International Journal of
Advanced Research in Accounting, Economics and Business Perspectives
p-ISSN: 2636-6894 | e-ISSN: 2636-6886

IJARAEBP
Vol. 7, No. 2
September, 2023

Public Health Financing Model and Under-Five Mortality Rate in Nigeria

[1]Kalu, U. Christopher, [2]Anigbogu, Hilary Ikechikwu, [3]Ezenekwe, R. Uju, & [4]Nga Chukwudi
[1,2&3]Department of Economics, Nnamdi Azikiwe University, Awka
[4]Chartered Institute of Stockbrokers (CIS)

Article DOI: 10.48028/iiprds/ijaraebp.v7.i2.05

Abstract

Despite enormous resources committed to reduce under-five mortality rate in Nigeria, not much has been achieved. This paper, therefore, examined the impact of public health expenditure on under-five mortality rate in Nigeria from 1986 to 2022 using the Grossman health capital theoretical framework. The variables used in this study included the under-five mortality rate as the dependent variable and foreign direct investment, food security, per capita income, urbanization, carbon emission, sanitation, female school attainment and government expenditure. These variables were sourced from Central Bank of Nigeria Statistical Bulletin (CBN), National Bureau of Statistics (NBS) and World Bank Development Indicator (WDI). The analytical techniques used were the Granger causality test and the vector error correction model (VECM) involving the forecast error variance decomposition (FEVD) and the impulse response functions (IRFs). The result showed that the coefficient of government health expenditure was negative but significantly related to under-five mortality rate while foreign direct investment was negative and insignificant to under-five mortality rate. The result further showed a unidirectional causality between government health expenditure and under-five mortality rate and no causality between foreign direct investment and under-five mortality. From the result the shock of public health expenditure is exogenously weak throughout the ten period horizons implying that public health expenditure had no significant positive impact on under-five mortality rate. This paper recommended among others, the need for government and policy makers to make concerted efforts to ensure full implementation of capital spending on the health sector, as any negative shock from government health expenditure health human development outcome including under-five mortality rate.

Keywords: *Food security, Government expenditure, Per capita income, Public health financing model, Urbanization.*

Corresponding Author: **Kalu, U. Christopher**

Background to the Study

The mortality rate of children aged less than 5 years is the probability that a child born in a specific year or period will die before reaching the age of 5 years, subject to the age-specific mortality rates of that period. Globally, infections disease, including acute respiratory infections, diarrhea and malaria along with pre-term birth complications, birth asphyxia and trauma and congenital anomalies remain the leading cause of death of children under 5 (UNICEF, 2021).

Over the past five years, infant and under-five mortality rates have remained steady in Nigeria, at 74 and 117 deaths per 1000 live births, respectively. At these mortality levels, one Nigerian child of every 13 born dies before reaching age 1, and one in every eight does not survive to their fifth birthday (WHO, 2021). Although there is a substantial global reduction in under-five mortality in the world, with one in thirteen children dying before reaching the fifth thus, placing the region at top risk region of under-five deaths. According to World Health Organization (WHO), half of the global under-five deaths occurred in five countries including Nigeria. Nigeria is one of the countries that presented a high under-five mortality rate of 117 per 1,000 births in the past three decades. The countries are listed among the top five countries with the highest under-five in the past three years.

In order to enhance health, sufficient health resources must be prepared. Preparing these resources needs money; hence, achieving a healthy country requires health spending (WHO, 2010). Health expenditures increase the quality of human resources and lead to high life expectancy, reduction in under-five mortality rate and promotion of longevity (Homaie & Samadi, 2013). Increase in life expectancy are reduction in under-five mortality leads to an increase in the desire of savings and investing and eventually results in higher rates of economic growth (Anyanwu & Erhijakpor, 2009). Public health expenditure especially in Nigeria will play an important role. In particular, public health expenditure contains social security spending, taxing to private and public sectors, and foreign resources like loans and subventions. This is different from private health expenditures, which includes private health insurance, and out-of-pocket health expenditure (Poullier, 2002). In order to enhance health, sufficient health resource allocation must be prepared and utilized. Health expenditures increase the quality of human resources and lead to higher life expectancy as well as longevity. An increase in life expectancy also leads to an increase in the desire of saving and investment and eventually results in higher rates of economic growth (Anyanwu & Erhijakpor, 2009).

Private and public health expenditures has different effects on the health status. Increase in out-of-pocket health expenditures increases the number of catastrophic expenditures and may lead to more poverty (WHO, 2000; Yardim *et al.,*2010). Meanwhile, increasing the public health expenditure may increase the budget shortage, but it decreases the number of catastrophic expenditures. Public health expenditure improves the society's health and eventually improves human capital and leads to economic growth (Enayatollah *et al.,* 2013).

Between 1986 and 1990, health expenditure as a percentage of gross domestic product (GDP) averaged 0.32% and changed to 0.33 between 1995 and 1999, and since 1999 to 2023, it has not

gone beyond the recognized standard of agreement. (Comparing the health allocation performance of Nigeria with other African countries, Olaniyi and Adam (2003), and Bolaji and Samina (2017) averred that Nigeria has performed poorly with Ghana's 3.5 percent; 4.3 percent for Kenya and 4 percent for Seychelles. Poor expenditure on health sector in Nigeria is worsened by an inverted nature of health expenditure pyramid. About three quarters of Nigeria public health expenditure are for expensive medical care that benefits a small minority of the population living in the urban areas, while a higher proportion is spent on hospitals, almost all located in the cities (Edeme *et al.,* 2017).

