EFFECT OF PUBLIC EXPENDITURE ON HEALTH AND EDUCATION ON MATERNAL AND UNDER-FIVE MORTALITY IN NIGERIA

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ABSTRACT

Health outcomes in Nigeria remain particularly poor, with women and children being disproportionately affected. This study analyses the effect of public expenditure on health and education on maternal and under-five mortality in Nigeria. The theoretical framework for the study is adapted from Grossman's (1972) model. The study employed the Autoregressive Distributed Lag (ARDL) model to estimate time series data obtained from the World Development Indicators, spanning 1980-2023. The study's findings indicate that public expenditure on education decreased maternal mortality rates in both the short- and long-term, whereas public spending on health did not reduce under-five mortality rates. The ratio of midwives per population decreased deaths among women of reproductive ages over the long term. Measures of access to health care, such as the number of physicians per population, vaccination coverage, and skilled birth delivery, did not have a significant impact on children under five. It is recommended that government increase health expenditure, particularly in the areas that promote women's and children's health, such as increased access to antenatal care, vaccination coverage, and increasing the number of physicians and midwives available to these population groups.

Keywords: Public Expenditure, Maternal Mortality, Under-five Mortality, Health, Education

JEL classification: B55, C10, I15, I31, O15

1. Introduction

International and national agencies are increasingly advocating for improved health outcomes that align with the Sustainable Development Goal 3 (SDG 3) of the United Nations. The SDG 3, and its target 3.1 and 3.2, address maternal and child health, aiming to improve healthcare access, quality, and outcomes for mothers and children worldwide. Health outcomes represent the tangible effects of interventions on the health status of individuals or population groups. These outcomes are critical indicators of the quality and effectiveness of healthcare systems and practices. In Nigeria, health outcomes remain particularly poor, with women and children being disproportionately affected. Nigeria has the second highest rate of maternal and child mortality globally (World Health Organization, 2023). The maternal mortality rate stands at an alarming 1,047 deaths per 100,000 live births, far surpassing the SDG Target 3.1, which seeks to lower this figure to 70 deaths per 100,000 live births (World Bank, 2024). In 2022, the under-five mortality rate was reported at 107.2 deaths per 1,000 live births, significantly exceeding the SDG target of 25 deaths per 1,000 live births (World Bank, 2024). The consistently poor health outcomes for women and children highlight significant challenges within Nigeria's healthcare system and signal a deteriorating standard of well-being among the population, with both immediate and long-term implications (Dauda et al., 2023).

Human capital development focuses on government investments aimed at improving healthcare access, increasing school enrolment, and boosting adult literacy. This concept emphasizes the importance of viewing expenditure on education, health, and overall development as essential investments. Such public spending not only improves individual well-being but also contributes to the overall welfare of society. Existing research on Nigeria has predominantly examined the link between public health expenditure as an indicator of human capital development, while largely overlooking the critical role of public spending on education and its effect on health outcomes. Grossman's (1972) human capital model highlights that individuals' health deteriorates over time, resulting in rising rates of morbidity and mortality. Nevertheless, Grossman argues that adverse health outcomes can be mitigated through improved access to healthcare services and improved literacy. His model emphasizes the significance of government investment in both health

and education as essential drivers of societal well-being and key strategies for reducing mortality rates. Furthermore, these studies have largely neglected to examine the impact of healthcare access factors on the health outcomes of women and children. Such factors include the availability of physicians and skilled birth attendants in proportion to the population, as well as coverage of antenatal care and vaccinations. This study advances the existing body of literature by examining the distinct impacts of public expenditure on health and education on maternal and under-five mortality. In addition, the study incorporates healthcare access variables, specifically the availability of medical services and healthcare personnel as well as literacy rates as control variables within the analytical framework. The study examined the effect of public expenditure on health and education in reducing maternal and under-five mortality rates in Nigeria.

2. Literature Review

The link between investment in human capital and health outcomes can be situated within the human capital theory (HCT), The major proponents being Shultz (1961) and Becker (1964). Shultz (1961) noted that investments in education and training are a significant source of economic growth, classifying expenditures on human capabilities as investment rather than mere consumption. Becker (1964) developed the model of individual investment in human capital. He argued that individuals act as wealth maximizers, choosing to invest in education, training, and health up to the point where the expected rate of return (higher future earnings) exceeds the cost (direct costs plus foregone earnings/time). This established the link between investment, productivity, and higher individual income. Critics argue that HCT offers a poor conception of capital, viewing human activity solely through the lens of a "commodity exchange" and failing to recognize the non-economic, social, and cultural aspects of human development.

Grossman (1972) further applied the HCT to health, viewing health not as a simple consumption item, but as a durable capital good that individuals produce and invest in over their lifetime. The Grossman model established the individual as both the consumer and producer of their own health, using an

intertemporal optimization framework (maximizing lifetime utility). Health, or the stock of health capital, plays three distinct roles in the model. Firstly, as a consumption good, health enters the utility function directly. Being healthy provides direct utility (pleasure or satisfaction), while being sick causes disutility. Secondly, health is seen as an investment good that depreciates over time with individuals' expenditure in this stock offsetting depreciation in their health level. Thirdly, health serves as an input in production. It determines the amount of health time available for all other activities such as work, leisure and health investment activities. Healthier people have less sick time and, therefore, more productive time to allocate to increasing their income or consuming commodities. This is the investment function of health. Despite its influence, the Grossman model has faced criticism (Sepehri, 2015). The model essentially treats medical care as a generic input for preventive investment. Critics argue it fails to adequately model the demand for curative care, which is typically demanded after an illness occurs to restore a lost stock, making it act more like a standard consumption good than a capital investment.

