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An assessment of the impact of health care expenditure on infant mortality in Nigeria

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Abstract
To accomplish favourable health outcomes, especially reducing infant mortality, remains a challenge for Nigeria. The autoregressive distribution lag technique (ARDL) was employed in this study in examining the long-run effect of public health expenditure on under-five mortality in Nigeria. Data were sourced from the World Development Indicators for the period 1990–2022. The long run result shows that general expenditure on health has a negative and significant impact on infant mortality rate. This shows that the level of income matters in the amount spent on health. Based on the results. 1 unit increase in HEXP will decrease general infant mortality rate by 2.260 units. This is not surprising as greater financial resources and improved living standards means improved healthcare infrastructure, access to medical services, and better health outcomes for individuals and society. The coefficient of SSE has a positive but insignificant impact on GDP per capita. Finally, the coefficient of GDP per capita has a negative and significant impact on infant mortality rate. Based on the result 1 unit increase in GDP per capita will decrease infant mortality rate by 0.100 units. Therefore, this paper recommends an increased funding in the health sector and all-inclusive coverage of the health insurance scheme for Nigerians.

Keywords: Health care expenditure, Infant mortality, Nigeria, ARDL

1. Introduction

An infant is a child of birth up to around one (1) year old. Everybody was once an infant. Most importantly then they deserve to live their full lives like everybody. Infants cannot take care of themselves but are taken care of by the parents, relations, family friends and the society. Therefore, the ability to take care of both the mothers, pre-post-natal and the infant will largely depend on the parents' level of income level of education and health facilities and programs provided by the society/government These can be measured by GDPC, SSCE, Public Health Expenditure.

Death of an infant, infant mortality is of paramount importance to all and its prevention ardently pursued. Infant mortality means the death of infants measured by the infant mortality rate (IMR). IMR is the number of resident new born in the country dying under one year of age divided by the number of resident live births for the same area for a specified area period and multiplied by 1000. IMR is an important indicator of a society's overall health.

The current infant mortality rate for Nigeria in 2024 is 53.674 deaths per 1000 live births, a 1.95% decline from 2023. The infant mortality rate for Nigeria in 2023 was 54.740 deaths per 1000 live births, a 2.63% decline from 2022. The infant mortality rate for Nigeria in 2022 was 56.220 deaths per 1000 live births, a 2.57% decline from 2021.The infant mortality rate for Nigeria in 2021 was 57.701 deaths per 1000 live births, a 2.5% decline from 2020 (2010-2024 Macrotrends LLC).

Nigeria's public health expenditure has been low and insufficient compared to other African countries: In 2021, Nigeria's health expenditure as a share of GDP was

4.08%, a 20.71% increase from the previous year. However, this is still low compared to the 4–5% of GDP suggested for universal health coverage (D D Sasu, 2024).

Infants die due to birth defects, diseases, injuries such suffocation, preterm birth and low birth weight, maternal pregnancy complications, etc. However, children within the African continent (including Nigeria) die mostly from diseases. This study analyses empirically the impact of healthcare expenses on the mortality level of infants.

Nigeria's public health expenditure has been low and insufficient compared to other African countries:

The Abuja Declaration of 2001 set a target of 15% of government expenditure to be allocated to health, but Nigeria has not met this target in the past 21 years. In 2023, the health sector accounted for only 5.75% of the total budget.

The health status of any given country depends upon maternal and infant mortality rates, which play a crucial role in evaluating the country's population health, quality of care, socioeconomic status, and poverty (Szreter S, Woolcock M., 2004).

The Sustainable Development Goal (SDG 3) of reducing the deaths to 70 per 100,000 live births and ensuring that all human beings, at all ages, achieve healthy lives by 2030, has intensified their struggles to promote the health sector (Hill K, Thomas K, AbouZahr C, et al, 2007). This implies that spending in the health care system improves peoples' health and generates employment opportunities, increases social and political stability, and ultimately leads to the growth and development of the whole economy (Permanyer I, UNDP).