Weak and poor budgetary allocation to health sector and poor implementation of health policies in Nigeria have been identified as some of the reasons for the low health status. In Nigeria despite the relative huge budgetary allocation for health sector, this has not really manifested in the health status of an average Nigerian. The health status of Nigerians is consistently ranked low. Nigeria is ranked 74th out of 115 countries based on the performance of some selected health indicators (World Bank, 2020). Nigeria's overall health system performance is also not on the positive note. Nigeria ranked 187th among the 191 member states by the World Health Organization (WHO) over the years.

The causal relationship between public health expenditure and under-five mortality rate continues to attract the attention of public policy researchers. However, despite decades of intensive study, there is no general consensus regarding the effectiveness of monetary health inputs to health outcomes. The proposition in this study is that if public spending is imperative in improving the healthcare of the citizens, then it is necessary to re-examine and re-assesses the contribution of the government spending towards the improvement in health status within the framework of the health production function. This paper examines the relationship between public health expenditure and under-five mortality rate between the period 1986 to 2022.

Previous attempts to study the relationship between health expenditure and health status include the works of (Aregbeshola & Samina, 2010; Olarinde & Bello, 2014; Baldacci, 2004; Enayatolla et al, 2013; Edeme et al, 2017; Novynon et al., 2012; Boachie & Ramu, 2015; Abbas 2010; Ahmed and Hassan, 2016; Barenberg et al., 2015; Akina et al., 2015; Sanya & Yemisi; 2017; Kalu & Attamah, 2021; Isa & Quattara, 2012; Sango-Coker &Murad, 2018). The empirical of these studies are: first, mixed-negative and positive, others are inconclusive. Some others are not current, yet others are cross-country studies. This study overcame these challenges by extending the time period to the current period introducing more variables that directly impacts on health outcome which has been ignored by previous studies. These variables include macroeconomic variables (saving, investment), education, food security and environmental factors (water and sanitation, WASH). This additional variable adds to the extant knowledge and extends the body of knowledge. Therefore, this study examined the relationship between government health expenditure and health outcome in Nigeria from 1986-2022 econometrics-quantitative approaches.

The objectives of this paper are to:

1. Investigate the impact of public health expenditure on under-five mortality rate in Nigeria.
2. Determine the causal relationship between public health expenditure and under-five mortality rate in Nigeria.
3. Analyze the shock of public health expenditure on under-five mortality rate Nigeria.

This paper is structure as follows: Section one presents the introduction and background information. This section helped in contextualizing the topic. The next section, which is section two the related literature review which presents the concepts and reviews the extant empirical literature. Section four presents the results and discussion of these results in relation to the objectives of this study while section five presents the summary of this study and the policy recommendations.

Empirical Literature Review

In a paper, Anyanwu and Erhijiakpor (2007), examined the linkage government health expenditure and infant mortality between 1999 and 2004. The study utilized the panel data approach. The results show that health expenditure has a statistically significant effect on infant mortality and under-five mortality and that total health expenditure are certainly important for African countries depending on each region peculiarities. The authors concluded that both infant and under-five mortality are positively and significantly associated with Sub-Saharan Africa while the reverse is not true for North Africa.

Novignon, Olakojo and Novignon (2012), examined the effects of public and private healthcare expenditure on health status in 44 Sub-Saharan African countries with panel data from 1995-2010. The variables used are public health expenditure, private health expenditure, health status, infant mortality and under-five mortality. The result show that healthcare expenditure significantly influences health status, through improving life expectancy, reducing death and infant mortality rates. Both public and private healthcare spending showed story positive association with health status even though public healthcare spending had relatively higher impact.

Boachie and Ramu (2015), examined the relationship between public health expenditure and health status in Ghana, between 1990-2002 employing standard Ordinary Least Square and Newey-while estimation technique. The variables used are per capita income, literacy level and female participation in the labour market. The result showed that the declining infant mortality rate in Ghana is explained by public health spending among other factors. Thus, the author concluded that public healthcare expenditure is associated with improvement in health status through reduction in infant mortality.

Barenberg, Basu and Soyly (2015), investigated the impact of public health expenditure on infant mortality rate in Indian states between1983-1984 and 2011-2012, the study used the macro econometric approach. The variables used are per capita income, female literacy, and urbanization. The study showed that public expenditure on healthcare dampens infant

mortality rate. The baseline specifications shows that an increase in public health expenditure by 1% of state-level GDP leads to a decrease in the infant mortality rate by about 8%. Furthermore, the study showed that female literacy and urbanization also reduce the infant mortality rate.

