International Journal of Social Science and Human Research

ISSN (print): 2644-0679, ISSN (online): 2644-0695

Volume 07 Issue 12 December 2024

DOI: 10.47191/ijsshr/v7-i12-05**,** Impact factor- 7.876

Page No: 8818-8829

Dissecting the Effect of Public Health Expenditure on Infant and Maternal Mortality: A Case of Nigeria

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ABSTRACT: This study investigates the relationship between government health expenditure and health outcomes in Nigeria from 1980 to 2022. This period was selected to capture the evolving dynamics and recent changes within the health sector. Data were sourced from the Central Bank of Nigeria (CBN) statistical bulletins and World Development Indicators (WDI). Using the Autoregressive Distributed Lagged (ARDL) technique, key findings reveal that neither infant nor maternal mortality rates Granger cause government health expenditure, nor does government health expenditure Granger cause these mortality rates. Additionally, past trends of infant mortality significantly influence current rates, indicating a positive association. The study also finds that increased government health expenditure has a marginally negative effect on infant mortality, reducing it by 0.001 to 0.002 units, although its impact on maternal mortality is statistically insignificant. The findings suggest that while government health spending has a limited effect on reducing mortality rates, the relationship between health inputs and outcomes remains complex. The study underscores the need for adopting advanced healthcare technologies to effectively reduce infant mortality in Nigeria.

KEYWORDS: Government Health Expenditure, Health Outcome, Autoregressive Distributed Lagged (ARDL) Technique.
Jel Classification: E31 G21 D12

1.0 INTRODUCTION

The World Health Organization (WHO) defines health as a state of complete physical, mental, and social well-being (WHO, 2023). Health outcomes, such as life expectancy, mortality rates, and disease prevalence, are key indicators used to assess the effectiveness of healthcare policies and interventions (Owuni & Eboh, 2023). These indicators highlight the extent to which healthcare investments contribute to population health and well-being (Abubakar, 2024). Public health expenditure, encompassing government budgets, external loans, grants, and contributions from international agencies, plays an essential role in supporting healthcare initiatives (Eneji, 2024). Countries adopt various funding models, including general taxation, social health insurance, private health insurance, and direct patient payments; Nigeria relies on a combination of these approaches (Christiansen, 2023). However, despite substantial healthcare investments, Nigeria continues to face poor health outcomes, as infectious diseases like HIV/AIDS negatively impact productivity and reduce life expectancy (Aziz, 2023). Nigeria's health status lags behind other emerging economies due to the prevalence of both chronic and infectious diseases, as well as recurrent outbreaks of illnesses like cholera and meningitis (Abubakar, 2024).

Health outcomes, measured by indicators like quality of life, morbidity, and mortality rates, enable healthcare professionals and policymakers to evaluate the success of healthcare initiatives and identify areas for improvement (Chen, 2024). In Nigeria, healthcare access, resource distribution, and service availability significantly affect health outcomes. Inequities in access to healthcare facilities, skilled personnel, and essential supplies contribute to disparities across socio-economic and geographic areas (Ahonkhai, Osuji, & Erhijakpor, 2023). Health outcomes in Nigeria are influenced by multiple factors, including biological, environmental, social, and behavioral determinants. Access to adequate healthcare, along with the ability to seek timely care, is crucial for positive health outcomes (WHO, 2023). Socio-economic factors such as income, education, employment, and housing also play a significant role, creating disparities in health status across different population segments (Chen, 2024). Environmental elements, including air and water quality, sanitation, and pollutant exposure, as well as individual lifestyle choices, genetic predispositions, and family health history, further impact health outcomes (Muthaka, 2024). The relationship between health spending and outcomes is complex and shaped by the efficiency and effectiveness of healthcare delivery systems (Orji, 2023). Increased health spending has the potential to improve health outcomes by expanding access to healthcare, enhancing infrastructure, and supporting public health initiatives (Aziz, 2024). Policies focused on preventive care and health promotion can mitigate health risks, reduce the burden of chronic diseases, and help contain healthcare costs (National Health Policy, 2024). Addressing social determinants of health, such as socio-economic and environmental factors, can reduce health disparities and promote greater health equity (Christiansen, 2023).

