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RESEARCH ARTICLE

HEALTH CARE EXPENDITURE AND INFANT MORTALITY IN NIGERIA

Linda Mary Joseph, Kabiru Muhammed, Umar Mohammed, Idowu Daniel Onisanwa

Department of Economics and Development Studies, Federal University of Kashere, Gombe State

ABSTRACT

In order to improve health status and reap the benefits associated with healthy population, government and policymakers increased budgetary allocation to health sector in Nigeria. Despite the increased budgetary allocation and rising total health spending, health outcomes remain relatively poor in Nigeria, thus the need to examine the relationship between health expenditure and health outcomes. This study investigates the effect of health expenditure on infant mortality in Nigeria. The Grossman theory provided the theoretical framework for the study. The study considered infant mortality rate as a measure of health outcome, total health expenditure, gross domestic product per capita, and carbon emission. All variables were tested for time series properties using Augmented Dickey Fuller and Philip Peron. Cointegration among the series was established using Autoregressive Distributive Lag (ARDL) bound test approach. The ARDL approach allows short run and long run impact of health expenditure on infant mortality in Nigeria. Data were sourced from World Bank database and Central Bank of Nigeria Statistical Bulletin. Total health spending had significant negative effect on infant mortality in the short run and long run. The estimated error correction term is negative and statistically significant, meaning that the model was adjusted back to equilibrium in the long run at a speed of 08.00%. Gross Domestic Product per capita is negative and statistically significant in explaining rate of infant mortality. Increased health expenditures reduced infant mortality in Nigeria. Policymakers should consider a more targeted and efficient allocation of healthcare resources, develop and encourage the production base of the economy in other to improve GDP per capita.

Keywords: Total health expenditure, Health outcomes, Infant mortality, Nigeria

Corresponding Author

Linda Mary Joseph:
Email Address: josephlinda980@mail.com

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1.0. INTRODUCTION

The health of a country's population is crucial for economic productivity. Fit and healthy workers contribute effectively to national output. Therefore, adequate provision of health facilities should be a priority for any government. Health is vital for individual and national well-being. It is necessary for sustainable long-term economic development and allows us to full development of human capacities. Neglecting health can lead to physical and emotional weakening, hindering people's lives. Good health status is essential for economic activities (Cremieux et al., 2010). Improved health status leads to increased labour supply, productivity, and overall economic productivity (Ilori et al., 2017). Research has indicated a favourable connection between healthcare expenditure and economic growth (Ercelik, 2018). The study of this relationship has recently attracted interest due to most studies concluding that healthy time is crucial for economic growth and conducting various activities.

The well-being of the population is shaped by factors like the healthcare system and available resources, that is, human health is affected by social and economic conditions. Assessing the link between resources and health outcomes helps evaluate the functionality of a country's healthcare system. Financing health systems can be done through taxes or income-related social contributions. However, social security's contribution to healthcare financing is more significant in countries with more elevated income per person (Joshua & Adedeji, 2019). In Nigeria, healthcare expenditure has been increasing over the years. The government has allocated more funds to the healthcare sector, reflecting the importance of producing healthy population and development of human capital. The effects of healthcare expenditure can be measured by examining health indicators such as infant mortality, maternal mortality, as well as life expectancy (Kilanko, 2019). Health outcomes are a fundamental aspect of health promotion objectives, economic development and advancement, but they are still not ends to themselves, but rather a prerequisite for an increase in productive output and economic growth and development agenda. Considering the importance of quality health in the economic growth and development agenda, countries have prioritized health promotion interventions through expenditure on health as a means to improve quality health outcomes (Piabuo & Tieuhong 2017). Even with the crucial role of health in growing the economy, the amount of resources devoted to healthcare is poor and inadequate in most Sub-Saharan countries, particularly in Nigeria.

In Nigeria, health spending on a per person basis went up from 2004 to 2015, but had a small impact on the development of the economy. Despite the increased healthcare spending, Nigeria still faces challenges such as high infant and maternal mortality rates and low life expectancy. Worldwide, child death rates have declined, but still on the high side in sub-Saharan Africa (SSA) and Southern Asia. These regions have the highest infant mortality rates. In SSA about one hundred and fifty-five (155) children died before their fifth-year birthday out of every 1000 live births, while infant mortality was about 50 deaths per 1,000

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newborns in 2021. Factors contributing to high infant mortality include poverty, malaria, malnutrition, poor infrastructure, and inadequate healthcare Nwanze et al. (2023).