Akinli, Samer, Farrukh and Akhmedjonov (2015), examined the impact of healthcare expenditure on selected health outcomes for 19 countries in the Middle East and North African region. Using panel data for 1990-2010; the variables used are government and private health expenditures, infant- and under-five mortality rates. The results show that government and private spending on healthcare significantly improve infant/under-five, and maternal mortality in the region, though its impact is not significant. In specific terms, a percentage increase in per capita government expenditure reduces the infant mortality rate by 8.6-9.5%, under-five mortality by 10.3-12%. In the same vein, a percentage increase in the log per capita private expenditures reduces the infant mortality rate by 7.2-8.1%, under-five mortality rate by 9.5-9.8% and the maternal mortality rate by 25.8-25.9%.

Hu (2010), examined the empirical determinants of infant and child mortality in developing countries and how public policy may interact with these. Using panel data analysis covering 136 countries over 1960-2005. The variables used are infant mortality, child mortality, governance, and government expenditure. The results show that governance does play a role in enhancing the link between public spending and child health. The effects of public financing on health expenditures, insurance coverage and other factors on health outcomes are examined by Berger and Messer (2002) with health production models estimated, using 1960-1992 data across 20 OECD countries. The variables used are health expenditures, health outcomes, infant and under-five mortality rates. The results show that mortality rates depend on the mix of health care expenditures and the type of health coverage. In particular, increases in the publicity financed share of health expenditures are associated with increase in mortality rates. The authors therefore concluded that as countries increases the level of their health expenditures, they may want to avoid increasing the proportion of their expenditures that are publicly financed.

Wixon and Ulmann (2006), showed that health expenditure and the number of physicians have made significant contribution to improvements in infant mortality, health care expenditure has made relatively marginal contribution to the improvement in life expectancy in the countries over the period of the analysis covering 1980-1995. Day and Tousignant (2005), examine the relationship between health outcome and health spending in Canada for the periods 1960-1997, 1950-1997 and 1926-1999. The study used variables including health-infant mortality rate, under-five mortality rate and real per capita health expenditure. The study concluded that the relationship were statistically significant. The authors indicated that their results may be due to model misspecification or may reflect the fact that a high level of population health, the return to increases in health spending is small.

Cremisux et al (1999), examine the relationship between health indicators such as infant mortality rates and life expectancy and total per capita spending on health, using pooled time

series cross-section data for the ten provinces for the period 1978-1992. The authors estimated a similar model using data for the period 1981-1998 but disaggregated per capita health spending in three categories: public spending on drugs, private spending on drugs, and non-drug healthcare spending. Kee (2001) used pooled time series cross sectional data for the ten provinces for the 1975-1996 period. The variables used are population health status, life expectancy and age standardized mortality rates on a number of variables, including real per capita public expenditure on health. The study showed that there is a statistically significant relationship between health status and both health spending and per capita income.

In a similar study, Awe and Ogundele (2001), examined social spending, human capital formation and output expansion in Nigeria from 1977 to 2005 using the vector autoregressive (VAR) model approach. The study suggested that there is a causal linkage among social spending, human capital formation and output expansion in Nigeria. Using demographic and health survey (DHS) data, Wang (2002) investigated the low-income countries both at the national level, and for rural and urban areas separately. The study showed that public health expenditure reduces child mortality.

Or (2000/1) examined the determinants of health outcomes in industrialized countries using a pooled, cross-country and time-series approaches, between the periods 1972-1992 of 21 OECD countries. The variables of the study are health outcome, total health expenditure, share of public expenditure, GDP and Alcohol. The study showed that environmental factor are more important than medical inputs in explaining variations in premature mortality in industrialized countries.

Issa and Quattara (2012), examined the effect of private and public health expenditure on infant mortality rates; does the level of development matters from the period 1990 to 2000 using the pooled OLS, fixed effects and the GMM-SYS estimation techniques. The variables used are private, public health expenditures and infant mortality rates, secondary school enrolment, CO_2 emissions, female labour force, real income per capita, and governance. The results show that at low stages of development public health expenditures is more effective in reducing infant mortality rates (IMRs), whilst at higher levels of development private health expenditure takes the lead in reducing IMRs. The results also show that IMRs tend to be lower in countries with good governance, whereas they tend to be higher in countries located inside the tropics.

Ehikioya and Ismaila (2013), examined the determinants of public healthcare expenditure in Nigeria: an error correction mechanism approach from 1986 to 2010. The study employed the cointegration approach. The variables used are total health expenditure, unemployment rate, population per physician, consumer price index and political instability. The results show that total population of 14 years of Age and Younger and health expenditure share in gross domestic product are the major determinants of health expenditure in Nigeria while gross domestic product per capita, unemployment rate, population per physician, consumer price index and political instability are insignificant. The study recommended that government should initiate adequate spending on health at all levels (primary, secondary and tertiary).

Babatunde (2014), explored the growth impact of health expenditure in Nigeria covering the period 1970-2010, using the multiple regression analysis. The variables used are the gross fixed capital formation, total health expenditure, second school enrolment, life expectancy rate and gross domestic product. The results show that gross capital formation, total health expenditure and the labour force productivity are important determinants of economic growth in Nigeria while life expectancy rate has negative impact on growth for the period under study. The study suggested that government should encourage savings and investments in the economy, increase expenditures on health provisions, induce the level of labour productivity and place priority on the issues of security of lives and properties in Nigeria.