It's obvious that there is a link between health expenditure and health outcomes and the patterns alter considerably; therefore, the debate over health care expenditure and health outcomes remains questionable, which warrants more investigation (Mogalakwe B, 2006).

Statement of Problem

Generally, Scountries with high incidence of corruption have high tendency of experiencing high level of child and infant mortality rates. In the world, about 99% of the incidence of infant deaths occurs in developing countries, and 86% of these deaths are due to infections, premature births, complications during delivery, and prenatal asphyxia and birth injuries. Most preceding studies ignored other macro-level factors of infant mortality, such as education, per capita income, etc.

Nigeria healthcare spending for 2019 was $71, a 7.39% increase from 2018. Nigeria healthcare spending for 2018 was $67, a 9.94% decline from 2017. The health expenditure as a share of gross domestic product in Nigeria increased by 0.7 percentage points (+20.71 percent) compared to the previous year. Therefore, the share in Nigeria reached a peak in 2021 with 4.08 percent (D D Sasu, 2024).

Research Questions

i. What is the effect of health expenditure on the reduction of infant mortality rate in Nigeria?

ii. What is the effect of per capita income on the reduction of infant mortality rate in Nigeria?

iii. What is the effect of education on the reduction of infant mortality rate in Nigeria?

Objectives of the Study

The general objective of the study is to find out the effect of health expenditure on infant mortality in Nigeria. Specifically, the study intends

i. To evaluate the effect of health expenditure on the reduction of infant mortality rate in Nigeria.

ii. To estimate the effect of per capita income on the reduction of infant mortality rate in Nigeria.

iii. To assess the effect of education on the reduction of infant mortality rate in Nigeria.

Hypotheses

$H_0$1: health expenditure has no significant effect on the reduction of infant mortality rate.

$H_0$2: per capita income has no significant effect on the reduction of infant mortality rate.

$H_0$3: level of education has no significant effect on the reduction of infant mortality rate.

Significance of the Study

This study is bent on contributing to the literature available on infant mortality. The following users will find this study useful and pertinent. The outcome of the study will be of immense benefit to government agencies and bodies for effective health policies formulation. An advancement of knowledge is achieved when series of researches are being carried out in the academic environment. Thereby the scope and horizon of the readers or researchers are widened in order to achieve academic excellence through series of researches, development of the intellectual faculty and planning. Most important is the positive impact the study may make in the reduction of infant mortality in Nigeria.

2. Literature Review

2.1 Conceptual Review

Infant mortality

Infant mortality means the death of infants measured by the infant mortality rate (IMR). IMR is the number of resident new born in the country dying under one year of age divided by the number of resident live births for the same area for a specified area period and multiplied by 1000. Some factors that contribute to infant mortality in Nigeria include:

Sanitation: Inadequate sanitation can lead to the spread of infection, which increases the risk of infant deaths. Electricity: Access to electricity is important for healthcare, as it helps to provide quality care in health facilities.

Education: The level of women's education in a community can impact infant mortality.

Prenatal care: The utilization of prenatal care services and hospital delivery can impact infant mortality.

Socioeconomic and demographic factors: Maternal, fertility, and health service delivery factors.

Neonatal factors: Access to health services and professionals.

Quality of prenatal care: Nigeria has nearly 31 million children under the age of 5. while each year at least 7 million babies are born.

2.2 Public Health Expenditure

Health expenditure includes all expenditures for the provision of health services, family planning activities, nutrition activities and emergency aid designated for health, but it excludes the provision of drinking water and sanitation. Health financing is a critical component of health systems. National health accounts provide a large set of indicators based on information about expenditure collected within an internationally recognized framework. These accounts are a synthesis of the financing and spending flows recorded in a health system's operation, from funding sources and agents to the distribution of funds between providers and functions of health systems. It is also reflective of SDG 3: "Ensure healthy lives and promote well-being for all at all ages"
General government expenditure on health as a percentage of total government expenditure - This indicator is defined as the level of general government expenditure on health (GGHE) expressed as a percentage of total government expenditure. It shows the weight of public spending on health within the total value of public sector operations. This indicator includes not just the resources channeled through government budgets, but also the expenditures channeled through government entities for health by parastatals, extrabudgetary entities and,

notably, compulsory health insurance. The indicator refers to resources collected and pooled by public agencies, including all revenue modalities (WHO).