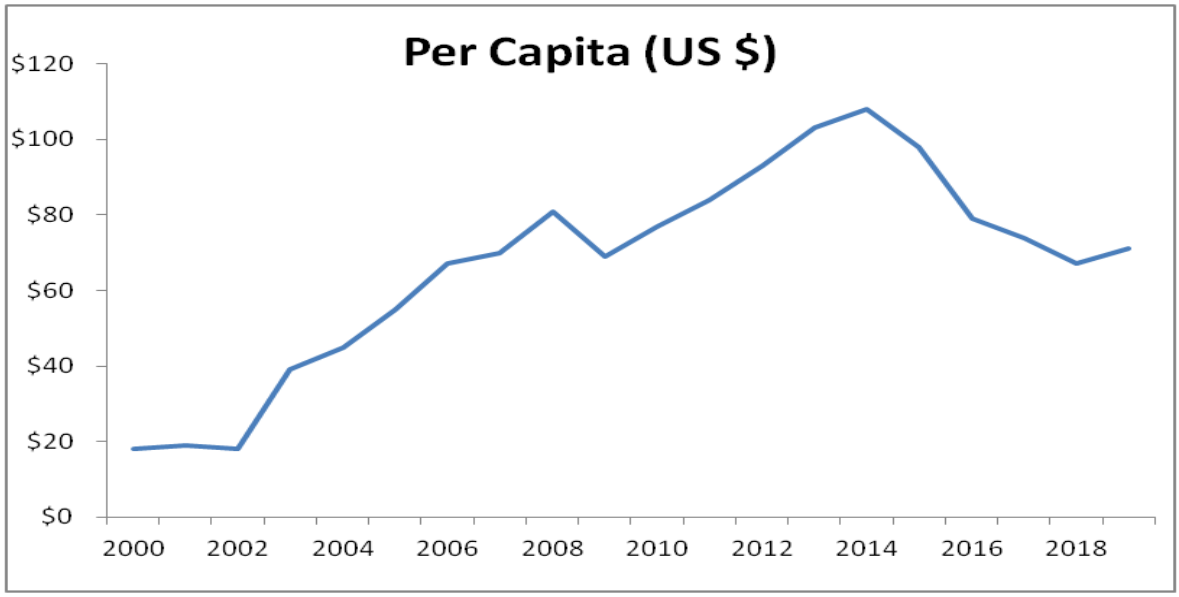

Figure 1.1 Nigeria Healthcare Spending per Capita ($), 2000-2019**.**

Source: Authors' Computation Using Data from World Bank (2020).

In 2019, India, Nigeria, and Pakistan had the highest number of newborn deaths. These fatalities are frequently due to insufficient antenatal care, skilled care services at birth, postnatal care, and proper care for small and sick newborns (WHO, 2019). The level of infant mortality observed in Nigeria was 57.701 fatalities per 1000 live births during the year 2021, this differs from the global average of 27.4 per live births and a far cry from the 25 deaths per 1000 live birth target within the framework of Sustainable Development Goals (SDGs).

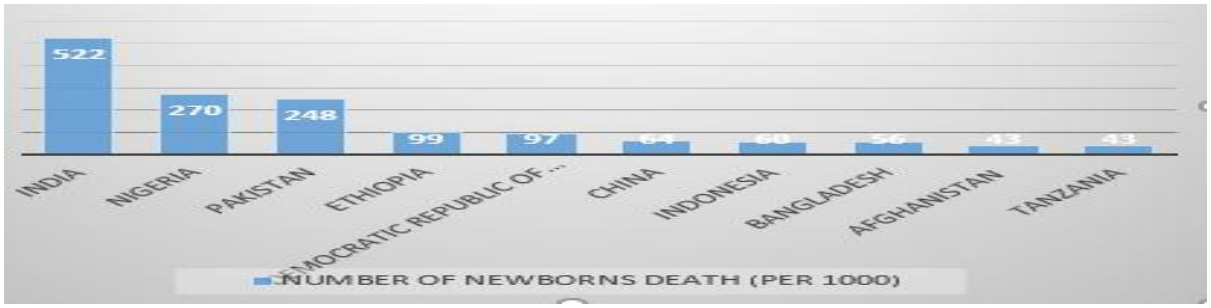

Figure 1.2 Top 10 Countries with the Highest Number of Newborn Deaths per 1000 Births
Source: World Health Organization (WHO, 2019).

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Infant mortality is a significant issue, particularly in developing countries like Nigeria. Unhealthy infants and children can grow up to become sickly adults, leading to a weakened labor force, low productivity, and unstable economic growth (Novignon & Lawanson, 2017; Nwanze *et al.,* 2023). This cycle further worsens population health. From the analysis shown in the figures above, it is evidenced that despite the increase in per person health spending and a reduced infant mortality, the role of health care expenditure on shaping infant mortality in Nigeria hasn't been fully explored.

Studies (Drifi, 2018; Raeesi et al, 2018; Navignon & Lawanson, 2017; Kiross et al, 2020; and Kilanko, 2019) on health care spending and health indicators tend to compare other underdeveloped countries and Nigeria's expenditure on health, health indicators and economic development. All these studies, however, made use of panel data and failed to condiser the extent and magnitude of how health investments affect population health in Nigeria. This study focuses on health care expenditure and how it relates to infant mortality in Nigeria.