Sanya and Yemsi (2017), examined the relationship between life expectancy and government expenditure in Nigeria between 1980 and 2015. The variables used are life expectancy, share of government expenditure on health, the real growth rate, the total number of physician, carbon dioxide emission, death and birth rates. The technique employed was the VAR approach (vector autoregressive). The results show that the highest shocks to the life expectancy were accounted for by the share of government expenditure. The second was the number of physicians and carbon dioxide. The study recommended that for life expectancy to increase in Nigeria, the share of government expenditure on health should increase and that plantation of grasses and trees should be encouraged to reduce the effect of carbon dioxide.

Coker and Murad (2018) investigated the private, public and public-private healthcare on life expectancy in selected West African Countries, between the periods 1999-2014. The variables used are private health expenditure, public health expenditure female population, male population and total population. The technique employed was that of pooled regression and pairwise correlation. The government, policy and decision-makers are recommended to focus on increasing the expenditure on the public healthcare system to achieve positive outcomes for increased life expectancy.

Cheweand Hangoma (2020), examined the drivers of health in Sub-Saharan Africa from the period 1995-2014. The variables used are healthcare expenditure, healthcare access, lifestyle and alcohol consumption. The study adopted the dynamic panel data estimator based on the generalized method of moments (GMM) as expressed by Arellano and Bond (1990). The findings show that increases in health expenditure, educational attainment and healthcare access quality are associated with increases in life expectancy and reduction in infant mortality. The study concluded that increases in life expectancy and reductions in infant mortality can be accelerated by paying particular attention to interventions linked to these drivers, including healthcare access quality.

From this paper reviewed, there are five major conclusions derivable from these studies. The conclusions include the following (i) There papers that showed positive relationship between health expenditure and health outcome (Baldacci, 2004; Anyanwu & Erhijiakpor, 2007; Novignon et al, 2012; among others). (ii) There are studies that showed negative relationship between health expenditure and health outcome (Hu, 2010) (iii) Bidirectional causality between health expenditure and health outcome (Ogungbenle et al, 2013), (iv) from the

previous studies, infant mortality rate, under-five mortality rate, health expenditure, governance, education, total per capita spending, environmental factor (CO_2), female labour force rate and population per physician are some of the variables used by the reviewed studies, (v) from the reviewed studied, multiple regression of OLS, Granger causality, VAR, VECM and macro econometric analysis and panel data are some of the techniques utilized in examining the relationship between health expenditure and health outcome.

Methodology

Theoretical Framework

The theoretical framework of this study is anchored on the Grossman framework. The framework hypothesizes that the production function of health defines the relationship between health expenditure and the health inputs. Grossman treats health as a form of human capital. The author showed that public policies and programmes that determine the price and availability of key inputs have critical effects on outcome ranging from birth weight and infant mortality. Individuals simultaneously optimize two assets over their life cycle: health and wealth. The return to health is non-financial, in the guide of healthy days, it contributes to wealth because additional healthy time can be used to generate more labour income.

In this model, health is durable capital goods which is inherited and depreciates over time. Investment in health takes the form of medical care purchases and other inputs and depreciation is interpreted as natural deterioration of health over time. In the model, health enters the utility function directly as a good people derive pleasure from and directly as an investment which makes more healthy true available for market and non-market activities. The model creates a dynamic system of equations which can be cast as an optimization problem where utility is optimized over gross investment in health in each period, consumption of medical care, and time inputs in the gross investment function in each period. However, in the model, health is neither a pure investment good nor a pure consumption good, but health stock benefits the agent in two ways, directly increasing utility and second by increasing healthy time available for other activities. One early criticism is that framing health as a dicholomons concept is intuitively wrong in that health is simultaneously both and health provides both alternatives simultaneously.

Estimation Technique and Procedure

In statistics, a unit root test tests whether a time series variable is non-stationary and possesses a unit root. The null hypothesis is generally defined as the presence of a unit root and the alternative hypothesis is stationarity, trend stationarity or explosive root depending on the test used. If there are unit roots, there is stationarity. Accordingly, if the P-value of z(t) is not significant, the series is not stationary. If $Z \leq Z0.05$ then we reject the null hypothesis H_o that the series has a unit root. If there are no unit roots, then we conclude the series is stationary.

The ADF test is an extension of the Dickey-Fuller test by allowing a higher order of autoregressive process, such that:

$$\Delta X_i = a_0 + a_1 X_{i-1} + a_{2t} + \sum_{i=2}^{p} b_i \Delta X_{i-1} + U_t \qquad (1)$$

Where P is the number of lagged changes in X_t necessary to make U_t serially uncorrelated. Testing the null H_O: $\alpha_1 = 0$ against the H_a: $\alpha_1 < 0$, the null of unit root is rejected if the observed t-statistics is sufficiently negative compared to the critical value.