2.3 Empirical Review

Infant mortality is of worldwide concern especially in developing Sub Saharan Africa. There were so many opinions, articles and the sort written in finding a way to reduce to the barest minimum infant mortality in Nigeria. So many researches were done using many variables with the view of finding which of them to use in curbing infant mortality especially in Nigeria.

Adesete, A. A., Dauda, R. O. S., & Okirie, U. I. (2022), st6died the effect of public health spending and macroeconomic uncertainty on health outcome in Nigeria. The autoregressive distributed lag (ARDL) model was the method used to analyze the objectives of the study, as there were mixture of both level (I(0)) and first difference (I(1)) series. Annual time series data on public health expenditure and health outcome indicators used for 1981 to 2020. Results obtained showed that as public income increases, life expectancy rate is expected to improve and infant mortality rate will reduce.

Azuh, D. E., Osabohien, R., Orbih, M., & Godwin, A. (2020). Looked at the contribution of the health expenditure by the government on under-five mortality in Nigeria. The autoregressive distribution lag technique was employed in this study in examining the long-run effect of public health expenditure on under-five mortality in Nigeria. Data were sourced from the World Development Indicators for the period 1985–2017. Results from the study showed that though public health expenditure is statistically significant, it showed a positive relationship with the under-five mortality.

Health expenditure, child mortality and economic growth in Nigeria was examined using time series data covering the 1980 – 2020 sample periods. The Ordinary Least Square (OLS) technique was employed in analyzing the data. Empirical results showed a negative and insignificant impact of government health expenditure on under-five child mortality. It was also found that government capital expenditure had a negative and insignificant impact on under-five mortality, while government recurrent expenditure had a negative and significant impact on under-five mortality.

Despite the global attempt at achieving goal 3 of the Sustainable Development Goals by improving health outcomes, some countries (West African countries inclusive) still do not spend a significant proportion of their income on health and they exhibit health outcomes that are still far below that of developed countries. Besides countries like Nigeria, Chad and Guinea-Bissau are experiencing worsening insecurity and political instability. This study, therefore, examines the effect of health expenditure on three health outcomes in the West African sub-region, while investigating the effect of the quality of governance in this nexus (Ibukun, C.O. (2021),

The result of this study shows that all forms of health expenditures significantly influenced health outcomes. That is, there is a negative relationship between health expenditure, infant mortality and under-five mortality, but a positive relationship between health expenditure and life expectancy at birth. Besides, the general effect of the same quantity of public health spending is subject to the quality of governance because countries with a higher quality of governance benefit better from their public health spending.

Health outcome such as infant mortality rate is an important measure of the standard of living. It is a part of Millennium Development Goals, which all countries of the World strive to achieve, by allocating enormous economic resources to the health sector. A study by Mustapha, R. A., Onikosi-Alliyu, S. O., & Babalola, A. (2021) assessed the impact of government expenditure on health and on health outcome (infant mortality rate) in the West Africa Sub-region and found in the study that public health spending has an indirect impact on infant mortality rate in the West Africa Sub-region.

Human capital investment is vital to achieving sustainable development in an economy. As an important aspect of human capital investment, education, and health spending should be given priority in the sustainable development agenda of a developing country like Nigeria. This study examined the impact of government spending on education and health on sustainable development in Nigeria using the Autoregressive Distributed Lag Model (ARDL) bounds test technique. Sustainable Society Index (SSI) was used as a measure of sustainable development. The findings provided significant evidence that government spending on education and health is vital to sustainable development in both the short- and long-run in Nigeria (Ojike, R. O., Ikpe, M., Uwajumogu, N. R., Yuni, D. N., Okwor, S. A., & Enyoghasim, M. O. (2021).