The study provides information on how money spent on healthcare in Nigeria correlates with actual health results, this affirmed the relation between increased health spending and improved health outcome. This information would be valuable for policymakers in making well informed choices, and distribute resources efficiently, and enhance the overall healthcare system in Nigeria.

2.0 LITERATURE REVIEW

The link between health care spending and infant mortality rate is established on the underlying theories of healthcare demand and supply. The concept of demand in the structure of the healthcare market contrasts with that of the regular market. The customer's understanding of their health condition and the impact of alternative treatments on their well-being may deviate from the conventional assumptions of demand theory. Unlike in the ordinary market, consumers in the healthcare market lack the same level of knowledge and decision-making freedom.

In a study conducted by Phelps and Newhouse (1974), they developed a model to analyze the behavior of individuals who seek to optimize their satisfaction and have their healthcare expenses covered by a basic form of insurance. The study explored the demand for healthcare, where consumers are covered for a fixed percentage of their healthcare costs. The demand for healthcare examines the relationship between the quantity of healthcare desired and its price. Significant advancements in healthcare demand research have been attributed to the theoretical insights of Grossman (1972).

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Grossman (1972) proposed that the demand for healthcare is derived and influenced by factors beyond price, such as time and insurance. Grossman argued that healthcare demand is derived because an individual's health status is endogenous and depends on the resources invested in maintaining and improving it. Good health is not only valuable in itself, but it also serves as an investment that determines the individual's ability to produce goods and services. Grossman emphasized that the demand for health highlights the influence of various factors, including the effect of consumers' time and insurance.

The demand for healthcare indicates that as the cost of healthcare decreases, the demand for healthcare tends to increase. This indicates that healthcare costs in an economy decreases over time, the demand for healthcare among the population of that country surpasses the previous levels observed when the cost was higher. Moreover, as an economy allocates more funding for the health of its population, the demand for healthcare among the population increases due to the reduction in costs resulting from policy implementations. Grossman (1972) concluded that health is a long-term asset that yields healthy time as an output.

The burden of disease, particularly in low-income regions like sub-Saharan Africa, poses a significant obstacle to economic growth. Therefore, addressing this issue effectively should be a central element of any comprehensive development strategy. Public health programs or the provision of "free" healthcare services tend to redistribute resources towards underserved populations (Caselli & Ventura, 1996).

The theory of healthcare supply examines the divergence in the organization and behavior of hospitals, which differs from the conventional supply theory. In perfect competition market structures, both buyers and sellers possess complete information about the market or product. However, in the healthcare market, consumers lack complete knowledge, granting producers a certain degree of monopoly power.

Newhouse (1970) examined the behavior of non-profit hospitals and suggested that they strive to maximize both quantity and quality while operating without profit. The study found that non-profit hospitals operate based on either pure profit or pure patient welfare motivations. The decision-makers in these hospitals have two major objectives: quantity and quality of healthcare delivery (Newhouse, 1970). Additionally, the demand curve for healthcare shifts upwards as the quality of healthcare increases because quality healthcare holds greater significance for consumers. Non-profit hospitals are the primary providers of such trustworthy healthcare services (Hansmann, 1980 in West 1989).

In same way as the viewpoints expressed by Frank and Salkever (1991), Harrison and Lybecker (2005), and Horwitz and Nichols (2009), non-profit hospitals strive to gain public goodwill by offering healthcare services to poor or indigent patients.

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These hospitals maintain their operational margin even when faced with profit competition, indicating that their focus is on maximizing output. Thus, non-profit hospitals prioritize quantity in terms of the number of patients treated, while also placing great emphasis on delivering high-quality healthcare. Quality is a critical factor in the operation of non-profit hospitals, ensuring that patients receive the best possible treatment, including the dedicated care of doctors who prioritize the best interests of their patients.

A growing number of empirical studies assess the extent to which health expenditure affect health outcomes in developing countries. Findings from empirical data reveal a strong relationship between government health spending and mortality rates in developed countries (Dhrifi, 2018) and public health expenditure influences infant deaths in African countries (Anyanwu & Erhijakpor, 2009). Overall, health expenditure is instrumental in determining health outcomes globally (Gani, 2009; Novignon & Lawanson, 2017; Raeesi et al., 2018). However, the link between health spending and infant mortality may differ among various healthcare systems and countries (Tae & Shannon, 2013; Arthur & Oaikhenan, 2017; Rad et al., 2013; Yaqub et al., 2012; Onofrei et al., 2021; Syeda et al., 2013).