Equation (1) allows us to investigate whether the series can be characterized as an I(1) process with a positive drift and/or with a deterministic trend variable. Another recommended method to check for the series stationarity is by performing the Phillips and Perron (1988) test. The PP test statistic are modifications of the Dickey-Fuller t-statistic. The test allows the error terms to be weakly dependent and heterogeneously distributed. The Phillips-Perron test can be conducted using the following equations:

$$X_t = \alpha_0 + \alpha_1 X_{t-1} + U_t \quad (2)$$

and

$$X_t = \overline{\alpha_0} + \overline{\alpha_1} X_{t-1} + \overline{\alpha_2} (t-T/2) + U_t \quad (3)$$

The research design of this paper is the cause-and-effect design. In other words, the ex-post-factor research design. The choice of this design is in line with the objectives of this study which is to examine the impact of government health expenditure on health outcome (under-five-mortality) rate between 1986 to 2022. The dependent variable of this study is the under-five mortality rate while the explanatory variables are savings, investment, food security, education, per capita income; urbanization; government health expenditure; climate extremes; economic downturns and water and sanitations.

Model Specification

This paper starts with a health status model specified the empirical studies of Novignon et al (2012); Anyanwu and Erhijiakpor (2007) and Enayatollah *et al* (2013). The model's functional form is as follows: Health Outcome/Status=f(savings, investment, food security, per capita income, urbanization, government expenditure, climate extremes, water and sanitation, education). Taking the statistical and econometrics of equation (3) becomes:

$$U5MR = \alpha_1 ß_1 SAV + ß_2 INV + ß_3 FODS + ß_4 PCI + ß_5 URB + ß_6 GOVEX + ß_7 C02 + ß_8 SANI + ß_9 FEM + £_t \quad (4)$$

Where U5MR represents under-five mortality rate; SAV is national savings; INV is investment (foreign direct investment); FODS is food security; PCI is per capita income; URB is urbanization; GOVEX is government health expenditure; CLEX is climate extremes (proxy by C02), sanitation and female education attainment.

Equation (4) can be further liberalized by taking the proportional effects into statistical consideration by long-linearizing the equation. As such,

$$LogHs = \alpha_1 ß_1 LnSAV + ß_2 LnINV + ß_3 LnFODS + ß_4 LnPCI + ß_5 LnURB + ß_6 LnGOVEX + ß_7 LnCLEX + ß_8 LnSANI + ß_9 LnFEM + £_t \quad (5)$$

The model equation of (5) can be causally linked by specifying the following bivariate vector auto regression model:

$$X_t = \sum_{j=1}^{j} \alpha_j X_{t-1} + \sum_{j=1}^{j} ß`_j Y_{t-j} + C + £_t \quad (6)$$

Where C is a constant, $£_t$ is the error term, and J is the number of time lags for {X, Y}. To test the hypothesis of non-causation (exogenity) from {X} – government health expenditure to {Y} is a test on

H_O: $ß_j = 0$, for j = 1,2, …. J.

The vector error correction model of equation (6) becomes.

$$\Delta_{yt} = V + \alpha ß^1 Y_{t-1} + \theta_1 \Delta Y_{t-1} + \theta_2 \Delta Y_{t-2} + U_t \quad (7)$$

Where:

$\alpha ß^1 = \Pi$

α = is a matrix or vector of adjustment of coefficient (KXr). ß is a matrix or vector of cointegrating relationship (KXr).

There Π is a KrK matrix. Hence, the VECM model of the equations gives us estimate of short-run behaviour, long-run cointegrating relationship as well as short-run adjustment coefficients. The short-run deviation from long-run equilibrium is corrected and the speed of this correction is shown by the adjustment coefficients. The included variables are expected to impact positively on health outcome (under-five mortality rate) except climate extreme (C02 emission. The methods of estimation used in this study involved the Granger causality method and the VECM which also include the impulse response function and variance decomposition. An impulse response function of the VAR/VECM traces the effect of a onetime shock to one of the innovations on current and future values of the endogenous variables. The accumulated response is the accumulated sum of the impulse response.

While impulse response function traces the effect of a shock to one endogenous variable to other variable in the VAR/VECM, variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR/VECM. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR.

The data set for this study is mainly secondary data, sourced from the official sources of secondary data collection in Nigeria as presented in Table 1.

Table 1: Data Sources

Variables	Definitions	Measurement	Sources
Health outcome	Under-five mortality rate, the health outcome. The probability of dying between birth and age five per 1000 live birth	U5MR	UNDPP 2021 WDI, 2
Saving	National saving	Percentage of GDP	CBN, 2021
Investment	Foreign direct investment	Percentage of GDP	CBN, 2021
Food security	Food accessibility and availability	Food production index	FAO, 2021
Per capita income	Quality of life, the population	Average per-person income	NBS, 2021
Urbanization	Concentration of human population	Population growth percentage of GDP	NBS, 2021
Government expenditure	Government spending	Percentage of GDP	CBN, 2021
Climate extremes	Environmental hazards	Carbon emission (CO_2)	FAO, 2021
Female school attainment	Human capital through formal learning	Literacy rate	WDI, 2021

Source: Authors' Compilation (2023) Note: UNDPR = United Nations Development Programme Report; CBN = Central Bank of Nigeria, FAO = Food and Agricultural Organization; NBS = National Bureau of Statistics; WHO = World Health Organization, WDI = World Development Indicator

Results Presentation and Discussion of Findings

Summary of Descriptive Statistics

Table 2 showed the mean, standard deviation, maximum and other values of the variables. Descriptive statistics show the statistical characteristics of the data used. The summary is presented in Table 2.