Several studies have tried to established the validity of the propositions of both the HCT and the health care demand theory in terms of how human capital investment affects health outcomes. Previous studies have concentrated on public health expenditures, often overlooking the potential impact of public spending on education on reducing mortality rates in the short and long terms. Empirical research on the relationship between government health expenditures and maternal and child mortality rates can broadly be categorized into studies conducted for sub-Saharan Africa (SSA) and those focused on individual countries. Studies conducted across multiple countries in SSA generally applied static panel data methodologies. The findings consistently show an inverse relationship between public expenditure on health and under-five mortality rates. However, research addressing the relationship between public health spending and mortality among women of reproductive age in the region is relatively sparse. Using panel data methodology, Arthur and Oaikhenan (2017) found that government spending on health significantly reduced maternal and under-five mortality rates in SSA. Similarly, Nicholas et al. (2016), using a fixed-effect model, observed a significant negative relationship between government health expenditure and under-five mortality. However, they noted no significant effect on maternal mortality rates.

Additionally, out-of-pocket health expenditure was found to be insignificant in improving maternal and child health outcomes.

Novignon and Lawanson (2017) demonstrated that a 10% increase in public health spending resulted in a 0.9% reduction in under-five mortality, emphasizing that increased health expenditure was strongly associated with improved health outcomes. These findings were corroborated by other studies in SSA, which similarly indicated that higher public health spending reduces infant mortality and enhances child health outcomes (Kiross et al., 2020; Ayipe & Tanko, 2023).

In contrast, findings from single-country studies present mixed results. Oladosu et al. (2022), in a comparative study of Nigeria and Ghana, reported a positive association between public health expenditure and both infant and maternal mortality in Nigeria. Interestingly, in Ghana, public health expenditure was found to have no significant effect on mortality measures. Azuh et al. (2020), employing the Autoregressive Distributed Lag (ARDL) methodology on time series data, found that government spending on health did not improve under-five mortality rates in Nigeria. Anokwuru and Chidinma (2023), using data from 2002 to 2021, observed that government health expenditure had no significant long-term effect on infant mortality. However, they noted that in the short term, public spending did not improve infant mortality levels. Similarly, David (2018), using data from 1980 to 2016, found a significant but negative association between public health spending and infant mortality in Nigeria. This implies that despite increased expenditure, health outcomes for children remained unimproved. In a related study, Razakamanana et al. (2023) examined the effects of public health spending in the 22 regions of Madagascar. They observed that while public funding significantly improved maternal health, it had no discernible impact on child health. Notably, none of the reviewed studies for Nigeria specifically examined the impact of government expenditure on maternal mortality outcomes. While some studies investigated the effects on under-five mortality, there remains a gap in the literature regarding simultaneous analysis of both maternal and child health outcomes. This study addresses this gap by investigating the impact of government expenditure on child and maternal mortality in Nigeria. Thus, it

enhances the existing body of literature by providing a more nuanced understanding of how public spending influences critical health outcomes.

Ogunjimi and Adebayo (2018) examined the relationship among health expenditure, health outcomes, and economic growth in Nigeria over the period from 1981 to 2017. This study used the Toda-Yamamoto causality test to determine the direction of causality, and the Autoregressive Distributed Lag (ARDL) Bounds test approach to cointegration to investigate if a long-term relationship exists among the macroeconomic variables. The Augmented Dickey-Fuller unit root test checked the maximum order of integration of the variables used in the study. The results of the Toda-Yamamoto causality tests indicated a unidirectional causality running from health expenditure to infant mortality, with no causality between real GDP and infant mortality; a unidirectional causal relationship from health expenditure and real GDP to life expectancy and maternal mortality; and a unidirectional causal relationship from real GDP to health expenditure. The study recommended that efforts should be made by the country to increase health expenditure, at least to meet the WHO recommendation of allocating at least 13 percent of the country's annual budget to the health sector for effective funding to achieve desired health outcomes. The use of modern technology and professional health personnel should be sought to combat the high incidence of maternal and infant mortality in Nigeria's health sector.

Boundioa and Thiombiano (2024), in their study, analysed the effects of public health expenditure on maternal mortality in West African Economic and Monetary Union countries (WAEMU), recognizing that maternal mortality was the highest in WAEMU compared with other regions in the world, and health care sources were private and largely out-of-pocket expenditures, which may prevent healthcare access. The study covered seven countries using panel data from the World Bank Development Indicators (WDI) from 1996 to 2018. Two-step least squares (2SLS) was used to estimate the effect of public health expenditure on maternal mortality in the health demand function. The result revealed that public health care spending has a significant negative association with maternal mortality. However, it showed that private health expenditure was positively associated with maternal mortality. The study recommends that, to reduce maternal mortality, public health care expenditure remains essential, and that the authorities need to increase public health spending to build more

health centres and improve the equipment in existing infrastructure. They added that it is necessary to reduce the financial barriers for pregnant women by reducing household payments.

Azuh et al. (2020) investigated the contribution of government health expenditure to under-five mortality in Nigeria. Using the autoregressive distribution lag technique (ARDL), they examined the long-run effect of public health expenditure on under-five mortality in Nigeria. Data used were sourced from the World Development Indicators for the period 1985–2017. The study revealed a positive, significant relationship between public health expenditure and under-five mortality. In their conclusion, they observed that a 1-unit increase in public health expenditure would reduce the under-five mortality rate by 1.56 units. However, in the Nigerian context, the result can be better explained by the lack of proper health-fund coordination and other factors, such as maternal education.

Aderopo and Ekomoezor (2019) examined the direction of the relationship among public health spending, maternal education, and under-5 mortality using yearly time-series data covering the period 1980-2018 and employing the Toda-Yamamoto non-Granger causality test as the principal tool of analysis. The study established a unidirectional relationship running from under-5 mortality to public health spending and maternal education. To them, the finding appears to align with Wagner's law of increasing state activities, such that an increase or decrease in the rate of under-five mortality leads to an increase or decrease in public health spending, not vice versa. The study concluded that changes in the rate of under-5 mortality could be used to model or predict future growth in public health spending and maternal educational attainment, but the reverse was not true.