Dhrifi (2018) conducted a comprehensive investigation into the effect of health care spending on infant mortality rates in various income countries. The results reveal that government spending on health has a significant impact on declining mortality rates in upper-middle and high-income countries. However, for low and lower-middle-income countries, government expenditure on health shows limited influence on reducing mortality rates. The result also highlights that in less developed countries, public spending on health has a greater influence on fatality rates compared to private health expenditure, whereas in developed countries, private investment leads to an improvement in child health status.

Anyanwu and Erhijakpor (2009) analyzed how health expenditure correlates with mortality rates by using data from 47 African countries. The results shows that both public health spending and total expenditure on health play a crucial role in infant mortality and under-five mortality.

Gani (2009) conducted a study on the relationship between per person public health spending and various health outcomes. The study found that government healthcare finance has a stronger influence on infant mortality rates compared to under-five mortality rates. This result is in line with the government's budgetary allocation to healthcare in Pacific Island countries, where primary healthcare services such as immunization, nutritional training for mothers, and antenatal care are prioritized to control diarrhea.

Novignon and Lawanson (2017) discovered that healthcare spending exerts a significant and positive influence on infant mortality in Sub-Saharan African nations. A study on the impact

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of health expenditure on infant mortality in Sub-Saharan region, revealed that the majority of healthcare funding in the region comes from private and out-of-pocket expenditures, which may hinder future healthcare access. The outcome indicates that both public as well as external healthcare spending significantly reduced infant and neonatal mortality, while private health expenditure did not show a statistically significant relationship with infant or neonatal mortality (Kiross et al., 2020).

Raeesi et al. (2018) explored the link between health care expenditures and infant mortality within four different healthcare systems and the findings reveals that health expenditure, including public and private, had a strong impact on infant mortality. Additionally, Tae and Shannon (2013) found an inverse relationship between public health expenditure and infant mortality rate. Arthur and Oaikhenan (2017) examined the statistical association between health care expenditures and infant mortality and revealed that for every 1% increase in health expenditure, infant mortality declined by 50%.

Rad *et al.* (2013) established that public health expenditures were significant in explaining infant mortality across the Eastern Mediterranean area, while private health expenditures were not proven to be important determinants. Yaqub et al. (2012) analyzed the effect of public health spending relating to infant mortality revealed that public health expenditure has a notable effect on reducing infant mortality. Onofrei et al. (2021) found that increasing health expenditures contribute towards decreasing infant mortality rates in European nations. Conversely, Syeda et al. (2013) identified no statistically significant link between infant mortality and health expenditures.

3.0. METHODOLOGY AND DATA

Model Specification

This study adopts the Grossman model to estimate health outcomes. The model considers healthcare as durable capital used in producing health outcomes, with expenditure depending on medical care and time invested in health. It involves an optimization problem that optimizes utility over gross investment in health, medical care consumption, and time inputs. This endogenous model partially determines the agent's lifespan (Jones et al., 2012).

This study focuses on Nigerian health production functions from 1981 to 2022. Unlike developed nations that use crude mortality rates, this study uses infant mortality indicators as the health outcome measure. The inputs include public, private and total health expenditure expressed as a percentage of GDP. The production function explaining health outcomes is as follows:

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$$H_t = f(THE_t) \quad \text{(i)}$$

Where H_t is health outcome measured by infant mortality in this study, and THE_t denotes total health expenditure

Based on the theoretical framework, the estimable model with respect to the association between infant mortality and health expenditure within Nigeria is developed as follows

$$IMR_t = F\left(THE_t,\ CAR_t,\ GPC_t\right) \quad \text{(ii)}$$

Where IMR_t is infant mortality rate overtime, THE_t is as defined earlier, CAR_t is carbon emission, and GPC_t denotes GDP per capita. Equation ii, can be expressed as

$$IMR_t = \beta_0 + \beta_1 THE_t + \beta_2 CAR_t + \beta_3 GPC_t + \varepsilon_t \quad \text{(iv)}$$

Where ε_t is the random error term assumed to have a mean of zero and constant variance. The β s are the parameters to be estimated.

This study used Pesaran and Shin (1999) Autoregressive Distributed Lag (ARDL) bound testing in determining the existence of a long-run relationship.

The bounds test regression for the series in this analysis is specified as:

$$\Delta[Log(IMR_t)] = \alpha + \beta T + \gamma_1 Log(IMR_{t-1}) + \gamma_2 Log(THE_{t-1}) + \gamma_3 Log(CAR_{t-1}) + \gamma_4 Log(GPC_{t-1}) + \sum_{i=1}^{k} \lambda_i \Delta Log(IMR_{t-i}) + \sum_{j=0}^{M} \psi_j \Delta Log(THE_{t-j}) + \sum_{r=0}^{N} \theta_j \Delta Log(CAR_{t-r}) + \sum_{q=0}^{P} \phi_j \Delta Log(GPC_{t-q}) + \mu_t(v)$$

The long-run correlation among the variables is determined after the joint significance test assesses the null-hypothesis of no long-run relationship among the variables. When the calculated F-statistics exceeds the upper bound critical value, the null hypothesis of no long-run relationship is rejected, indicating the presence of cointegration among the variables which allows estimating both long and short runs coefficients, whereas, the null hypotheses cannot be rejected if the lower bound is above the F-statistic. The model investigates the long-run relationship among the series regardless of whether the variables are stationary at level or at first difference.