3. Methodology

The study used the ARDL method. The adoption was because the ARDL model is good in determining both long and short run elasticity and relationships among variables as there were mixture of both level (I(0)) and first difference (I(1)) series. The model can also be used irrespective of the order of integration of the series. Finally, the ARDL method provides robust results for small sample sizes and very reliable estimates of the long-run coefficients (Pesaran & Shin 1999). To ascertain whether the variables are stationary or not, the unit root test was applied to every variable used in the model.

3.1 Model Specification

It is a crucial and well recognized fact that a better understanding of various aspects in the economy leads to the formulation of effective economic Spolicy, including the nexus among infant mortality, health expenditure, income, education, etc. As the present study intended to explicate the long-run relationship of health expenditure effects on infant and the subsequent model was designed to analyze the relationship empirically.

Generally, the specification of an economic model is based on economic theory and the available data (Sulaiman et al. 2015). To capture the objective of the research, taking into consideration the reviewed literature.

The models are mathematically specified as follows:

INFMORT= F (HEXP, SSE, GDPPC) …… [3.1]

The model can be presented in an econometric form as follows:

$INFMORTt = \beta 0t + \beta 1HEXPt + \beta 2SSEt + \beta 3GDPPCt + \varepsilon_t$……………………………..…[3.2]

Where;

INFMORT= Infant Mortality Rate

HEXP= General Expenditure on Health

SSE = Senior Secondary Education

GDPPC = GDP Per Capita

Method of Analysis

To determine the long-term relationship between the variables, the model was put through an ARDL bound co-integration test. From Equation 3.2, the unrestricted error correction model, (ECM) for ARDL is specified below:

$$ln\, ln\, INFMORT = \beta 1t + \sum_{i=1}^{n} \alpha 1iINFMORT_{t-i} + \sum_{i=1}^{n} \beta 1iHEXP_{t-i} + \sum_{i=1}^{n} \chi 1iSSE_{t-i} + \sum_{i=1}^{n} \pi 1iGDPPC_{t-i} = \theta 1\, ln\, ln\, INFMORT + \theta 1\, ln\, ln\, HEXP + \theta 1\, ln\, ln\, SSE + \theta 1\, ln\, ln\, GDPPC + \mu t \quad ………………………[3.3]$$

Where Δ is first difference operator and n is optimal lag length.

To test the long-run cointegration relationship among the variables, the following hypotheses are stated:

H0: $\theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = 0$ (No cointegration)

Ha: $\theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5 \neq 0$ (Cointegration exists)

With the evidence of a long-run relationship among the variables, the following long-run (Equation 3.4) and short-run (Equation 3.5) models will be estimated simultaneously and the error correction term (ECT) in Equation is defined as in equation 3.6.

$$ln\, ln\, INFMORT = \beta 2t + \sum_{i=1}^{n} \beta 2i \; ln\, ln\, H\, EXP_{t-i} + \sum_{i=1}^{n} \chi 2i\; ln\, ln\, SS\, E_{t-i} + \sum_{i=1}^{n} \partial 2i \; ln\, ln\, GDPP\, C_{t-i} + \mu t \quad [3.4]$$

$$ln\, ln\, INFMORT = \beta 3t + \sum_{i=1}^{n} \alpha 3i \; ln\, ln\, \Delta\, INFMORTT_{t-i} + \sum_{i=1}^{n} \beta 3i \; ln\, ln\, \Delta\, HEXPP_{t-i} + \sum_{i=1}^{n} \chi 3i \; ln\, ln\, \Delta\, SSE_{t-i} + \sum_{i=1}^{n} \partial 3i \; ln\, ln\, \Delta\, GDPPC_{t-i} + \lambda ECTt0 - 1 \quad [3.5]$$

$$ECTt = \sum_{i=1}^{n} \alpha 4i\; ln\, ln\, \Delta\, INFMORT_{t-i} - \sum_{i=1}^{n} \beta 4i \; ln\, ln\, \Delta\, HEXP_{t-i} - \sum_{i=1}^{n} \chi 4i \; ln\, ln\, \Delta\, SSE_{t-i} - \sum_{i=1}^{n} \partial 4i \; ln\, ln\, \Delta\, GDPPC_{t-i}$$