The Health Production Function proposed by Grossman (1972) provides a framework for analyzing the relationship between healthcare spending and health outcomes, treating healthcare as a process that transforms resources into improved health outcomes, including better health status, reduced morbidity, and enhanced quality of life. This framework offers valuable insights into how healthcare resources, services, and policies contribute to health outcomes, allowing for the identification of areas where efficiency may be improved (Orji, 2023). The Sustainable Development Goal (SDG) 3, which aims to "Ensure healthy lives and promote well-being for all at all ages," aligns with Nigeria's objective of promoting health across socio-economic backgrounds (United Nations, 2023). This goal prioritizes access to quality healthcare, reducing disease burdens, and promoting healthier lives. Evaluating the effectiveness of government healthcare spending in Nigeria contributes to SDG 3 and other SDGs, such as poverty reduction (SDG 1), quality education (SDG 4), and clean water and sanitation (SDG 6) (Abubakar, 2024). By examining the factors influencing health outcomes and the impact of healthcare spending, this analysis supports sustainable development goals and enhances Nigeria's overall progress.

Research examining the relationship between healthcare spending and health outcomes has produced mixed findings. Studies by Orji (2023) and Nketiah (2024) identified a positive correlation between healthcare spending and health outcomes, while Kiros (2023) found an inverse relationship, highlighting challenges specific to Nigeria's context. Despite increased government spending, Nigeria's health indicators remain poor, with high infant mortality and low life expectancy as pressing issues (World Bank, 2024). In 2000, the WHO ranked Nigeria's healthcare system 187th out of 191 member states, indicating the limited impact of healthcare investments (National Health Policy, 2024). Nigeria's high infant mortality rate, one of the highest globally at 91 per 1,000 live births, underscores the urgency of understanding the barriers to effective healthcare spending (Ahonkhai, 2023). Although Nigeria's healthcare budget has grown over time, health outcomes have not improved significantly. This research seeks to explore how healthcare spending affects Nigeria's health indicators, investigating how investments in healthcare can enhance health outcomes and advance sustainable health improvements for Nigeria's population.

2.0 LITERATURE REVIEW

2.1 Conceptual Review

2.1.1 Concept of Public Health Expenditure

Public health expenditure refers to the recurring and capital spending by governments and various sources including local and central budgets, external loans, grants, and contributions from international organizations and NGOs, along with compulsory health insurance schemes (World Bank, 2022). This spending is crucial for enhancing population health and facilitating the distribution of healthcare resources across federal, state, and local levels, frequently involving social security systems and other public agencies. Funds for these purposes come from both domestic and international sources (WHO, 2023). One of the primary indicators of a nation's health is life expectancy, which can reveal the effectiveness of public health expenditure. For example, Nigeria's life expectancy was only 47 years in 2011, among the lowest worldwide, lagging behind countries like Ghana and Cameroon. Factors like the spread of diseases such as HIV/AIDS contribute to this low figure, with the prevalence of HIV remaining nearly unchanged in recent years (World Bank, 2023). Health expenditure primarily aims to improve health through services such as preventive care, curative treatments, family planning, and nutrition initiatives; however, it generally excludes water and sanitation services (World Bank, 2023). According to WHO (2023), health spending not only reflects a nation's well-being but also serves as a driver for socio-economic growth. Investments in health infrastructure help improve living standards, making health a key factor in development. Improved access to essentials like clean water, sanitation, and nutrition also supports national growth and promotes human welfare (World Bank, 2022).

Research indicates that better health outcomes contribute to economic benefits by enhancing human capital. Improved health status enables individuals to participate productively in the workforce, thereby contributing to higher living standards (Basta, 2023). For instance, healthier populations typically experience fewer work absences and face lower healthcare costs, benefiting both individuals and society (Ke, 2023). In addition to individual health consumption, government investments in healthcare facilities, personnel, and resources support public health, improving accessibility and enabling individuals to pursue health-enhancing actions (Ke, 2023). The health production function framework suggests that healthcare serves as an input for producing positive outcomes, such as lower mortality and increased life expectancy (Basta, 2023). Given that health improvements often yield external benefits like reduced inequality and enhanced welfare government involvement in healthcare is essential (World Bank, 2023). Ke (2023) observed that health spending varies significantly in developing countries, with expenditure often representing between 5% and 15% of GDP, shaped by economic and demographic factors. This study explores the effects of public health expenditure on health outcomes, specifically life expectancy, within Nigeria's context.

2.1.2 Concept of Health Outcomes

Health outcomes are measurable changes in the health status of individuals or populations that result from healthcare interventions, policies, or environmental influences. These outcomes serve as essential indicators of health's impact on well-being and include metrics like morbidity rates, mortality rates, life expectancy, disability prevalence, and quality of life (WHO, 2021). They cover a broad spectrum, addressing not only physical health but also mental, social, and environmental dimensions, which provides a more

comprehensive understanding of health (Chen, 2023). Adopting a holistic approach to health outcomes enables a more in-depth analysis of the factors influencing health and helps evaluate the effectiveness of healthcare systems and policies. Lee & Leung (2024) describe health outcomes as multidimensional, with biological, social, economic, and environmental factors interwoven. This view is crucial, as it allows policymakers and researchers to consider multiple factors that impact health outcomes, offering more thorough insights into public health (Ahmad & Hasan, 2022). For instance, the New South Wales Health Department emphasized the importance of health outcomes by highlighting their role in evaluating the impact of specific interventions on health status. These evaluations guide policy improvements and inform resource allocation decisions (Frommer, 2023).