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To take care of short-term deviations while determining the long-run co-integration, an error correction representation is included in the ARDL model (Pesaran et al., 2001). The ECM model is specified as

$$\Delta[Log(IMR_t)] = \sum_{i=1}^{k} \lambda_i \Delta Log(IMR_{t-i}) + \sum_{j=0}^{M} \psi_j \Delta Log(THE_{t-j}) + \sum_{r=0}^{N} \theta_j \Delta Log(CAR_{t-r}) + \sum_{q=0}^{P} \phi_j \Delta Log(GPC_{t-q}) + \alpha ECM_{t-1} + \varepsilon_t \qquad (vi)$$

The model is subjected to post-estimation tests such as diagnostic analysis and stability tests to assess the model's stability. The Breusch-Godfrey Serial Correlation LM Test was employed to assess whether the residuals in the regression model exhibit autocorrelation over time. Heteroscedasticity test was conducted using Breush-pagan test to check whether the variances of the residuals in the models are constant over time, also the study checked if the residuals in the models are normally distributed.

Furthermore, stability test was conducted based on CUSUM and CUSUM square tests. CUSUM (Cumulative Sum) and CUSUM square tests are statistical techniques employed to detect structural changes or shifts in time series data. These tests are frequently used in quality control practices, econometrics, and other fields to monitor and analyze changes in a process over time.

The CUSUM test involves calculating the cumulative sum of deviations from a reference value or target value. It helps identify when the cumulative deviations exceed a certain threshold, indicating a significant change in the process. The CUSUM test is useful for detecting both upward and downward shifts in the data.

The a priori expectation of the impact of Health Expenditure (HEXP), Carbon Emissions (CAR) and GDP Per Capita (GPC) on infant mortality in Nigeria can be analyzed drawing on theoretical underpinnings and existing literature:

Health Expenditure (HEXP): Higher health expenditure is expected to have an inverse effect on infant mortality. Increased spending on healthcare can lead to improved healthcare infrastructure, better access to healthcare services, and enhanced quality of healthcare provision. Therefore, the a priori expectation is that higher health expenditure (HEXP) would contribute positively to health in Nigeria by reducing infant mortality.

Carbon Emissions (CAR): Carbon emissions, primarily from industrial activities and energy production, contribute to environmental pollution and climate change. The effect of carbon emissions on health is complex. On one hand, increased carbon emissions may result in air pollution, which is linked to respiratory and cardiovascular conditions, among other health concerns. Conversely, carbon emissions are frequently linked to economic growth, which may lead to positive effects on health through improved healthcare infrastructure and living

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standards. Therefore, the a priori expectation regarding the effect of carbon emissions (CAR) on infant mortality in Nigeria is ambiguous and depends on the balance between the adverse health impacts of pollution and the potential benefits associated with economic growth. GDP Per Capita (GPC).: High Per Capita GDP is anticipated to positively influence health outcomes.

Sources of Data

Annual time series data that span the period 1981-2022 are used in this study. This study uses data extracted from the statistical bulletin of Central Bank of Nigeria and World Bank Database.

4.0. PRESENTATION OF RESULTS AND DISCUSSIONS

Descriptive Statistics

Table 1. Presents the descriptive analyses of the data used in the study. The purpose of this is to describe the nature of the data and ensure that the appropriate techniques are employed.

Table 1. Descriptive Statistics

	CAR	GPC	HEX	IMR
Mean	80328.42	1352.601	99.46005	102.7233
Median	90055.20	992.7453	77.04211	106.6000
Maximum	119544.1	3200.953	204.5515	126.0000
Minimum	489.6406	270.0275	1.297241	68.89999
Std. Dev.	32322.64	867.4646	70.93367	20.23194
Skewness	-1.188843	0.407377	0.001983	-0.257330
Kurtosis	3.254238	1.773211	1.314950	1.430719
Jarque-Bera	10.24479	3.885831	5.087277	4.886804

Source:2023 Authors' computation using EViews 10

Infant Mortality Rate (IMR) during the study period clearly indicates roughly 102.72 deaths per every 1,000 infant births and a standard deviation of 20.23 which shows the deviation based on the sample average. The highest rate of infant mortality (126) was recorded in 1980, while the minimum was 68.89 recorded in year 2022.