4. Results and Discussion

4.1 Descriptive Statistics

	GDPPC	HEXP	INFMORTALITY	SSE
Mean	285282.3	3.409567	95.95515	34.97981
Median	284949.4	3.320779	92.40000	34.93866
Maximum	379251.6	5.053610	124.2000	56.17987
Minimum	202255.7	2.490640	56.22000	23.53617
Std. Dev.	65595.59	0.578987	19.56677	9.563787
Skewness	0.004011	1.014973	0.061716	0.244086
Kurtosis	1.341286	3.721794	1.795093	1.749684
Jarque-Bera	3.783168	6.382295	2.017174	2.477204
Probability	0.150833	0.041125	0.364734	0.289789
Sum	9414315.	112.5157	3166.520	1154.334
Sum Sq. Dev.	1.38E+11	10.72724	12251.47	2926.913
Observations	33	33	33	33

The mean value of GDP per capita looks average as it is in local currency. The mean value of general expenditure on health which was measured as percentage of GDP is very low which signifies low government spending on the health sector. The mean value of Infant mortality rate per 1000 birth is pretty high which showcase poor health standard in the country. The result shows the values of standard deviation of all variables are low. This means that the values of all the variables are closer to mean.

The skewness result shows that all the variables are fairly symmetrical as only the value of HEXP falls outside -0.5 to 0.5. The result also depicts that none of the variable kurtosis values exceeds 3. This shows the data sets of all the variables have no heavy tails.

The overall result of Jarque Bera shows that the variables have a normal distribution.

4.2 Correlation Matrix

	GDPPC	HEXP	INFMORTALITY	SSE
GDPPC	1	0.23863636...	-0.6553030...	0.78409090...
HEXP	0.23863636...	1	-0.3863636...	0.27272727...
INFMO...	-0.6553030...	-0.3863636...	1	-0.6515151...
SSE	0.78409090...	0.27272727...	-0.6515151...	1

Results from the correlation statistics shows no strong correlation among all the variables. Results of the correlation matrix indicate the variables can be used in the same model and can produce reliable estimates.

4.3 Unit Root Test Augmented-Dicky Fuller (ADF) & Philips Perron (PP)

ADF (GDPCC)

Null Hypothesis: GDPPC has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.922105	0.7675
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

Null Hypothesis: GDPPC has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.826707	0.2001
Test critical values:	1% level	-4.323979	
	5% level	-3.580622	
	10% level	-3.225334	

Null Hypothesis: D(GDPPC) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.894262	0.0575
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

Null Hypothesis: D(GDPPC) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.838568	0.1951
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

PP (GDPPC)

Null Hypothesis: GDPPC has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.638210	0.8481
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

Null Hypothesis: GDPPC has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.747887	0.7060
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

Null Hypothesis: D(GDPPC) has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.873318	0.0601
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

Null Hypothesis: D(GDPPC) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.794113	0.2098
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

ADF (HEXP)

Null Hypothesis: HEXP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.874305	0.0596
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

Null Hypothesis: HEXP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.005751	0.1463
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

Null Hypothesis: D(HEXP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.243782	0.0000
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

Null Hypothesis: D(HEXP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.118240	0.0000
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

PP (HEXP)

Null Hypothesis: HEXP has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.815571	0.0673
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

Null Hypothesis: HEXP has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.969343	0.1560
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

Null Hypothesis: D(HEXP) has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.672768	0.0000
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

Null Hypothesis: D(HEXP) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.537136	0.0000
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

ADF (INFMORTALITY)

Null Hypothesis: INFMORTALITY has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.649631	0.9992
Test critical values:	1% level	-3.711457	
	5% level	-2.981038	
	10% level	-2.629906	

Null Hypothesis: INFMORTALITY has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.144427	0.0150
Test critical values:	1% level	-4.323979	
	5% level	-3.580622	
	10% level	-3.225334	

Null Hypothesis: D(INFMORTALITY) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.214479	0.9264
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

Null Hypothesis: D(INFMORTALITY) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.177340	0.9907
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

PP (INFMORTALITY)