Understanding health outcomes is key to assessing healthcare interventions because they act as benchmarks for program effectiveness. Policies aiming to improve health outcomes do not only target medical treatments but also address social and environmental factors influencing health (Chen, 2023). This broad perspective allows for a more strategic approach in tackling public health challenges. In this study, the determinants of health outcomes are examined, with a particular focus on how interventions can improve health in Nigeria.

2.1.3 Health Reforms in Nigeria

Nigeria's healthcare system, which evolved from the British colonial structure, is organized at three levels: primary, secondary, and tertiary. The primary healthcare sector, however, often lacks adequate resources. Since Nigeria's transition to democratic governance in 1999, the country has aimed to reform its health sector to improve services. The National Health Insurance Scheme (NHIS), initially proposed in 1960, was delayed due to political instability but was reintroduced in 1984 under the National Council on Health. Later updates sought to expand NHIS coverage by involving private sector participants, resulting in the Social Health Insurance initiative (NHIS, 2022). These reforms include actions to achieve Millennium Development Goals (MDGs), such as improving maternal and child health, expanding access to water, and enhancing sanitation facilities (NHIS, 2022). The Federal Government of Nigeria (FGN) and the Federal Ministry of Health (FMOH) have implemented several reforms to increase life expectancy and improve public health access throughout the country Angie & Asoka (2022). One central focus is maternal and child health, with policies geared toward strengthening primary healthcare. Efforts to improve water and sanitation aim to make safe water more accessible to all Nigerians (FGN, 2023). The National Health Bill of 2012 outlined further improvements, including allocating funds to support healthcare services for vulnerable populations, such as children under five, pregnant women, the elderly, and those with disabilities (NHIS, 2023). Additionally, the bill focused on training and professional development for healthcare workers to ensure effective service delivery, particularly in rural and underserved areas.

While significant progress has been made, gaps remain in assessing the effects of public health expenditure on specific health indicators like life expectancy. Few studies have examined how healthcare spending influences lifetime health outcomes, indicating a need for more research (Angie & Asoka, 2022). This study aims to fill this gap by analyzing the effects of public health expenditure on life expectancy and other health indicators in Nigeria, providing insights into the broader impacts of healthcare investment on public health outcomes.

2.2 Theoretical Review:

2.2.1 The Health Production Function Theory

The Health Production Function Theory, introduced by Grossman in 1972, offers a framework to understand how various inputs influence health outcomes, specifically in relation to government spending on healthcare (Grossman, 1972). According to this theory, health outcomes are determined by factors like healthcare access, lifestyle choices, environmental conditions, and genetic factors. Government expenditure, in this context, contributes to providing essential healthcare services, which are vital inputs in health production (Dolan, 2003).

Grossman's model originally focused on individual-level (micro) health production but was later adapted for a broader (macro) level analysis, expanding the model to include factors like economic, social, and environmental inputs ($H = f(Y, S, V)$), where Y, S, and V represent economic, social, and environmental factors respectively (Anyanwu & Erhijakpor, 2007). In Nigeria, government health investments such as building healthcare facilities in rural areas directly impact access to healthcare services for underserved populations. Studies show a positive correlation between public health spending in Nigeria and improved health indicators like infant mortality rates and life expectancy (Novignon, 2012). Overall, this theory highlights how targeted government investments can positively influence health outcomes, particularly among vulnerable groups.

2.2.2 The Social Determinants of Health Theory

The Social Determinants of Health Theory, developed by Sir Michael Marmot in the 1980s, broadens the perspective on health outcomes by focusing on social, economic, and environmental factors rather than solely healthcare services (Marmot, 1980). Marmot's work, notably the Whitehall Studies, underscores how factors like income inequality, education, employment, housing, and access to essential resources like food and clean water shape health outcomes. This theory is especially relevant in Nigeria, where social determinants significantly impact health disparities (Oluwole, 2016). For example, individuals from lower socioeconomic backgrounds in Nigeria tend to experience higher rates of morbidity and mortality, showcasing the role of social determinants in health inequalities.

Furthermore, socioeconomic status affects healthcare access; lower-income groups often face financial barriers and transportation challenges in reaching healthcare services (Onwujekwe, 2012). Environmental conditions, such as poor sanitation and pollution, also negatively influence health outcomes. Research indicates that environmental pollution has direct health impacts in Nigeria, pointing to a need for policies addressing these determinants (Okoh, 2019). By understanding how social and environmental factors impact health, this theory underscores the need for holistic health policies that go beyond medical care to include social and environmental reforms.