Table 2a: Summary of Descriptive Statistics

	U5MR	SAVINGS	FDI	FPIND	PCI	URB	GHEXP	C02	SANITATION	FEMALESCH
Mean	166.4257	35.99046	2.982641	71.55356	1317.377	38.35075	0.23763	0.547632	2.340952	5750.587
Maximum	209.6000	64.35459	10.83256	109.5647	3200.953	51.67575	0.254656	0.770377	6.370300	26875.19
Minimum	110.8000	15.84586	0.180459	29.90000	270.0275	26.41400	0.225692	0.234537	0.500000	295.3277
Std.Deviation	35.25854	13.25105	2.297060	23.42049	922.6107	7.687712	0.011453	0.174811	1.342443	6577.656
Skewness	-0.043830	0.301561	1.666115	-0.11749	0.492922	0.223251	2.624622	-0.437508	1.340051	1.506799
Kurtosis	1.403044	2.051049	6.021290	2.006920	1.738308	1.795433	12.66947	1.830830	4.628610	4.235794
Jarque-Bera	3.730346	1.8413718	29.50493	1.518713	3.738808	2.406830	160.1394	3.110061	14.34317	15.47140
Probability	0.154869	0.397779	0.000000	0.467966	0.154216	0.300167	0.000000	0.211183	0.0000768	0.000437
Observation	35	35	35	35	35	35	35	35	35	35

Note: U5MR = Under-five mortality rate; SAVINGS = National Savings; FDI = Foreign direct investment: FPIND = Food Production Index (food security); PCI = Per capita income; C02= Carbon emission; SANITATION = Sanitation and Hygiene; FEMALESCH = Female school attainment.
Source: Researchers' Computation using Eview 11 Software.

Table 2a presents the summary of the descriptive statistics. From the result, it was suggested that female school attainment has the highest average value. This implies the importance of women education to reproductive health. value of female education to under-five mortality. Anecdotal evidence has shown the positive link of girls and women education in reducing child and maternal deaths, improved child health, and lower fertility. Women with at least some formal educations are more likely than uneducated women to use contraception, marry later, have few children and be better informed on the nutritional and other needs of children. From the result also, government health expenditure had the lowest average value at 0.23 percent. Thus, increase in government and private healthcare expenditure reduces neonatal, infant and under-five deaths. Overall, increase in healthcare expenditure is associated with an increase in life expectancy by and a reduction in the number of deaths, under-five deaths and others.

Per capita and female school attainment had much of the spread of the data about the mean value. Per capita income had about N922, less than the $2.50 a day. This implies poor level of income for an average Nigerian. The female school attainment had about 6577 values, implying poor girls and women education in Nigeria. Furthermore, the standard deviation for government health expenditure at 0.011 also confirmed the mean of the distribution of the data set. The skewness result showed that under-five mortality; food production index, proxy for food security; and carbon emission was negatively skewed, while national savings, foreign direct investment, per capita income and urbanization were all positively skewed. The negative skewness showed a long or fatter tail on the left side of the distribution while positive skewness refers to a longer or fatter tail on the right. These two skews refer to the direction or weight of the distribution. Again, government health expenditure, sanitation and female school attainment were also positively skewed.

From the Jarque-Bera results, generally, all the variables were greater than the 5 percent (0.05) level of significance, implying the rejection of the null hypothesis and acceptance of the alternative hypothesis that the model included variables are normally distributed. Table 3 presents the correlation matrix for the multicollinearity test.

Table 3: Correlation Matrix

Correlation	U5MR	SAVINGS	FDI	FPIND	PCI	URBAN	GHEXP	C02	SANITATION	FEMALESCH
U5MR	1.00000									
SAVINGS	0.834372	1.00000								
FDI	0.506878	0.394312	1.00000							
FPIND	-0.954720	-.0.829925	-0.43364	1.00000						
PCI	-0911017	-0.735182	-0.512506	0.803726	1.00000					
URBANIZATION	-0.981203	-0.844194	-0.482006	0.974864	0.877770	1.00000				
GHEXP	-0.791577	-0.547514	-0.438811	0.762420	0.685164	0.817035	1.00000			
C02	-0.713523	-0.495108	-0.465887	0.695967	0.527776	0.662993	0.516791	1.00000		
SANITATION	0.127369	0.317766	-0.113174	-0.307996	0.073467	-0.165072	0.0400806	-0.204169	1.00000	
FEMALESCH	-0.802660	-0.674207	-0.516082	0.825417	0.627665	0.866057	0.822739	0.601465	-0.026840	1.00000

Source: Authors' Computation using E-view 11 Software

Table 3 presents the correlation matrix. From the results, the diagonals equal to one (1). This implies the correlation of the variables with itself. From the presented results, with the exception of savings, foreign direct investment, majority of the variables were negatively correlated with under-five mortality rate. For example, food production index correlates with urbanization. In other words, the mutual relationship between health outcome, proxy by under-five mortality rate and food production index was negative. This implies that as food security increases, under-five mortality rate decreases. Similarly, as government expenditure, and female school attainment increase, under-five mortality rate decreases and as carbon emission mitigation increases, under-five mortality rate decreases.