Null Hypothesis: INFMORTALITY has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		1.094015	0.9966
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

Null Hypothesis: INFMORTALITY has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		1.094015	0.9966
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

Null Hypothesis: D(INFMORTALITY) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.214479	0.9264
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

Null Hypothesis: D(INFMORTALITY) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.177340	0.9907
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

ADF (SSE)

Null Hypothesis: SSE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.054253	0.7213
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

Null Hypothesis: SSE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.092066	0.5305
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

Null Hypothesis: D(SSE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.218408	0.0000
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

Null Hypothesis: D(SSE) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.106714	0.0000
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

PP (SSE)

Null Hypothesis: SSE has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.985910	0.7463
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

Null Hypothesis: SSE has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.973313	0.5932
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

Null Hypothesis: D(SSE) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.218408	0.0000
Test critical values:	1% level	-3.661661	
	5% level	-2.960411	
	10% level	-2.619160	

Null Hypothesis: D(SSE) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.106714	0.0000
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

Results of the unit root test based on the ADF and PP approach shows that HEXP and INFMORTALITY attained stationarity at level I(0). GDPPC and SSE attained stationarity at first difference I(1). It is thus established that the series are integrated at different levels; meaning that some of the series are stationary at I(0) and others at I(1). The results from the unit root test have validated the adoption of the ARDL bounds test. Mixed order of the integration justified the use of ARDL as the ARDL model can be applied when variables are purely I(0), I(1) or mixed.

4.4 Lag Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: INFMORTALITY HEXP GDPPC SSE
Exogenous variables: C
Date: 07/08/23 Time: 11:49
Sample: 1990 2022
Included observations: 31

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-587.2902	NA	4.34e+11	38.14775	38.33278	38.20807
1	-474.5503	189.1120	8.55e+08	31.90647	32.83162*	32.20805
2	-451.9808	32.03420*	5.93e+08*	31.48263*	33.14791	32.02547*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The lags selected for the model are depicted in Table can be seen that LogL did not suggest any lag, LR, FPE, AIC, and HQ all suggested lag 2, while SC suggested the use of lag 1. Therefore, lag 2 was selected for further estimations of the model.

4.5 Autoregressive Distributed Lag (ARDL)
Long Run Result and ARDL Bound Test

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
HEXP	2.260397	1.211427	1.865896	0.0754
SSE	-0.042824	0.184840	-0.231683	0.8189
GDPPC	0.100286	2.73E-05	10.51207	0.0000
C	185.3359	3.606610	51.38783	0.0000

EC = INFMORTALITY - (2.2604*HEXP -0.0428*SSE -0.1003*GDPPC + 185.3359)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	5.815121	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Actual Sample Size	31		Finite Sample: n=35	
		10%	2.618	3.532
		5%	3.164	4.194
		1%	4.428	5.816
			Finite Sample: n=30	
		10%	2.676	3.586
		5%	3.272	4.306
		1%	4.614	5.966

The cointegration results has proved the presence of co- integrating relationships between the dependent and independent variables. This is because the calculated F-statistics of 5.815, is higher than the Narayan (2005) upper critical values at 1 percent significance level. Therefore, conclusively there is a long run relationship among the variables in the model.

The long run result shows that general expenditure on health has a negative and significant impact on infant mortality rate. This shows that the level of income matters in the amount spent on health. Based on the results. 1 unit increase in HEXP will decrease general infant mortality rate by 2.260 units. This is not surprising as greater financial resources and improved living standards means improved healthcare infrastructure, access to medical services, and better health outcomes for individuals and society. The coefficient of SSE has a positive but insignificant impact on GDP per capita. Finally, the coefficient of GDP per capita has a negative and significant impact on infant mortality rate. Based on the result 1 unit increase in GDP per capita will decrease infant mortality rate by 0.100 units

4.6 Short Run Results

ARDL Error Correction Regression
Dependent Variable: D(INFMORTALITY)
Selected Model: ARDL(2, 1, 0, 2)
Case 2: Restricted Constant and No Trend
Date: 07/08/23 Time: 12:14
Sample: 1990 2022
Included observations: 31

