insufficient to tackle under-five mortality effectively. Finally, the result shows that Access to Child Healthcare (ACH) (β = -0.169587; t = -2.807987; Pr(0.05) = 0.0112) has a significant negative effect on under-five mortality rates

in Nigeria. The result indicates that an increase in access to child healthcare is associated with a significant decrease in under-five mortality rates which underscores the critical role of improving access to child healthcare services in reducing under-five mortality in Nigeria. This result suggests that healthcare accessibility initiatives, immunization programmes, and community-based healthcare programmes aimed at enhancing access to child healthcare can be pivotal in achieving sustainable reductions in under-five mortality rates.

The result corroborates the findings from the study of Hawkins et al. (2019) on the significance of healthcare policy changes, such as reductions in Planned Parenthood clinics and restrictions on abortion, in influencing maternal mortality rates. Their study underscores the importance of access to reproductive healthcare services in addressing health challenges. However, it does not specifically analyze the role of health personnel or access to child healthcare services. It is also in line with Gitobu et al. (2018) on the impact of Kenya's free maternal health care policy on child health utilization, emphasizing the challenges in policy implementation despite positive intentions. While their findings underscore the importance of healthcare policies, they do not directly address the role of health personnel or access to child healthcare services. In contrast, Akinyemi et al. (2015) examine the stagnation of neonatal mortality rates in Nigeria and identify factors such as antenatal care and facility delivery as significant determinants. While their study focuses on neonatal mortality, it underscores the importance of healthcare utilization factors in improving child health outcomes. Kilpatrick (2012) reviews maternal deaths in Illinois and identifies the importance of quality care in reducing mortality. Their study emphasizes the need for comprehensive healthcare system reforms to improve health outcomes. However, it does not directly address the role of health personnel or access to child healthcare services.

The analysis of the research objectives two shows that Public Expenditure on Health (PHE) ($\beta = 8.678796$; $t = 1.239345$; $Pr(0.05) = 0.2303$) exerts a statistically insignificant effect on under-five mortality rates in Nigeria. This suggests that public expenditure on health does not have a discernible impact on under-five mortality rates in Nigeria during the observed period. This indicates that increases in healthcare spending alone may not effectively reduce under-five mortality rates. Also, Out of Pocket Health Expenditure (OUHE) ($\beta = -0.837500$; $t = -2.263470$; $Pr(0.05) = 0.0355$) shows a statistically significant negative effect on under-five mortality rates. This implies that an increase in out-of-pocket health expenditure is associated with a significant decrease in under-five mortality rates. This finding suggests that individuals spending more out-of-pocket on healthcare services might have better access to quality child healthcare, leading to improved child health outcomes. However, it also raises concerns about financial barriers to healthcare access for vulnerable populations who may struggle to afford out-of-pocket expenses. This result is in line with Hawkins et al. (2019) which provide evidence of the impact of state-level changes on mortality rates in the United States. They identify reductions in Planned Parenthood clinics and restrictions on abortions as factors contributing to increased mortality rates. Contrastingly, Grépin and Bharadwaj (2015) focus on the relationship between maternal education and child mortality in Zimbabwe. Their study highlights the significant impact of increased maternal secondary education on reducing child mortality rates. Moodley, Fawcus & Pattinson (n.d) employ a clinical audit approach in South Africa to analyze reported maternal deaths and identify avoidable factors, aiming to reduce the mortality ratio. Their findings highlight a decline in deaths reported and institutional mortality rates over time. Azuh et al. (2017) investigate factors influencing maternal mortality in rural communities in Nigeria, emphasizing non-medical factors such as place of consultation and awareness of pregnancy complications.

On the basis of the analysis in this study, it can be inferred that the factors that determine the under-five mortality rates in Nigeria are access to child healthcare and out of pocket health expenditure. While access to child healthcare and out of pocket health expenditure were shown to reduce under-five mortality rates in Nigeria, availability of skilled health personnel and public expenditure on health were found to play an insignificant role in reducing under-five mortality rates. Based on the conclusion, the following recommendations are proffered: There is the need to expand access to affordable and quality child healthcare services through Universal Health Coverage (UHC) initiatives to reduce under-five mortality rates. Countries like Thailand and Rwanda have successfully implemented UHC programmes that have led to improvements in child health outcomes by ensuring access to essential child healthcare services without financial barriers. Equally there is the need to invest in the development and strengthening of child healthcare facilities, including healthcare facilities, equipment, and skilled health personnel, which is crucial for improving child health outcomes. Countries like Ethiopia have successfully implemented policies to expand and upgrade healthcare facilities, train skilled health workers, and improve the availability of essential child health commodities.

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