Food insecurity adversely affects human health (under-five mortality rate) inclusive, which means food security and nutrition are crucial to improving people's health outcome. Both food insecurity and health outcomes are the policy and agenda of the 2030 Sustainable Development Goals (SDGs). Melgar-Quinonez (2006) submitted that household food insecurity has been linked to child stunting growth. Therefore, the ultimate objective of interventions such as general food distribution is to save lives by providing food in order to prevent the deterioration of nutritional values. Furthermore, Harid (2022) averred that human development index, gross national income, urbanization rate and government health expenditure as a percentage of gross domestic product have decreasing effects on the under-five mortality rate, while inequality in income distribution worsens health status and increases the under-five mortality rate. Table 4 presents the unit root test. The unit root test was carried out to find out if the variables are stationary or not. The essence of the stationarity test is to ensure that the mean and the variance of the data are fairly constant to help the predictability of the model.

Table 4a: Unit root result using Augmented Dickey Fuller (ADF)

At Level				At First Difference			
	ADF	**5% Level**	**Prob. Value**	**ADF Stat.**	**5% Level**	**Prob. Value**	**Order of Integration**
L U5MR	-2.327818	-1.952006	0.0215	-2.327818	-1.952008	0.0215	I(0)
L SAVINGS	-1.2345	-1.952008	0.0000	-7.642475	-1.952008	0.0000	I(1)
L FDI	-1.54321	-1.952008	0.000	-8.259453	-1.952008	0.0000	I(1)
L FPIND	-1.24.804	-1.952008	0.0000	-24.804	-1.952008	0.0000	I(1)
L PCI	-1.02858	-1.951000	0.0002	-4.02858	-1.951000	0.0002	I(1)
L URBANIZATION	-2.808416	-1.951687	0.0065	-2.808416	-1.951684	0.0065	I(0)
L C02	-1.7033810	-1.951000	0.0000	-6.9033810	-1.951000	0.0000	I(1)
L SANITATION	-1.21448	-1.951000	0.0001	-4.24448	-1.951000	0.0000	I(1)
L FEMALESCH	-1.699647	-1.951200	0.000	-5.899147	-1.951000	0.0001	I(1)
L GOVEXP	-1.270365	-1.951332	0.000	-7.270365	-1.951000	0.0001	I(1)

Source: Authors Computation using EView 11 Software

Table 4b: Unit root result using Phillip-Perron (PP)

At Level				At First Difference			
	PP	**5% Level**	**Prob. Value**	**PP**	**5% Level**	**Prob. Value**	**Order of Integration**
L U5MR	-3.5043	-1.950687	0.0009	-	-1.950687	0.0009	I(0)
L SAVINGS	-1.23456	-1.951000	0.0000	-6.435672	-1.951000	0.0000	I(1)
L FDI	-1.56789	-1.951000	0.0000	-5.567893	-1.951000	0.0000	I(1)
L FPIND	-1.123054	-1.951000	0.0000	-7.123054	-1.951000	0.0000	I(1)
L PCI	-1.672456	-1.951000	0.0002	-4.013103	-1.951000	0.0002	I(1)
L URBANIZATION	-3.8225	-1.951332	0.0004	-3.8225	-1.951332	0.0004	I(0)
L C02	-1.56423	-1.951000	0.0000	-7.023047	-1.951000	0.0000	I(1)
L SANITATION	-1.567859	-1.951000	0.0002	-4.094693	-1.951000	0.0002	I(1)
L GOVEXP	-1.567432	-1.951332	0.0000	-7.270365	-1.951332	0.0000	I(1)
L FEMALESCH	-1.56743	-1.952066	0.0000	-6.506275	-1.952066	0.0000	I(1)

Source: Authors' Computation using EView 11 Software

From Table 4a and 4b, it was shown that the model included variables were stationary at both the levels and first difference. This showed the invariance of the variables with respect to the mean. It is used to check whether the mean value and variance of the stochastic process are constant over time. Since the variables have mixed order of integration (0 and 1), there is need for co-integration test using the Johansen co integration test-to check for existence of long-run relationship of the co integrating equation. Consequently, the vector error correction model (VECM) was used. Table 5 presents the Johansen co-integration test.

Table 5: Johansen Co-integration Test

Trace Test				Max-Eigen Test		
H_O	**Trace Statistic**	**0.05 level of sig.**	**Prob. Value**	**Max-Eigen Statistics**	**0.05 level of Sign.**	**Prob. Value**
None	721.9883	239.2354	0.0000	199.3752	64.50472	0.0001
At most 1	522.6131	197.3709	0.0001	139.3318	58.43354	0.0000
At most 2	383.2813	159.5297	0.0000	112.2765	52.36261	0.0000
At most 3	271.0049	125.6154	0.0000	84.50352	46.23142	0.0000
At most 4	186.5013	95.75366	0.0000	54.96044	40.07757	0.0005
At most 5	131.5409	69.81889	0.0000	41.00531	33.87687	0.0060
At most 6	90.53559	47.85613	0.0000	40.24704	27.58434	0.0007
At most 7	50.28855	29.79707	0.0001	26.23509	21.13162	0.0088
At most 8	24.05346	15.49471	0.0020	13.21458	14.26460	0.0728
At most 9	10.83888	3.841466	0.0010	10.83888	3.841466	0.0010

Source: Researchers' Computation using EViews 11 Software

Table 5 showed the result of the co integration test using the Trace statistics and Max-Eigen value tests. From the results, there are 10 co integrating equations using the Trace statistics and 8 co-integrating equations using Max Eigen statistics. From the result, we therefore reject the null hypothesis and accepted the alternative hypothesis and concluded that there is a long-run relationship between government health expenditure and under-five mortality rate within the reviewing period. Presented next is the optimal lag length. The purpose of the lag length selection is to reduce residual correlation. Table 6 presents the optimal lag length.