3. Method

3.1 Model specification

The study examined the effects of human capital development on maternal and under-five mortality rates in Nigeria. The demand for a health model proposed by Grossman (1972), is adapted for this study because it offers a conceptual framework for understanding the accumulation of human capital and its

relationship to health outcomes. A key contribution of this model is its dual focus on health and education as critical components of human capital and their influence on health outcomes. Health capital is distinguished from other forms of human capital by its unique impact on various activities. Like other types of capital, health depreciates over time, with the rate of depreciation increasing with age. To counteract this decline, investments are required to maintain or restore health stocks, incorporating inputs such as exercise, nutrition, and healthcare services. Additionally, the model posits that higher levels of education enhance the efficiency of health investments, leading to improved health outcomes.

The theoretical model for this study is based on the Grossman (1972) health production function. The model assumes that health outcome is an output that depends on investments in medical inputs, and public and private investments in health. The health production function is specified as:

$$Y_t = \alpha_0 + \alpha_1 \upsilon_t + \alpha_2 \beta_t + \partial_t + \varepsilon_t \quad (1)$$

where: Y_{it} is a vector of health outcomes, namely maternal mortality rate (MMR) and under-five mortality *(U5M)*. υ_t, is a vector of covariates comprising health expenditure, specifically public health expenditure *(GEH)*, public education expenditure *(GEE)*, and out-of-pocket healthcare expenditure *(OOP)*. The vector of the access to health variable is β_t. The covariates are represented by ∂_t. Equation (1) is broken down into the maternal mortality and under-five mortality equations:

Maternal Mortality Equation

$$MMR = f(GEH, GEE, LR, AHC, OOP, ACC, RMP) \quad (2)$$

Under-5 Mortality Equation

$$U5M = f(GEH, GEE, LR, AHC, OOP, VC, SBA) \quad (3)$$

where:

MMR = Maternal mortality rate, measured in percentages

U5MR = Under-five mortality rate, measured in percentages

GEH = Total government expenditure on health, measured in millions of naira

GEE = Total government expenditure on education, measured in millions of naira

LR = Literacy rate, measured by the adult literacy rate in the country

OOP = Out-of-pocket expenditure on health, measured in millions of naira

*PP*1000=Physicians per 1000, measured as a percentage and used as a proxy for Access to Health Care (AHC)

ACC = Antenatal care coverage

RMP = Ratio of midwives to population used as a proxy for Access to Health Care (AHC)

VC = Vaccination coverage, proxied by measles immunization rate of 12 - 23 months-old children, used as a proxy for Access to Health Care (AHC)

SBA = Number of skilled birth attendance per 1000 live births (Access to health proxy)

Equations (2) and (3) can be expressed in their econometric forms as equations (4) and (5):

$$\text{MMR} = \alpha_0 + \alpha_1\text{LNGEH} + \alpha_2\text{LNGEE} + \alpha_3\text{LR} + \alpha_4\text{PP1000} + \alpha_5\text{LNOOP} + \alpha_6\text{ACC} + \alpha_7\text{RMP} + U_1 \quad (4)$$

$$\text{U5M} = \beta_0 + \beta_1\text{LNGEH} + \beta_2\text{LNGEE} + \beta_3\text{LR} + \beta_4\text{PP1000} + \beta_5\text{LNOOP} + \beta_6\text{VC} + \beta_7\text{SBA} + U_2 \quad (5)$$

α_0 and β_0 are the constant and intercept terms for each of the specified equations above.

α_1, α_2, $\alpha_3, \alpha_4, \alpha_5, \alpha_6,$ and α_7 are respective parameters of the independent variables of the public expenditure and maternal mortality equation.

β_1 - β_7 are the respective parameters of the independent variables in the human capital and under-five mortality equation.

U_1 and U_2 are the error terms for each of the specified equations above.

To examine the relationship between public expenditure on health and education and health outcomes of women and children in Nigeria, three steps are applied in the estimation process. In the first step, stationarity of the variables using unit root tests is analysed. In the second step, tests of the presence of both short-run and long-run relationships between the variables are carried out, and the third step conducts the diagnostics to ensure that the coefficients are stable and not driven by biases. In this study, the autoregressive distributed lag (ARDL) bounds testing technique to cointegration pioneered by Pesaran et al. (2001) was employed. This econometric technique has advantages over other traditional cointegration techniques. First, it is a more robust econometric technique for analysing level relationships even when the sample size is small, and it can be employed regardless of whether the variables are integrated of order zero or one, that is, the variables can either be I(0)s and or I(1)s. Second, the use of the ARDL method is advised because it can correct for any possible endogeneity among the independent variables. Thus, equations (3) and (4) are specified in the ARDL model as follows:

$$\begin{aligned}\Delta MMR = {} & \alpha_0 + \sum_{i=1}^{t} \alpha_1 \Delta MRR_{t-i} + \sum_{i=1}^{t} \alpha_2 \Delta LNGEH_{t-i} + \\ & \sum_{i=1}^{t} \alpha_3 \Delta LNGEE_{t-i} + \sum_{i=1}^{t} \alpha_4 \Delta LR_{t-i} + \sum_{i=1}^{t} \alpha_5 \Delta PP1000_{t-i} + \\ & \sum_{i=1}^{t} \alpha_6 \Delta LNOOP_{t-i} + \sum_{i=1}^{t} \alpha_7 \Delta ACC_{t-i} + \sum_{i=1}^{t} \alpha_8 \Delta RMP_{t-i} + \\ & \varphi_1 MRR_{t-i} + \varphi_2 LNGEH_{t-i} + \varphi_3 LNGEE_{t-i} + \varphi_4 LR_{t-i} + \\ & \varphi_5 PP1000_{t-i} + \varphi_6 LNOOP_{t-i} + \varphi_7 ACC_{t-i} + \varphi_8 ACC_{t-i} + \mu_t \end{aligned} \quad (6)$$