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INFMORTALITY(-1))	-4.478626	1.002226	-4.468679	0.0002
D(HEXP)	0.101559	0.619614	0.163907	0.8713
D(GDPPC)	8.92E-05	4.38E-05	2.035747	0.0540
D(GDPPC(-1))	0.000187	5.30E-05	3.543844	0.0018
CointEq(-1)*	0.709273	0.120997	5.861917	0.0000

R-squared	0.611548	Mean dependent var	-2.183226
Adjusted R-squared	0.551786	S.D. dependent var	2.402455
S.E. of regression	1.608415	Akaike info criterion	3.935065
Sum squared resid	67.26195	Schwarz criterion	4.166353
Log likelihood	-55.99351	Hannan-Quinn criter.	4.010459
Durbin-Watson stat	1.634723		

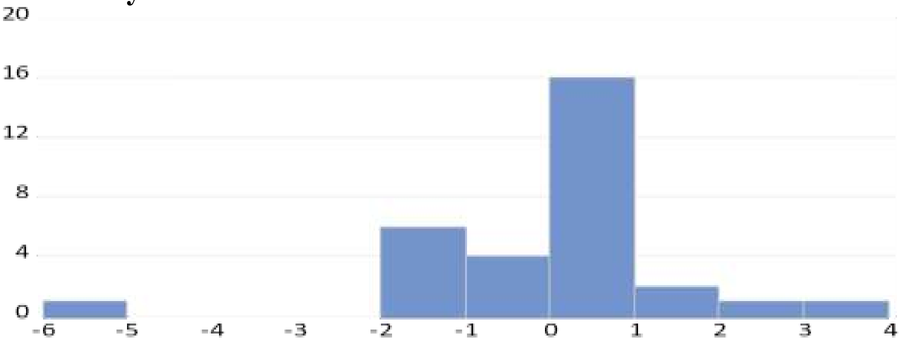
* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.815121	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

4.7 Diagnostic Tests

Normality Test



Series: Residuals	
Sample 1992 2022	
Observations 31	
Mean	-2.81e-15
Median	0.246705
Maximum	3.176514
Minimum	-5.290370
Std. Dev.	1.497353
Skewness	-1.074096
Kurtosis	6.698066
Jarque-Bera	23.62513
Probability	0.000007

Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.588382	Prob. F(2,20)	0.5646
Obs*R-squared	1.722629	Prob. Chi-Square(2)	0.4226

Heteroskedasticity

Heteroskedasticity Test: ARCH

F-statistic	4.579441	Prob. F(14,2)	0.1935
Obs*R-squared	16.48572	Prob. Chi-Square(14)	0.2846

Ramsey Reset

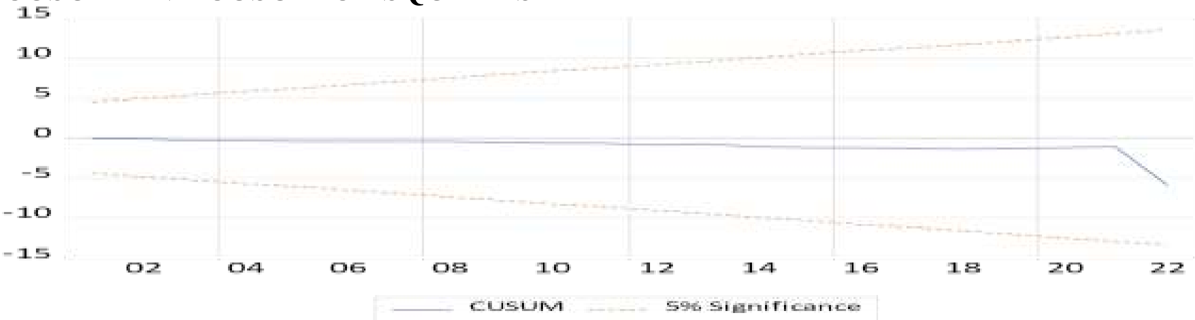
Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: INFMORTALITY INFMORTALITY(-1) INFMORTALITY(-2) HEXP HEXP(-1) SSE GDPPC GDPPC(-1) GDPPC(-2) C