The result further revealed that the typical value of carbon emission into the atmosphere over the review period was approximately 80328.42 kiloton, while the highest and lowest recorded values are 119544 and 489 kilotons respectively. Gross Domestic Product per Capita (GPC) had an average value of 1352.60, a maximum value of 3200.95 and a minimum value of 270.02

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From the distribution, CAR mirrors a negatively skewed and leptokurtic because it reflects a skewness value of -1.188 and a Kurtosis value greater than 3 this signifies that CAR has a long Left-Tail. GPC, HEX, and IMR have kurtosis value of less than 3 each, this shows a normal skewness and a platykurtic kurtosis which implies that the distribution contains additional values which are below its sample mean and has a flat surface.

Consequently, the Jarque-Bera test is employed to determine whether the data follows a normal distribution, CAR with a p-value 0.0059 which is clearly less than 0.05 shows that there is a significant deviation of the data from normality, while GPC, HEX, and IMR all have a P-value that exceeds the critical value of 0.05 which indicates that the distributions are normally distributed.

Unit Root Test

The properties of the time series are evaluated using Augmented Dickey Fuller (ADF) and Philip Peron (PP) unit root tests. The unit root result is presented in Table 2.

Table 2: Unit Root Test Result

	Augmented Dickey Fuller		**Philip Perron**		
	Levels	**First Difference**	**Level**	**First Difference**	**Order of Integration**
HEXP	-2.6723	-6.9287*	-2.6737	-6.9487*	I(1)
CAR	-1.0639		-1.2035	-5.5124	I(1)
	5.5264*				
GPC	-3.7615**		-1.7315	-6.9743*	I(0)
IMR	-11.4936*		-3.2061*		I(0)

Note: *, ** and *** imply significance at 1%, 5% and 10%, respectively
Source: 2023 Authors' computation using EViews 10

The finding indicates that infant mortality rate, health expenditure, gross domestic product per capita and carbon emission are of mixed order of integration. This implies that the variables are integrated at different order. This is an important and necessary condition for the use of ARDL technique.

Result of Cointegration Test

Cointegration is established among the series if the computed F- statistic is beyond the upper bound critical values at any conventional levels of significance. However, when the calculated F- statistic falls below the lower bound critical value, the null hypothesis of no long run relationship cannot be rejected. Moreover, when the F-statistic lies between the lower and upper critical bounds, no definite conclusion can be drawn regarding the long run relationship at least using the ARDL bound cointegration approach (Mintz & Chi Huang, 1990).

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Table 3 ARDL Bound Test Result

Critical value bounds of the *F*-statistics: F_{limr} (lhex, lgpc, lcar)						
F-statistics	1% critical value		5% critical value		10% critical value	
	1(0)	1(1)	1(0)	1(1)	1(0)	1(1)
12.980**	4.310	5.544	3.100	4.088	2.592	3.454

Note: ** represent significance level at 5%. The critical values are based on the underlying data for N = 40 due to the modest sample size of the study.

Source: 2023 Authors' computation using EViews 10

The findings in Table 3 indicate the presence of cointegration among the series. The cointegration is obtained at five percent significance level. Thus, Table 3 provides evidence that long-run relationship exist between infant mortality rate, health expenditure, gross domestic product per capita and carbon emission.

The Impact of Health Expenditure on infant mortality in Nigeria

The result of the long run parameter estimates for infant mortality rate, health expenditure, gross domestic product per capita and carbon emission model as shown in Table 4. The table displays the estimation results of the model. Specifically, model 1 depicts an indirect link between infant mortality rate, health expenditure and the environmental indicator.

Table 4: Long Run Results

Variables	**ARDL (2, 0, 1, 0)**
LHEX	-0.0485***
	(0.0080)
LGPC	-0.3330***
	(0.0000)
LCAR	0.04617*
	(0.0807)
Const.	3.1893***
	(0.0000)

Note: *, ** & * represent significance level at 1%, 5% and 10%, respectively. The figures in parenthesis are the Probability values of the estimates. Model i= limr f(lhex, lgpc, lcar)**

Source: Authors' computation using EViews 10

Table 4 reveals that spending on health care is negatively signed and statistically significant in explaining changes in infant mortality rate (IMR). A percentage increment in health care expenditure by the government will lead to 0.049% decrease in infant mortality rate (IMR). In accordance with the apriori expectation of the study, increased health expenditure can lead

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to improved healthcare infrastructure, better equipped facilities and increased accessibility to essential services. This in turn allows for early detection and treatment of diseases and enhanced child health interventions. This finding is in line with the findings of Eboh *et al.* (2018) which revealed that public health expenditure exerts an inverse relationship with infant mortality.

The findings further indicates that, a 1 percent increase in gross domestic product per capita (GPC) will lead to 0.0333% decrease in the rate of infant mortality (IMR). Increase in GPC is associated with improvements in healthcare, infrastructure and living standards. This can lead to reduction in infant mortality rates as access to better healthcare and nutrition improves as disposable income of individuals' increase, it helps to improve their health conditions and their children's well-being. This is in agreement with the findings of Musa (2022).