$$\begin{aligned}\Delta U5M = {} & \beta_0 + \sum_{i=1}^{t} \beta_1 \Delta U5M_{t-i} + \sum_{i=1}^{t} \beta_2 \Delta LNGEH_{t-i} + \\ & \sum_{i=1}^{t} \beta_3 \Delta LNGEE_{t-i} + \sum_{i=1}^{t} \beta_4 \Delta LR_{t-i} + \sum_{i=1}^{t} \beta_5 \Delta PP1000_{t-i} + \\ & \sum_{i=1}^{t} \beta_6 \Delta LNOOP_{t-i} + \sum_{i=1}^{t} \beta_7 \Delta VC_{t-i} + \sum_{i=1}^{t} \beta_8 \Delta SBA_{t-i} + \\ & \vartheta_1 U5M_{t-i} + \vartheta_2 GEH_{t-i} + \vartheta_3 GEE_{t-i} + \vartheta_4 LR_{t-i} + \vartheta_5 PP1000_{t-i} + \\ & \vartheta_6 OOP_{t-i} + \vartheta_7 ACC_{t-i} + \vartheta_8 ACC_{t-i} + \mu_t \end{aligned} \quad (7)$$

where: Δ denotes the first difference operator, *t* is the lag length, short run coefficients for maternal mortality and child mortality are expressed as $\alpha_1 \ldots\ldots \alpha_8$ *and* $\beta_1 \ldots\ldots \beta_8$ respectively. The long-run coefficients are expressed as $\varphi_1 \ldots \ldots \varphi_8$ and $\vartheta_1 \ldots \ldots \vartheta_8$ respectively and LN represents the log form of the variables.

To account for short-run deviations from the established long-run equilibrium, the specified equation is reformulated into an error correction version. This transformation incorporates an error correction term, which quantifies the speed at which any disequilibrium in the short run is corrected to restore the long-run equilibrium relationship. To account for the short-run deviation from the long-run equilibrium, equations (5) and (6) are re-specified into the error correction version as:

$$\Delta MMR = \alpha_0 + \sum_{i=1}^{t} \alpha_1 \Delta MRR_{t-i} + \sum_{i=1}^{t} \alpha_2 \Delta GEH_{t-i} + \sum_{i=1}^{t} \alpha_3 \Delta GEE_{t-i} + \sum_{i=1}^{t} \alpha_4 \Delta LR_{t-i} + \sum_{i=1}^{t} \alpha_5 \Delta PP1000_{t-i} + \sum_{i=1}^{t} \alpha_6 \Delta OOP_{t-i} + \sum_{i=1}^{t} \alpha_7 \Delta ACC_{t-i} + \sum_{i=1}^{t} \alpha_8 \Delta RMP_{t-i} + \rho ECT_{t-1} + \mu_t \quad (8)$$

$$\Delta U5M = \beta_0 + \sum_{i=1}^{t} \beta_1 \Delta U5M_{t-i} + \sum_{i=1}^{t} \beta_2 \Delta GEH_{t-i} + \sum_{i=1}^{t} \beta_3 \Delta GEE_{t-i} + \sum_{i=1}^{t} \beta_4 \Delta LR_{t-i} + \sum_{i=1}^{t} \beta_5 \Delta PP1000_{t-i} + \sum_{i=1}^{t} \beta_6 \Delta OOP_{t-i} + \sum_{i=1}^{t} \beta_7 \Delta VC_{t-i} + \sum_{i=1}^{t} \beta_8 \Delta SBA_{t-i} + \rho ECT_{t-1} + \mu_t \quad (9)$$

where: ρ indicates the speed of adjustment and ECT_{t-1} is the error correction term.

3.2 Data sources

Data for 1980-2023 was sourced from the World Bank World Development Indicators, and the Global Health Observatory of the World Health Organization (WHO). The following variables were obtained from the Global Health Observatory: antenatal care coverage, vaccination coverage, number of skilled birth attendance per 1,000 live births. Other variables were obtained from the World Bank database.

4. Results and Discussion

4.1 Unit root test

The results of the unit root test are reported in Table 1. The results of this study indicate that government health spending, government spending on education, and the ratio of midwives to the population were stationary at their levels. In

contrast, the other variables were found to be non-stationary at levels. Similarly, the Phillips-Perron (PP) unit root test results presented in Table 1 indicate that government expenditure on health and education, as well as the ratio of midwives to the population, are stationary at their levels. The computed t-statistics for these variables were larger than the critical value at the 5% significance level. However, other variables were stationary after their first differencing, given that the series were integrated of either 1(0) or 1(1). Since the variables are integrated of the order of I(0) and I(1), we use the Autoregressive Distributive Lag methodology (ARDL).

Table 1: Unit Root Test Results

Variable	At level		After first difference		Remark
	ADF	PP	ADF	PP	
MMR	-1.37	-1.38	-5.69	-5.65	I(1)
	(0.89)	(0.95)	(0.00)	(1.00)	
U5M	1.92	-2.10	-6.10	-6.11	I(1)
	(0.26)	(0.37)	(0.00)	(0.001)	
LNGEH	4.75	9.28	-	-	I(0)
	(0.01)	(0.001)			
LNGEE	4.69	4.77	-	-	I(0)
	(1.00)	(1.00)			
LR	-2.42	-2.14	-7.96	-7.78	I(1)
	(0.4596)	(0.55)	(0.00)	(0.00)	
PP1000	-1.23	-1.24	-7.00	-7.01	I(1)
	(0.99)	(0.56)	(0.02)	(0.00)	
LNOOP	-0.86	-0.66	-6.51	-8.05	I(1)
	(0.99)	(0.99)	(0.00)	(0.00)	
ACC	-1.79	-1.78	-7.04	-7.04	I(1)
	(0.54)	(0.32)	(1.00)	(1.00)	
RMP	-3.96	-3.88	-	-	I(0)
	(0.00)	(0.00)			
VC	-0.80	-0.74	-5.85	-5.93	I(1)
	(0.31)	(0.31)	(0.0042)	(0.0024)	
SBA	-1.17	-1.02	-5.51	-5.61	I(1)
	(0.31)	(0.33)	(1.00)	(1.00)	

Source: Authors' computation, 2024.