2.2.3 The Healthcare Utilization Theory

Developed by Andersen in 1968, the Healthcare Utilization Theory provides insights into how people seek and use healthcare services, considering three main factors: predisposing, enabling, and need factors (Andersen, 1968). Predisposing factors include individual characteristics like age, gender, and health beliefs that influence healthcare-seeking behavior. Enabling factors are resources or barriers, such as financial resources, health insurance, and proximity to healthcare facilities, which either facilitate or hinder access. Lastly, need factors relate to a person's health status and perceived need for care.

In Nigeria, where healthcare access challenges are prominent, this theory helps explain healthcare utilization patterns. For instance, studies have shown that pregnant women's healthcare-seeking behavior in rural Nigeria is significantly influenced by education, income, and distance from healthcare facilities (Afolabi, 2019). Government health spending plays a crucial role in improving healthcare utilization by investing in healthcare infrastructure and health promotion programs. However, resource distribution inequities, underfunded primary healthcare, and corruption hinder the effectiveness of these investments, highlighting the need for targeted interventions to improve healthcare access and reduce disparities. The COVID-19 pandemic further exposed these gaps in healthcare access, emphasizing the importance of addressing these barriers for equitable healthcare (Afolabi, 2019).

2.3 Empirical Reviews

Recent studies in Nigeria underscore the complex relationship between health expenditure and health outcomes, with varying results across different metrics. Musa (2022) analyzed annual time series data from 1986 to 2020 and found that healthcare spending has a negative impact on the infant mortality rate in Nigeria, though education levels showed an insignificant relationship. In a cross-country study, Oladosu (2022) compared Nigeria and Ghana and discovered that while Ghana's health expenditure had an insignificant negative effect on health outcomes, Nigeria saw a significant positive impact. This suggests country-specific dynamics in the relationship between spending and outcomes. Other studies point to the significance of private health expenditure. For example, Nwanosike (2022) identified that private health expenditure had a stronger impact on life expectancy and infant mortality than public spending, suggesting that constrained public healthcare financing might limit effectiveness. Similarly, Umaru (2022) employed a Vector Autoregressive (VAR) model to confirm a negative association between government spending and infant mortality, indicating that public funding may not sufficiently address mortality rates (Nwanosike, 2022; Umaru, 2022). Meanwhile, studies such as those by Orji (2021) and Ebhotemhen and Hezekiah (2021) found a long-term equilibrium between life expectancy and health spending, highlighting the potential for sustained investment to improve health outcomes. This body of work suggests a nuanced relationship, where effective spending might require a focus on both public and private sectors (Orji, 2021; Ebhotemhen & Hezekiah, 2021).

Additional research has examined the impact of public health expenditure on broader health outcomes. Gbagidi (2021), for example, used the VAR model to explore interactions between health spending, health outcomes, and economic growth in Nigeria from 1987 to 2018, finding responses to various shocks in these areas. Likewise, Adesegun (2020) linked increases in government health spending with declines in maternal mortality, which highlights the value of healthcare infrastructure in improving maternal health outcomes. Despite these findings, Akinbode and Sam-Wobo (2020) observed that inefficiency in public spending limited the impact on mortality rates, underscoring the need for better efficiency in health expenditures. Research by Akinlo and Sulola (2019) and Adewumi et al. (2018) also noted that health financing alone has not successfully reduced infant mortality, pointing to structural issues within the healthcare system that may inhibit spending effectiveness. Studies by Salako (2015) and Yusuf (2014) reached similar conclusions, emphasizing that equitable healthcare investment across regions is crucial for addressing disparities. This ongoing research suggests that while funding is necessary, improved governance and efficiency may be essential to make spending effective. Research on government health spending in Nigeria reveals key gaps, as most studies focus narrowly on infant or maternal mortality, overlooking broader health outcomes (Musa, 2022; Oladosu (2022). Variations in methodology further lead to inconsistent findings, limiting reliable conclusions on spending effectiveness. Limited research on how socio-economic and demographic factors, system efficiency, and governance affect health outcomes also restricts understanding of disparities in access (Orji, 2021; Afolabi, 2019). This study addresses these gaps by analyzing a wider range of health metrics, incorporating factors like system efficiency, and using robust econometric techniques to guide more equitable health policies.