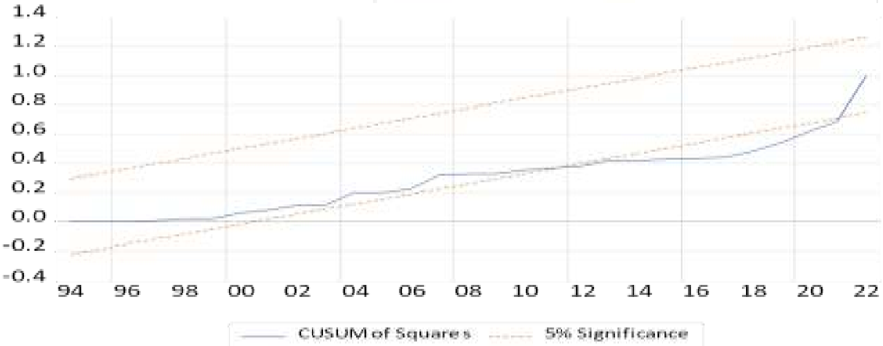
	Value	df	Probability
t-statistic	1.561827	21	0.1147
F-statistic	2.004419	(1, 21)	0.1477
Likelihood ratio	1.979081	1	0.0273

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	16.91493	1	16.91493
Restricted SSR	67.26195	22	3.057361
Unrestricted SSR	50.34701	21	2.397477

CUSUM AND CUSUM OF SQUARES





The result of the diagnostic tests reveals that the Breusch-Godfrey LM test shows that there is no presence of serial correlation in the model. The Jarque-Bera test shows that the data in the model is not normally distributed. The Heteroskedasticity (ARCH) shows no sign of heteroskedasticity in the model. The Ramsey RESET test shows that the model has been correctly specified. This means that the model is free from serial correlation, heteroscedasticity and normality problems. As such, this model could produce reliable results.

Cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests for stability of the ARDL model along the studied periods were conducted. It is suggested that for a model to be stable along the sampled period, the residuals line must be within the straight lines of the critical bounds at a 5% significance level. The results show that the model is stable within the study period.

5. Conclusion and Recommendations

Conclusion

The present study examined the impact of health expenditure on infant mortality rate for the period 1990-2022. Three null hypotheses that sought to establish to guide the study. A linear model which specified infant mortality rate as a function of expenditure, per capita income and education was formulated. Time series data was obtained from the World Bank database.

The long run result shows that general expenditure on health has a negative and significant impact on infant mortality rate. This shows that the level of income matters in the amount spent on health. Based on the results. 1 unit increase in HEXP will decrease general infant mortality rate by 2.260 units. This is not surprising as greater financial resources and improved living standards means improved healthcare infrastructure, access to medical services, and better health outcomes for individuals and society. The coefficient of SSE has a positive but insignificant impact on GDP per capita. Finally, the coefficient of GDP per capita has a negative and significant impact on infant mortality rate. Based on the result 1 unit increase in GDP per capita will decrease infant mortality rate by 0.100 units

Recommendations

Based on the result of data analysis, the study makes the following recommendations:

1. Having observed that infant mortality decreases as government expenditure on health increases, there is a need for more funds spent on this sector by the government.
2. It is observed that per capita income is well behaved in the model. This implies that Nigerians meet their health challenges from their out-of-pocket expenses mainly, rather than government welfare provisions. There is need for the increase in coverage of the health insurance scheme that would be inclusive for all Nigerians irrespective of where one comes from or the type of work the person does. This health scheme should be funded by the federal, state and local governments.
3. An institution like Tertiary Education Fund should be created to source up at least 25% of finance and communication companies' corporate social responsibility votes/budgets to be dedicated to infant health care initiatives. This is obviously owing to the fact that these two sectors are the major beneficiaries of the larger public in Nigeria.
4. Health care enlightenment should be intensified to educate the public on basic health precautions and requirements both at pre- and post-natal levels and basic medications be provided with ease.

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