Furthermore, Table 4 presents that the estimated coefficient of carbon emission (CAR) has a positive relation with infant mortality. That is, a percentage increase in carbon emission will lead to a 0.046% increase in the rate of infant mortality, although the result fails to attain statistical significance at 5% level, only at 10% significance level, this indicates a weak significance and it may be as a result of the lengthy nature of the data or in the long-run, spending on health by government mop up the adverse effect of carbon emission on infant mortality. This outcome is contrary to the study conducted by Uwani and Ujah (2023), who found a positive but insignificant relationship between carbon emission and infant mortality in SSA region because economic activities that emit carbon particles are at low ebb.

The coefficients in the short run appear to be similar in sign and magnitudes to the long run counterpart. The outcome is shown Table 6.

Table 5: Short Run Coefficients

Variables	**Model I IMR ARDL (4, 2, 1, 3))**	**Model ii MMR ARDL (3, 2, 0, 3)**	**Model iii LEB ARDL(2, 3, 3, 3)**
Δ(lhex(-1))	-0.001848** (0.0211)	-	0.012483** (0.0051)
Δ(lcar(-1))	0.005311** (0.0041)	0.018106 (0.0138)**	-0.009493** (0.0023)
Δ(lhex)	-	-0.048457** (0.0293)	
Δ(lgpc)	-	-0.01560 (0.3036)	
Δ(lgpc(-2)	-	-	0.023498 (0.0031)
ect_{t-1}	-0.080065*** (0.0001)	-0.198523** (0.0300)	-0.225226 (0.0000) ***

Note: ***, ** & * depict significance level at 1%, 5% and 10%. The parentheses are probability of the estimated values. Model 1 shows a relationship with the predicted variable IMR and (HEX, GPC and CAR), while Model ii includes MMR and the dependent variables and model iii is the short-run relationship between LEB and the dependent variables.

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The model for the short run reveals a negatively signed with a statistically significant error correction term. This indicates an adjustment speed of 8.0%, that is, the distortions may take a long time to converge back towards long run equilibrium.

4.6 Diagnostic Analysis

The consistency and validity in the model are examined. The outcome of the diagnostic tests is presented in Table 6.

Table 6: Diagnostic Tests (Model i)

Test Statistics	Chi-square/LM Test	Probability Value
Serial Correlation	5.2268	0.1733
Functional Form	0.9035	0.3487
Normality	0.2361	0.8886
Heteroskedasticity	3.0775	0.7991

Note: Serial correlation is determine using Lagrange multiplier test of residual, functional form base on Ramsey's RESET test, normality base on skewness and kurtosis and Heteroskedasticity based on squared residuals on squared fitted values

Source: Authors' computation using EViews 10

For the estimated model, the results of diagnostic tests in Table 6, confirmed the statistical validity of the long run model. The models are correctly specified; no evidence of serial correlation nor Heteroskedasticity effect in the disturbances as revealed by the non-significant p-values of the tests. Hence, the model is reliable and can be utilized in forecasting, predicting, and formulating economic policy.

Also, the plots of CUSUM and CUSUMSQ statistics lie within the critical bounds. This implies that the estimated coefficients remain consistent throughout the duration of estimation.

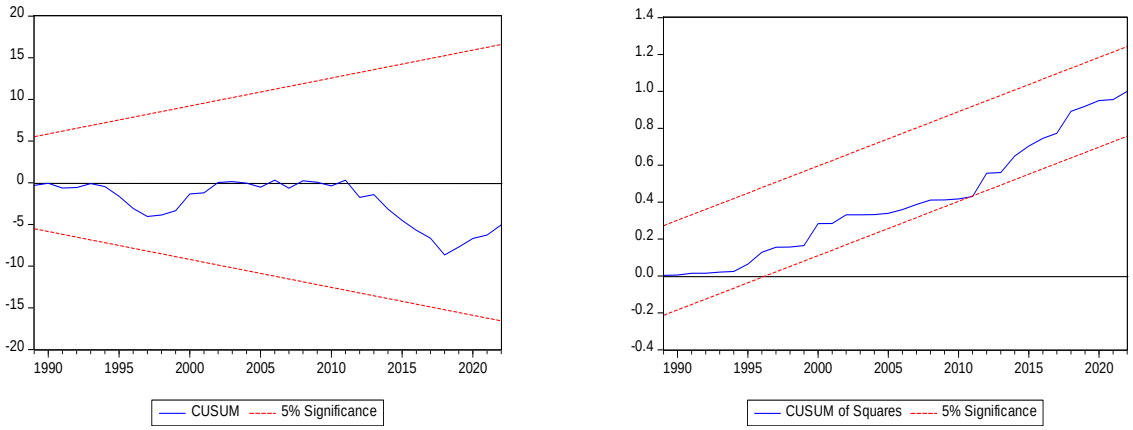

Figure 4.1 Model I CUSUM and CUSUM of Squares
Source: Authors' computation using EViews 10

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5.0. SUMMARY AND CONCLUSION

This study examined the link between health care spending and infant mortality in Nigeria, using ARDL over the span of 1980-2022. A thorough analysis of available data revealed a statistically significant correlation between the lagged values of health care spending and health outcomes in Nigeria. In examining the empirical data, it became evident that healthcare expenditure in Nigeria has a discernible implication on the selected health outcomes in Nigeria. The analysis revealed a statistically significant correlation between greater healthcare spending and improvements in health outcomes.