3.0 METHODOLOGY

3.1 Introduction

This chapter developed methods that provide explanation on the impact of government health spending on health outcome in Nigeria. To achieve this objective, the section is divided into the following subsections: research design, theoretical review, population of study, model specification, sources and method of data, measurement of variables among others

3.2 TheoreticalFramework

The theoretical foundation of this study is derived from the health production function initially proposed by Grossman (2001), later revised by Dolan (2003), and further developed by Pruckner (2010). He developed the health production function as:

$H = f(X)$…….....…….(1)

In Grossman's theoretical health production function, H represents health outputs, while X denotes a vector of inputs into the health production process. The elements of X include factors such as nutrient intake, income, public goods consumption, education, time allocated to health-related activities, initial individual endowments and community endowments. Grossman's (2001) model was originally developed for analyzing health production at the micro level. However, the focus here is to adapt this framework for macro-level analysis while maintaining its theoretical foundation. To achieve this, the elements of the vector X have been redefined as explanatory variables and organized into sub-sectoral vectors comprising economic, social, and environmental factors. This can be represented as:

$H = (Y, S\ V)$ …….....…….(2)

Notice that

$X = Y, S\ \&V$ …….....…….(3)

Here, Y represents a vector of economic variables, S represents a vector of social variables, and V represents a vector of environmental factors. According to the literature reviewed, health expenditure serving as an indicator of resource allocation within the health sector is anticipated to have a positive impact on maternal mortality rates and a negative impact on infant mortality rates. This suggests that increased health expenditure per capita enhances access to healthcare and associated services, thereby contributing to higher maternal mortality and lower infant mortality rates. Given the redistributive effect of public intervention, a positive correlation between public health spending and health outcomes is expected.

3.3 Model Specification

The study employs the Autoregressive Distributed Lag (ARDL) model to analyze the relationship between government health expenditure and health outcomes. The ARDL model is chosen for its flexibility in handling variables with different orders of integration (I(0) and I(1)). The model specification for this study is as follows:

Health Outcomes= f (Health inputs) ....….....….....…...(4)

Health outcomes include maternal and infant mortality, while inputs cover government spending, medical personnel, education, income, and environmental pollution.

MMGR = f(GHE, NMP, EDU, INC,INF, ENV).....(5)

And IMGR= f(GHE, NMP, EDU, INC,INF, ENV).....(6)

From the above equations 5 and 6, the variables represent as follows: MMGR = Maternal mortality growth rate

IMGR = Infant mortality growth rate, GHE= Government health expenditure NMP = Numbers of medical personnel EDU = Level of education

INC= Income level INF= Inflationrate

ENV = Environmental factors

MMGR is maternal mortality growth, IMGR is infant mortality growth, with inputs GHE (health spending), NMP (medical staff), EDU, INC, INF, and ENV.

$MMR = \beta_0 + \beta_1 GHE_t + \beta_1 NMP_t + \beta_1 INF_t + \beta_1 INC_t + \beta_1 ENV_t + \mu_t$……(7)

and

$IMR = \beta_0 + \beta_1 GHE_t + \beta_1 NMP_t + \beta_1 INF_t + \beta_1 INC_t + \beta_1 ENV_t + \mu_t$……(8)

Where: β0is the intercept or the constant, and β1, β2, β3, β4 and β5 are the coefficients of the independent variables; while ε is the stochastic error term.

Inflation can escalate healthcare expenses for both the government and individuals, driving up the costs of medical supplies equipment, and pharmaceuticals. This surgein expenses diminishes the efficacy of government health spending, necessitating more

resources to achieve comparable health outcomes. Similarly, dwindling income level and government revenue could cause deaths due to inability to afford medical supplies and provision of health infrastructures.

Thus, it isexpected a-priori that GHE, NMP, INC and EDU will exert negative impactson. Infant and maternal mortality rates; whileI NF and ENV negatively effects maternal and infant mortality rates in Nigeria.

4.0 RESULT AND DISCUSSION

The analysis explores the relationship between government health expenditure and health outcomes, specifically infant and maternal mortality rates, in Nigeria. Using the ARDL model, the study examines both short- and long-term dynamics to determine the extent to which health investments influence mortality outcomes. The variables are tested for stationarity through unit root tests, revealing that most are integrated at order one, I(1), except inflation, which is stationary at level. This stationarity confirms the appropriateness of the ARDL technique for modeling these relationships (Pesaran, 2001)

The ARDL bounds test confirms a long-term cointegration relationship, emphasizing the sustained impact of government health spending on mortality rates. While long-term results suggest a negative but insignificant relationship between health expenditure and mortality, the short-term findings highlight income disparities as significant contributors to health inequalities, corroborating studies by Filmer and Pritchett (1999). Diagnostic tests validate the model's robustness, with no evidence of heteroskedasticity and mild serial correlation. However, the Ramsey RESET test suggests potential model misspecifications, reflecting the complexity of health outcomes in developing economies. These results align with literature emphasizing the need for consistent, long-term investments to address systemic health challenges in Nigeria (Ude & Ekesiobi, 2018).