4.2 Analysis of maternal mortality equation

ARDL Cointegration Test

The cointegration test is estimated to test the possibility of a long-run relationship among the variables. The results of the bounds test are presented below.

ARDL Bounds Test for Maternal Mortality Equation

The results of the bounds test for cointegration of the maternal mortality rate equation are depicted in Table 2. The results demonstrate that the calculated F-statistic of 4.51 exceeded the upper bound critical value of 3.21 at the 5% significance level. Therefore, the study concluded that a long-run relationship exists among the variables in the maternal mortality equation.

Table 2: ARDL Bounds Test Result for Maternal Mortality Equation

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.51	10%	1.92	2.89
K	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.90

Source: Authors' computation, 2024.

The result of the long-run estimation is depicted in Table 3. The result shows that government expenditure on health (783.7) exerted a significantly positive impact on maternal deaths in the long run, suggesting that an increase in government health expenditure will create an additional 787 deaths in women of reproductive age. Overall, the estimate of government expenditure on education (-784.5) showed a significantly inverse relationship with maternal mortality rate in the long run, implying that government spending on education could lower maternal deaths.

The results of the coefficients of the literacy rate, and out-of-pocket expenditures (12.8 and 136.25 respectively) reveal a positive and insignificant relationship with the MMR, suggesting that literacy rates and out-of-pocket expenditures did not affect the maternal mortality rate.

Finally, the long-run results reveal that the estimate of physicians per 1000 persons (747.13) had a positive and insignificant impact on maternal deaths per 100,000 live births, indicating that an increase in the number of doctors in a hospital per patient did not have any effect on MMR. The coefficient of antenatal care coverage (-19.65) was negative and statistically significant, suggesting that increased ANC coverage among women of reproductive age lowered maternal deaths.

Table 3: ARDL Long-run Estimates of the Maternal Mortality Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1857.41	2892.16	0.64	0.53
LNGEH	783.71	231.97	3.38	0.01
LNGEE	-784.45	206.92	-379.00	0.00
LR	12.80	6.20	2.06	0.06
LNOOP	136.25	710.61	0.19	0.85
PP1000	747.14	473.34	1.58	0.14
ACC	-19.66	5.45	-3.61	0.00
RMP	-3.42	5.98	-0.57	0.58

Source: Authors' computation, 2024.

The short-run results in Table 4 show that the current value of government expenditure on health (ΔLNGEH, 319.99) has a significantly positive relationship with maternal mortality rate (MMR) in the short run. This indicates that increased health spending by government would lead to an additional 320 maternal deaths. The coefficient of government expenditure on education in the current period (ΔLNGEE -258.59) shows a negative and statistically significant relationship. The error correction results show that an increase in LNGEE will result in a decline of 259 deaths among women of reproductive age. The findings show that the coefficient of literacy rate (ΔLR 14.93) was positive and significantly different from zero. The coefficient of out-of-pocket expenditure (ΔLNOOP) was 265.56; although positive, it had an insignificant effect on the maternal mortality ratio (MMR).

The coefficient for the number of physicians per 1000 persons (-144.64) showed an inverse and statistically insignificant impact on the dependent variable maternal mortality (MMR) deaths per 100,000 live births in the short

run. The negative sign of the coefficient of Antenatal Care Coverage (ΔACC, -19.66) showed a negative and significant relationship between antenatal care coverage and maternal deaths in the short run. This means that an increase in antenatal care services to pregnant women will lead to an additional decline of 19 deaths in women of reproductive age.

The coefficient of the ratio of midwives to population (ΔRMP, -3.45) was negative and insignificant. The result means that the ratio of midwives in the population was not significant in reducing maternal mortality.

The error correction coefficient (ECT) of -0.62 from the short-run result was significant. This implies that approximately 62% of the disequilibrium in the short-run relationship between the variables in the maternal mortality equation will be corrected in the long run.

Table 4: ARDL Error Correction Model for Maternal Mortality Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ΔLNGEH	319.99	95.05	3.37	0.01
ΔLNGEE	-258.59	86.11	-3.00	0.01
ΔLR	14.93	2.17	6.88	0.00
ΔLNOOP	265.56	149.25	1.78	0.10
ΔPP1000	-144.64	260.57	-0.56	0.59
ΔACC	-19.66	3.14	-6.26	0.00
ΔRMP	-3.42	3.36	-1.02	0.33
CointEq(-1)*	-0.63	0.07	-8.37	0.01
R-Squared	0.88			
Adjusted R-Squared	0.74			
Dubin-Watson Stat	2.06			

Source: Authors' computation, 2024.

Diagnostic Test for Maternal Mortality Rate Equation

The maternal mortality equation diagnostic tests are specified in Table 5. The Breusch-Godfrey for Serial Correlation LM test value presented was 3.26 and a probability value of 0.0859. This is not statistically significant at 5% as the

probability value is greater than 0.05, so we accept the null hypothesis that there is no serial correlation in the estimated model at up to three lags. Checking for heteroscedasticity, the ARCH test was employed, and results showed a value of 3.059 and a probability value of 0.0884 which is larger than 5%. This result is not statistically significant, hence, we accept the null hypothesis that the model is homoscedastic.