The parameter of health expenditure showed a strong relationship with the selected health outcomes both in the short as well as the long run, having a 1% and 5% statistically significant and negatively signed relationship with infant mortality and maternal mortality while health expenditure has strong and significant link to life expectancy at 5%. This means that a percentage increase in healthcare spending by government will lead to 0.0485% and 0.1656% decrease in infant and maternal mortality respectively, and 0.0235% improvement in life expectancy at birth. This finding aligns with the apriori expectation of this study, but the discernible impact of health expenditure on infant mortality, maternal fatality is inconspicuous compared to other countries due to the relatively modest amount spent on the health care sector.

Increased spending on health by government in Nigeria reduced infant mortality rate, because high spending on health often means improved healthcare infrastructure, increased access to medical services, and better quality of care. This could lead to a decrease in infant mortality by addressing health challenges more effectively. Although from the result, the coefficients of the relationship tend to be meager. That is to say that despite the increased allocation to health care sector in Nigeria, the impact of health spending is still nothing compared to what is obtainable in other African countries and developing countries of the world.

GDP per capita showed strong evidence of an inverse and statistically significant association with infant mortality, from the result of the analysis the negative coefficient implies that an increase in GPC reduce infant mortality. Thus, an increase in GDP per capita is associated with improved healthcare, infrastructure and overall living standards. This can lead to reduction in infant mortality rate as better economic conditions often translate to healthcare services and resources. Although the result seems to follow the expectation of this study but in reality, the effect of GDP per capita seems to be very low in Nigeria compared to what is obtainable in other regions globally, hence its meager effect on health outcomes in Nigeria.

Carbon emission showed a positive but statistically insignificant association with infant mortality over the long run; however, the short run shows the coefficients of the nexus between carbon emission and infant mortality is positive and statistically significant. This result implies that the effect or influence of carbon emission is more noticeable over a

relatively brief period of time compared to an extended period of time. Although, the impacts could be immediate, its significance may diminish over time due to various elements like adjustments, adaptation or a long-term trend.

Also, the connection between carbon emissions and health outcomes can be complex and influenced by various factors. In Nigeria, the lack of statistical significance in the long run could be attributed to the interplay of multiple variables, such as healthcare infrastructure, socioeconomic factors, and regional disparities and educating people on self-care and guidance on practices that leads to overall well-being.

Conclusively, the study provides further insight into the intricate relationship between healthcare expenditure and infant mortality in Nigeria, by providing empirical evidence to advocate for more informed based decision making in healthcare policy and practices. The coefficients of the dependent variables and explanatory variables have the expected sign. In line with the objectives of this study, the result showed a strong correlation between health care expenditure and infant mortality in Nigeria. This implies that government spending on health care enhances overall health outcomes by lowering infant mortality rates in Nigeria. This is in conformity with the underpinning theoretical framework of the study which described healthcare as a durable capital used in producing health outcomes through investment in health care.

The study's outcome revealed that public health spending alone cannot cater for the growing demands for healthcare services. To address the issue of infant mortality in Nigeria the following recommendations were made, resources or alternative approaches will be necessary to address expanding healthcare needs effectively. There is need for the government to create an enabling environment and encourage the production base of the economy in other to improve Gross Domestic Product per capita which will in turn boost the out-of-pocket spending ability of individuals to access quality healthcare services.

Consequently, the implications of this study extend beyond the immediate focus on Nigeria, resonating with broader discussions on global health economics. By elucidating the links between health care expenditure and health indicators, this study offers important perspectives to other researchers and international organizations seeking effective strategies to enhance healthcare systems in developing nations.

Health outcomes may differ greatly across the different regions in Nigeria, failing to address regional disparities could cause a skewed representation. Typically, in rural areas carbon emission may cause more damage to the health outcome of the habitants than urban areas where the effect are not so prominent and easy access to health facilities can cater for the adverse effect. Establishing a direct causal relationship between healthcare expenditure and health outcomes can be challenging. Other factors, not considered in the study, might also contribute to changes in health outcomes and the current state of health within the Nation.

For instance, various socioeconomic, political, and environmental factors not considered in this study may independently affect health outcomes, aside healthcare expenditure.

Competing Interest

The authors declare that no competing interest exist in this paper.

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