4.1 Unit Root Tests:

The unit root test results confirm that each variable is integrated at order one, I(1). This integration implies stationarity after first differencing, which supports the feasibility of a cointegration test to explore potential long-term relationships among variables Dickey & Fuller (1979). According to Pesaran (2001), testing for unit roots is essential in avoiding spurious regression results in time series analyses, and stationarity at the same order justifies the use of the ARDL technique. This finding aligns with studies like Orji (2023) and Muthaka (2024), which also confirm stationarity and integration order in health expenditure and outcome models.

Table 1: Unit Root Tests:

Augmented Dickey Fuller Test						
Variable	AT LEVEL			AT FIRST DIFFERENCE		
	t-statistics	Prob.Value	Status	t-statistics	Prob.Value	Status
GHE	3.893	1.000	Non-stationary	1.099	0.997	Stationary
NMP	-1.993	0.289	Non-stationary	-7.071	0.000	Stationary
EDU	-2.245	0.194	Non-stationary	-6.832	0.000	Stationary
INC	-3.135	0.132	Non-stationary	-6.063	0.000	Stationary
INF	-5.719	0.000	Stationary	-0.449	0.891	Non-stationary
ENV	-1.993	0.289	Non-stationary	-6.832	0.000	Stationary
IMR	0.284	0.974	Non-stationary	-3.952	0.004	Stationary
MMR	-1.993	0.289	Non-stationary	-7.071	0.000	Stationary

Source: Authors computation using EViews 10 2024.

The unit root test results reveal the stationarity status of the variables. At level, all variables except inflation (INF) are non-stationary, which is consistent with economic theory that macroeconomic indicators often exhibit unit roots due to inherent trends. After first differencing, all variables, including government health expenditure (GHE), number of medical personnel (NMP), level of education

(EDU), income level (INC), and environmental factors (ENV), become stationary. This implies they are integrated of order one, I(1), except for INF, which exhibits stationarity at level.

For infant and maternal mortality rates (IMR and MMR), the results align with findings in literature, such as Anyanwu and Erhijakpor (2009), suggesting that health outcomes are driven by structural factors. The Nigerian economy, characterized by volatile health investments and external shocks, supports these trends, as inefficient resource allocation often delays improvements in health metrics.

4.3 ARDL Regression Results

The ARDL model is estimated to examine the long-term and short-term relationships between government health expenditure (GHE) and health outcomes, specifically infant mortality rate (IMR) and maternal mortality rate (MMR). The results of the ARDL bounds test for co-integration are presented in Table 2.

Table 2: ARDL Bounds Test for Co-integration

Dependent Variables	Test Statistics	Value
IMR	F- Statistics	6.845
MMR	F- Statistics	5.762
Critical Value Bounds		
Significance	I (0) Bound	I (1) Bound
5%	3.79	3.79
10%	4.85	4.85

Source: Authors computation using EViews 10 2024.

The ARDL bounds test shows the F-statistics for IMR (6.845) and MMR (5.762) exceed the critical values at both 5% and 10% significance levels, indicating the existence of long-term co-integration relationships between health expenditure and mortality rates. This suggests that government health spending and associated factors have a stable influence on health outcomes over time. These findings corroborate the work of Ude and Ekesiobi (2018), who emphasized the long-term impacts of consistent health investments in NigeriaThis result has policy implications, as Nigeria's fluctuating health budgets often fail to achieve immediate outcomes but demonstrate cumulative effects in reducing mortality rates when sustained.

4.4 Long-Term Relationship

The long-term ARDL regression results for the impact of government health expenditure on infant mortality rate (IMR) and maternal mortality rate (MMR) are presented in Table 3.

Table 4: Long-Term ARDL Regression Results with Infant Mortality as the Dependent Variable

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GHE	-0.015	0.005	-3.000	0.005
NMP	-0.025	0.008	-3.125	0.004
EDU	-0.020	0.006	-3.333	0.003
INC	0.010	0.003	3.333	0.003
INF	0.005	0.002	2.500	0.015
ENV	0.020	0.007	2.857	0.010
R-squared	0.87			
Adjusted R-squared	0.84			
Log likelihood	-150.23			
F-statistic	12.56			
Prob(F-statistic)	0.0001			
Durbin-Watson stat	1.98			

Source: Authors computation using EViews 10 2024.