The plot of the CUSUM test graph at the 5% critical lines as depicted in Figure 1 shows that the recursive line lies between the critical lines, indicating the stability of the model. The outcomes of the diagnostic evaluations indicate that the projected maternal mortality model is both sufficient and stable.

Table 5: Diagnostic Test Results

Test statistic	Value (prob.)
Breusch-Godfrey Serial Correlation LM Test	3.26 (0.09)
Breusch-Pagan-Godfrey Heteroscedasticity Test	3.05 (0.09)

Source: Authors' computation, 2024.

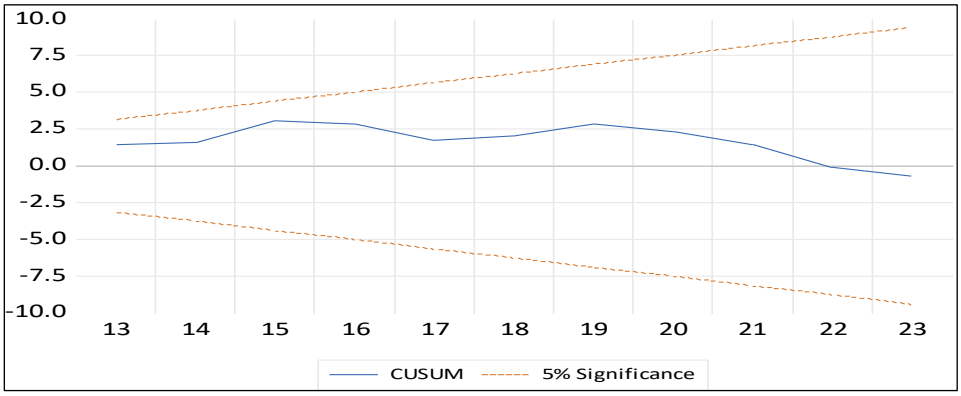

Figure 1: Cumulative Sum of Residuals (CUSUM) Test for Maternal Mortality Equation

Source: Authors' computation, 2024.

4.3 Under-five mortality equation

ARDL Bounds test of the under-five mortality equation

As shown in Table 6, the bounds test for cointegration reveals a calculated F-statistic of 10.77, which exceeds the upper bound critical value of 3.21 at the

5% significance level. Accordingly, the study infers a long-run association among the variables in the under-five mortality rate equation.

Table 6: Bounds Test for Under-five Mortality Rate Equation

Test Statistic	Value	Significance	I(0)	I(1)
F-statistic	10.77490	10%	1.92	2.89
K	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.90

Source: Authors' computation, 2024.

The results of the long-run estimation are presented in Table 7. The analysis reveals that the coefficient of government expenditure on health, estimated at -86.81, demonstrates an inverse relationship with under-five mortality rates. This suggests that an increase in government spending on the health sector is linked to a reduction of approximately 86.8 deaths. Government expenditure on education showed a positive and significant relationship with the death of children below the age of 5. This suggests that an increased government expenditure on education will bring about the death of an additional 78 children below the age of 5 in Nigeria.

The coefficient of literacy rate of 0.99 revealed a positive and significant impact on under-five mortality rates. This suggests that increased literacy rate will bring about an increase in child mortality in the long run. This, however, does not conform with economic theories. The coefficient of the number of physicians per 1000 people (23.67), although positive, was not statistically different from zero. Implying that it did not affect the under-five mortality rate.

Finally, the findings indicate that, over the long term, the estimate of out-of-pocket health expenditure of 130.7% was not statistically different from zero. The long-run estimates of vaccination coverage (66.68) and the number of skilled birth attendants per 1,000 live births (0.62) did not have a significant effect on under-five mortality figures.

Table 7: ARDL Long-run Estimate of Under-five Mortality Rate Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-641.37	339.81	-1.89	0.08
LNGEH	-86.81	17.09	-5.08	0.00
LNGEE	78.25	16.71	4.68	0.00
LR	0.99	0.47	2.11	0.05
LNOOP	130.70	75.32	1.74	0.11
PP1000	23.67	138.82	0.17	0.87
VC	66.68	95.21	0.70	0.50
SBA	0.62	0.34	1.82	0.09

Source: Authors' computation, 2024.

The result of the ARDL estimates for the short-run dynamics of the under-five mortality rate equation is presented in Table 8. In the current period, the estimate for government expenditure on health (-28.43) has an inverse relationship with the under-five mortality rate in Nigeria, implying that an increase in government health spending will result in a reduction of an estimated 28 deaths in children below five years in Nigeria.

The results indicate that current government expenditure on education, demonstrated a positive association with under-five mortality rates in Nigeria. This finding deviates from economic expectations, implying in real terms that a unit increase in government expenditure on education resulted in an increase in the number of deaths of children below five years by about 24.55%. The estimate was statistically significant at the 5% level of significance.

Also, the estimate of the literacy rate (0.19) had a positive but not significant impact on the under-five mortality rate in Nigeria. This implies that the literacy rate has no effect on the deaths of children below the age of five years. The coefficient estimate of the number of physicians per 1000 persons (-167.87) was positive and statistically significant suggesting that increased access to physicians in the short run would result in a decline of 167 deaths among children under-five. The coefficient for out-of-pocket expenditure for health (21.13), although positive was not statistically significant showing that there was no relationship between out-of-pocket payments and under-five mortality rates in Nigeria.

The coefficient of the error correction term (-0.32) was negative and statistically significant, suggesting that approximately 32% of the disequilibrium in the short run is corrected through a gradual adjustment in the long-run equilibrium.

Table 8: ARDL Error Correction Model for the Under Five Mortality Rate Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ΔLNGEH	-28.43	9.05	-3.14	0.01
ΔLNGEE	24.55	8.89	2.76	0.02
ΔLR	0.12	0.15	0.78	0.45
ΔLNOOP	21.14	13.95	1.52	0.15
ΔPP1000	-167.87	37.75	-4.45	0.00
ΔVC	66.68	34.79	1.92	0.08
ΔSBA	0.62	0.19	3.35	0.01
CointEq(-1)*	-0.32	0.03	12.52	0.00
R-squared	0.93			
Adjusted R-squared	0.86			
Durbin-Watson stat	2.24			

Source: Authors' computation, 2024.