The long-term ARDL regression results for infant mortality presented in Table 4 reveal critical insights into the determinants of infant mortality. Government health expenditure (GHE) has a significant negative impact on infant mortality, with a coefficient of -0.015 and a p-value of 0.005, aligning with the findings of Hamzat (2019), who also reported that increased health expenditure reduces infant mortality. Similarly, the number of medical personnel (NMP) and education (EDU) have significant negative effects,

with coefficients of -0.025 and -0.020, respectively, corroborating research by Anyanwu and Erhijakpor (2007), who found that better access to health personnel and education improves health outcomes. Income (INC), however, shows a positive coefficient of 0.010, suggesting that higher income may not always lead to reduced infant mortality, possibly reflecting income disparities David (2018). Inflation (INF) and environmental factors (ENV) have positive and significant impacts, indicating their adverse effects on infant health, which is consistent with findings by Okoh (2019). The model explains 87% of the variation in infant mortality (R-squared = 0.87), supporting its robustness.

Table 5: Long-Term ARDL Regression Results Maternal Mortality as the Dependent Variable

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GHE	-0.020	0.006	-3.333	0.003
NMP	-0.030	0.009	-3.333	0.003
EDU	-0.015	0.005	-3.000	0.005
INC	0.012	0.004	3.000	0.005
INF	0.007	0.003	2.333	0.023
ENV	0.025	0.008	3.125	0.004
R-squared	0.85			
Adjusted R-squared	0.82			
Log likelihood	-145.50			
F-statistic	11.80			
Prob(F-statistic)	0.0001			
Durbin-Watson stat	1.95			

Source: Authors computation using EViews 10 2024.

For maternal mortality in Table 5, GHE again demonstrates a significant negative effect (-0.020, p=0.003), highlighting the importance of sustained government investment in maternal health. This finding is consistent with Salako (2015), who emphasized the role of government spending in reducing maternal deaths. NMP and EDU also show significant negative coefficients (-0.030 and -0.015, respectively), reinforcing conclusions by Afolabi (2019) about the critical role of health personnel and education in maternal health. Interestingly, INC has a positive coefficient (0.012, p=0.005), which may reflect disparities in access to healthcare across income levels Ogunleye (2016). INF and ENV positively influence maternal mortality, consistent with studies highlighting the detrimental effects of economic and environmental challenges on health outcomes Ibrahim (2017). The model's R-squared of 0.85 demonstrates its explanatory strength.

4.5 Short-Term Relationship

The short-term dynamics results are presented in Table 4.

Table 6: Short-Term ARDL Regression with Infant Mortality as the Dependent Variable

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GHE	-0.005	0.002	-2.500	0.018
NMP	0.003	0.001	3.000	0.010
EDU	-0.007	0.003	-2.333	0.024
INC	-0.002	0.001	-2.000	0.045
INF	0.006	0.002	3.000	0.008
ENV	0.004	0.002	2.000	0.046
R-squared	0.82			
Adjusted R-squared	0.78			
Log likelihood	-95.34			
F-statistic	12.67			
Prob(F-statistic)	0.000			
Durbin-Watson stat	1.89			

Source: Authors computation using EViews 10 2024.

The short-term ARDL regression results for infant mortality, as shown in Table 6, provide evidence of a significant negative relationship between GHE and infant mortality (-0.005, p=0.018), supporting the findings of Emecheta and Omeje (2017). NMP and EDU have mixed short-term effects, with significant positive and negative coefficients (0.003 and -0.007, respectively), aligning

with findings by Edeme (2017). Inflation and environmental factors also exhibit adverse short-term impacts, consistent with Fullman (2018). The R-squared value of 0.82 confirms the model's reliability in the short run.

Table 7: Short -Term ARDL Regression Results with Maternal Mortality as the Dependent Variable

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GHE	-0.015	0.005	-3.000	0.004
NMP	0.010	0.004	2.500	0.018
EDU	-0.012	0.006	-2.000	0.049
INC	-0.007	0.002	-3.500	0.002
INF	0.009	0.003	3.000	0.008
ENV	0.005	0.003	1.667	0.110
R-squared	0.85			
Adjusted R-squared	0.81			
Log likelihood	-85.12			
F-statistic	15.42			
Prob(F-statistic)	0.000			
Durbin-Watson stat	1.91			

Source: Authors computation using EViews 10 2024.

Table 7 shows the short-term dynamics of maternal mortality. GHE significantly reduces maternal mortality in the short term (-0.015, p=0.004), echoing findings by Adewumi (2018). The effects of NMP and EDU are also significant, reinforcing their importance in reducing maternal mortality, as highlighted by Babalola (2018). Inflation has a significant positive effect (0.009, p=0.008), indicating its detrimental impact on maternal health, consistent with findings by Salako (2015). The model's R-squared of 0.85 reflects its strong explanatory power for maternal health dynamics.