Diagnostic test for under-five mortality rate equation

The serial correlation test and the heteroscedasticity test were utilized to assess the normality and adequacy of the model. A summary of the test results is presented in Table 9 and Figure 2. The LM test statistic of 1.1247, coupled with its high p-value of 0.36, indicates an absence of autocorrelation in the model. This suggests that the residuals are independent, confirming no autocorrelation in the estimated equation. Similarly, the heteroscedasticity test statistic of 1.61, with a p-value of 0.205, demonstrates that heteroscedasticity is not an issue, implying that the disturbance terms are normally distributed. Overall, the results of the diagnostic tests confirm that the estimated equation is both robust and well-specified. To check the condition of stability of the estimated model, we employed the CUSUM test. The plot of the CUSUM test graph at the 5% critical lines depicted in Figure 2 shows that the recursive line is in between

the critical lines, indicating the stability of the estimated under-five mortality rate equation.

Table 9: Diagnostic Test for the Under-Five Mortality Equation

Test statistic	Value(prob.)
Breusch-Godfrey Serial Correlation LM Test	1.13 (0.36)
Breusch-Pagan-Godfrey Heteroscedasticity Test	1.61 (0.20)

Source: Authors' computation, 2024.

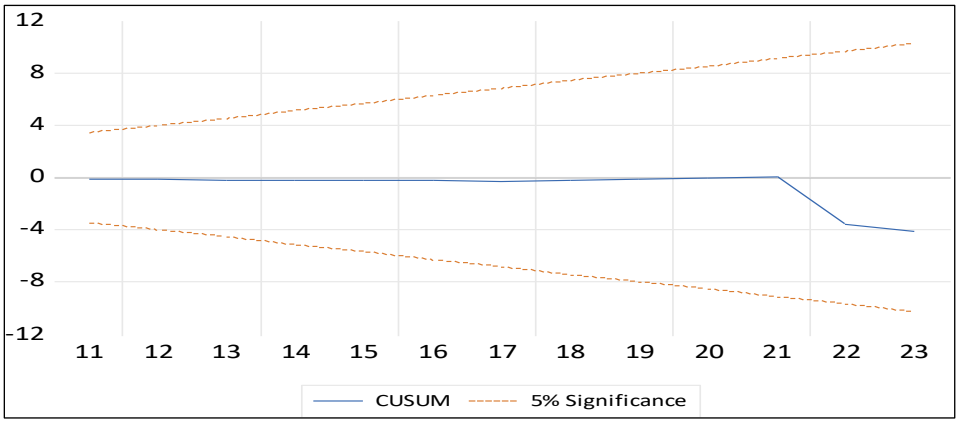

Figure. 2: Cumulative Sum of Residuals (CUSUM) test for the Under-five Mortality Rate Equation

Source: Authors' computation, 2024.

This study analysed the relationship between human capital development and maternal and under-five mortality outcomes in Nigeria from 1980 to 2023. The results from the findings reveal that government expenditure on health did not lower maternal mortality both over the short- and long-term periods. This finding is contrary to that obtained by Authur and Oaikhenan (2017). Public health care spending improved under-five mortality rates in the current period and over time. Similar findings were obtained by Nicholas et al. (2016) and Novignon and Lawanson (2019). However, contrary findings were expressed by Oladosu et al. (2020) and Azuh et al. (2020); they observed a positive association between public health expenditure and under-five mortality in Nigeria. Government expenditure on education lowered maternal mortality

rates in both the long-term and short-term periods. Government expenditure on education was positively associated with under-five mortality in the current period and over time. Long-term investments in antenatal care access and provision of care by skilled midwives reduced under-five mortality rates. Out-of-pocket spending on health did not have any effect on maternal and under-five mortality rates. These results indicate the need for targeted and consistent interventions by the government to address health challenges that affect women and children. For instance, the insignificant effects of factors such as the number of physicians per 1000 persons and deliveries by skilled birth attendants on the mortality rates stress the need to address factors that affect healthcare staff availability in the country. Also, the inverse relationship between out-of-pocket expenditure and mortality rates points to the financial barriers to getting quality healthcare services in Nigeria. Increasing out-of-pocket expenses deters people, particularly those from low-income households, from seeking timely and quality healthcare, leading to adverse health conditions and increased mortality rates, especially for women and children, who are the most vulnerable. Government expenditure on critical health services, such as vaccinations, disease control, preventive care, and educational initiatives, is warranted due to its effectiveness in curbing the prevalence of diseases and lowering death rates. Allocating resources toward human capital development not only improves overall health and well-being but also creates job opportunities, reinforces political and social cohesion, and drives economic expansion and productivity. The synopsis of these findings is that consistent investment in healthcare and education by government is necessary for reducing mortality rates in Nigeria. Targeted interventions to reduce financial barriers to healthcare access will help to mitigate mortality rates and improve the overall health of women and children.

5. Conclusion

Human capital development is crucial for improving health outcomes in developing countries, where women and children are largely disadvantaged due to lack of financial resources to meet their health care needs. The study

concludes that investments in health and education by the government would reduce mortality among women and children.

Based on the study's findings, it is recommended that the government reevaluate its healthcare expenditure by increasing funding, as higher investment in the health sector is likely to reduce mortality rates. Policies that prioritize increased public healthcare financing, in line with the 2001 Abuja Declaration from the African Union Summit, which recommended allocating 15 percent of national budgets to the health sector, can help alleviate the financial burden of out-of-pocket healthcare expenses for women. Such investments would enhance access to healthcare services and contribute to reducing maternal and child mortality rates. Additionally, education expenditure strategies should specifically focus on promoting the education of girls and women, as this has been shown to effectively lower maternal mortality in both the short and long terms.