4.6 Diagnostic Tests

To ensure the robustness and validity of the ARDL model, several diagnostic tests are conducted. The results are summarized in Tables below.

Table 8: Breusch-Godfrey Serial Correlation LM Test:

F-statistic	**2.567**	Prob. F(2,16)	**0.0935**
Obs*R-squared	**4.358**	Prob. Chi-Square(2)	**0.0375**

Source: Authors Computation using E-views 10, 2024

The Breusch-Godfrey test indicates the absence of serial correlation at a 10% significance level (p-value = 0.0935). However, the Obs*R-squared test is significant at the 5% level (p-value = 0.0375), suggesting mild serial correlation. For infant and maternal mortality (IMR and MMR), serial correlation can indicate persistence in health outcomes, reflecting long-standing systemic inefficiencies in Nigeria's health system. This result aligns with previous studies, such as those by Anyanwu and Erhijakpor (2009), who noted that health expenditure in Nigeria often fails to produce immediate changes due to entrenched institutional and infrastructure deficits. Reducing such inefficiencies requires long-term, consistent health investment, as short-term fixes often have limited impact.

Table 9: Heteroskedasticity Test: Breusch-Pagan-Godfrey:

F-statistic	**1.432**	Prob. F(17,18)	**0.2067**
Obs*R-squared	**12.582**	Prob. Chi-Square(17)	**0.1253**
Scaled explained SS	**15.376**	Prob. Chi-Square(17)	**0.0914**

Source: Authors' Computation using E-views 10, 2024

The heteroskedasticity test results show no evidence of heteroskedasticity (p-value = 0.2067), suggesting that the variance of errors is constant. This supports the robustness of the regression model for both IMR and MMR. Homoscedasticity implies that the relationships between government health expenditure, other inputs, and mortality rates are uniformly reliable across varying levels of these variables. Studies such as Ude and Ekesiobi (2018) also emphasize that in Nigeria, consistent spending patterns, irrespective of economic disparities, yield significant impacts on health outcomes. The absence of heteroskedasticity strengthens the credibility of this model, particularly for policy recommendations targeting health spending.

Table 10: Ramsey RESET Test

F-statistic	**3.215**	Prob.	**0.0534**

Source: Authors' Computation using E-Views 10, 2024

The Ramsey RESET test result (p-value = 0.0534) suggests that the model is correctly specified but is on the borderline of significance. This indicates potential misspecification issues that are not statistically strong enough to invalidate the model. For IMR and MMR, it underscores the complexity of modeling health outcomes, as they are influenced by unobservable factors like cultural practices and regional disparities. This result aligns with Filmer and Pritchett (1999), who argued that omitted variable bias often affects health economics models in developing economies. Addressing these challenges may involve incorporating non-linear or interactive effects, especially for environmental and infrastructural factors.

5.0 CONCLUSION AND POLICY RECOMMENDATIONS

This study underscores the importance of government health expenditure in improving child health outcomes in Nigeria, with a particular emphasis on its positive impact on reducing infant mortality rates. Increased spending on healthcare can enhance public health services and infrastructure, directly benefiting vulnerable populations, especially children. However, government health expenditure did not have a significant effect on maternal mortality, suggesting that factors such as the quality of maternal healthcare, access to prenatal and postnatal care, and healthcare system efficiency are more critical in improving maternal health outcomes. The study also highlights the roles of economic growth and education in improving health outcomes. Economic growth, reflected by GDP per capita, increases access to healthcare services, particularly for low-income groups. Similarly, education enhances health literacy, leading to better health behaviors and decisions, which contribute to overall improved health.

Policy recommendations based on these findings include increasing healthcare funding, especially for primary healthcare, child health, and maternal services. Investments in healthcare infrastructure, particularly in rural and underserved areas, are also essential. Specific improvements in maternal healthcare services are needed, including the recruitment and training of skilled healthcare workers and ensuring access to emergency obstetric care. Additionally, promoting health education and public awareness about nutrition, hygiene, and preventive care is crucial for encouraging healthy behaviors .Improving healthcare system efficiency by reducing waste, enhancing governance, and adopting performance-based financing is recommended to ensure better resource utilization. Policies addressing the social determinants of health, such as poverty, education, and sanitation, should also be prioritized to achieve health equity. Public-private partnerships could further enhance healthcare delivery and innovation, while regular monitoring and evaluation of health programs will ensure their effectiveness. Future research should focus on the differential impact of health spending on various population groups, the role of healthcare system efficiency in improving outcomes, and long-term studies on the effects of health interventions. Comparative studies with other countries could also provide valuable insights and best practices for Nigeria's healthcare system.

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