Furthermore, addressing the negative yet non-statistically significant relationship between the number of physicians per 1,000 persons and health outcomes is essential for enhancing the quality and accessibility of healthcare services. This can be achieved by improving physicians' remuneration and creating favourable working conditions to retain skilled healthcare professionals and strengthen the healthcare system. The findings suggest that long-term investments in antenatal care access and skilled midwifery services effectively reduce under-five mortality. Policies should focus on expanding maternal health services, strengthening midwifery training programmes, and ensuring widespread access to antenatal care. The inverse relationship between out-of-pocket health expenditures and healthcare access underscores the need for policies that reduce financial barriers. Expanding health insurance coverage to cover all categories of women and children, subsidizing maternal and child healthcare services, and implementing free or low-cost essential healthcare programmes can improve access to quality care and reduce mortality rates.

References

Abubakar, S., Doki, N.O., Aor, R.L. (2025). Revisiting the asymmetric impact of income inequality and health outcomes in Nigeria: The role of climate risk. *The Nigerian Journal of Economic and Social Studies*, *67*(1), 105 - 134.

Aderopo, R.A., & Ekomoezor, E. (2019). Can public health spending and maternal education predict future under-5 mortality rate in Nigeria? *Indian Journal of Economics and Development, 7*(12) ISSN (online): 2320-9836 ISSN (Print): 2320-828,https://www.researchgate.net/publication/340285543

Anokwuru, G., & Chidinma, C. (2023). Public health expenditure and infant mortality rate in Nigeria. *International Journal of Scientific Research and Management*, *11*(12), 5674-5686. https://doi.org/10.18535/ijsrm/v11i12.em14

Arthur, E., & Oaikhenan, H. E. (2017). The effects of health expenditure on health outcomes in Sub-Saharan Africa (SSA). *African Development Review*, *29*(3), 524–536.

Ayipe F.I, & Tanko, M. (2023). Public health expenditure and under-five mortality in low-income sub-Saharan African countries. *Social Sciences & Humanities Open*, *8*(1), 1-7 https://doi.org/10.1016/j.ssaho.2023.100570

Azuh, D.E., Osabohien, R., Orbih, M., & Godwin A. (2020). Public health expenditure and under-five mortality in Nigeria: An overview for policy intervention. Open Access *Macedonia Journal of Medical Science*, *8*(E), 353-362. https://doi.org/10.3889/oamjms.2020.4327

Becker, G. S. (1964). *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education*. National Bureau of Economic Research Inc.

Boundioa, J., & Thiombiano, N. (2024). Effect of public health expenditure on maternal mortality ratio in the West African Economic and Monetary Union. *BMC Women's Health*, *24*(1), 109. https://doi.org/10.1186/s12905-024-02950-2

David, J. (2018). Infant mortality and public health expenditure in Nigeria: Empirical explanation of the nexus. *Timisoara Journal of Economics and Business*, *11*(2), 149–164.

Dauda, R.S., Oyeleke, O. J., & Onatunji, O.G. (2023) Fiscal sustainability and health outcomes in Nigeria. *Nigerian Journal of Economic and Social Studies*, *65*(2), 213-234.

Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy*, *80*(2), 223–225.

Kiross, G. T., Chojenta, C., Barker, D., & Loxton, D. (2020). The effects of health expenditure on infant mortality in sub-Saharan Africa: Evidence from panel data analysis. *Health Economics Review*, *10*, 1–9.

Novignon, J., & Lawanson, A. O. (2017). Health expenditure and child health outcomes in sub-Saharan Africa. *African Review of Economics and Finance*, *9*(1), 96–121.

Nicholas, A., Edward, N.A., and Bernardin, S. (2016). The effect of health expenditure on selected maternal and child health outcomes in sub-Saharan Africa. *International Journal of Social Economics*, *43*(12) 1386-1399. https://doi.org/10.1108/IJSE-08-2015-0199

Oladosu, A.O., Chanimbe, T., & Anaduaka U.S. (2022) Effect of public health expenditure on health outcomes in Nigeria and Ghana. *Health Policy OPEN*, *3*, 10072-10078. https://doi.org/10.1016/j.hpopen.2022.100072.

Ogunjimi, J., & Adebayo, A. (2018). *Health Expenditure, Health Outcomes and Economic Growth in Nigeria.* Munich Personal RePEc Archive. Online at https://mpra.ub.uni-muenchen.de/94989/ MPRA Paper No. 94989, posted 18 Jul 2019 08:25 UTC

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches the analysis of level relationships. *Journal of Applied Econometrics*, *16*, 289–326. https://doi.org/10.1002/jae.616

Razakamanana, M.V., Andrianatoandro, V.T., & Ramiandrisoa, T.O. (2023). Do public health expenditures affect maternal and child health in Madagascar? *Health Economics Review*, *13*(47), 2-10. https://doi.org/10.1186/s13561-023-00462-7

Schultz, T. W. (1961). Investment in human capital. *The American Economic Review*, *51*(1), 1–17. http://www.jstor.org/stable/1818907

Sepehri, A. (2015). A critique of Grossman's canonical model of health capital. *International Journal of Health Service*, *45*(4), 762-78. doi: 10.1177/0020731415586407.

World Bank. (2024). *World Development Indicators* [Data set]. The World Bank. Retrieved October, 2024, from https://datacatalog.worldbank.org/dataset/world-development-indicators

World Health Organization. (2023). *Improving Maternal and Newborn Health and Survival and Reducing Stillbirth: Progress Report 2023.* Geneva. Licence: CC BY-NC-SA 3.0 IGO. https://www.who.int/publications/i/item/9789240073678