Table 6: Optimal Lag Length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-799.214	NA	4.37e+09	50.57758	51.03563	50.72941
1	-280.0829	681.3955	0.024556	24.38018	29.41865	26.05029
2	22.15372	207.7877*	7.99e-07*	11.74039*	21.35928*	14.92878*

Source: Researchers' Computation using E-views 11 Software

From the result presented in Table 6, all the lag length selection criteria (AIC, LR, FPE, SC & Ha) chose lag length 2. The lag time is the time between the two-time series been correlated? The importance of lag length determination is demonstrated in several works: Letkepohl (1993) indicates that selecting a higher order lag length than the true lag length causes an increase in the maen-square forecast errors of the VAR. The paper used lag 2 of the selection criteria. Table 7 presents the vector autoregressive estimate, preceding the impulse response function and variance decomposition.

Table 7: Pairwise Granger Causality Tests

Null Hypothesis	Obs	F-statistic	Prob.
SAVINGS does not Granger Cause U5MR	34	7.72485	0.0020
U5MR does not Granger Cause SAVINGS		2.27411	0.1209
FDI does not Granger Cause U5MR	34	0.22271	0.8017
U5MR does not Granger Cause FDI		3.49348	0.0437
FPIND does not Granger Cause U5MR	34	16.7811	1.E-05
U5MR does not Granger Cause FPIND		0.40342	0.6717
PCI does not Granger Cause U5MR	34	5.19550	0.0118
U5MR does not Granger Cause PCI		2.97873	0.0666
URBANIZATION does not Granger Cause U5MR	34	22.2214	1.E-06
U5MR does not Granger Cause URBANIZATION		2.59900	0.0916
GHEXP does not Granger Cause U5MR	34	19.4862	4.E-06
U5MR does not Granger Cause GHEXP		2.72696	0.0822
C_{O2} does not Granger Cause U5MR	34	1.87454	0.1715
U5MR does not Granger Cause C_{02}		2.93020	0.0693
SANITATION does not Granger Cause U5MR	34	1.15774	0.3283
U5MR does not Granger Cause SANITATION		1.83278	0.1780
FEMALESCH does not Granger Cause U5MR	34	10.5304	0.0004
U5MR does not Granger Cause FEMALESCH		1.37948	0.2689

Note: Hypothesized variables defined in Table 1
Source: Researchers' Computation using E-View 11 (2023)

There are three outcomes from a Granger causality test namely: unidirectional, bidirectional and no causality. Unidirectional, if X included variable (causes Y (U5MR), but Y doesn't cause "X". In bidirectional causality, each of the two variables (X, Y) may be causal to the other at the same time. The method is a probabilistic account of causality. Causality is closely related to the idea of cause-and-effect, although it isn't exactly the same. From the result presented in Table 8, it can be deduced that: (i) The null hypothesis of savings not Granger causing U5MR is rejected, as the probability is less than the 5% significance level, while the null hypothesis of U5MR not Granger causing SAVINGS is accepted since the probability is greater than 5%. Hence, there is a unidirectional causality between savings and U5MR. This implies that SAVING used for investment in the health sector will lead to a reduction in U5MR; (ii) there is no causality between FDI and U5MR at the 5% level of significance. This is at variance with the literature; (iii) there is a unidirectional causality between food security and under-five mortality rate; (iv) There is a unidirectional causality between per capita income and under-five mortality rate (v) The null hypothesis that urbanization does not Granger cause under-five mortality rate was rejected. Hence, urbanization leads to under-five mortality; (vi) The null hypothesis for GHEXP does not Granger causing U5MR was also rejected, and the alternative hypothesis was accepted. Therefore, Government health expenditure Granger causes under-five mortality rate; (vii) The null hypothesis that C02 does not Granger cause U5MR was accepted at the 5% level of significance. The same is applicable to sanitation and under-five mortality rate.

From the result, female school attainment drives under-five mortality rate. In other words, high female and women education will reduce under-five mortality rate. This implies the rejection of the null hypothesis. To examine how the shock of these variables impacted on under-five mortality rate and how the shock of under-five mortality rate impacted on the variable itself, the impulse response function and variance decomposition were used as presented in Table 8.

Table 8: Variance Decomposition of U5MR

Variance Decomposition of U5MR Period	S.E	U5MR	SAVINGS	FDI	FPIND	PCI	URBANIZATION	GHEXP	C02
1	0.328170	100.000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.703310	83.97099	1.321656	2.453543	2.327181	3.913901	2.597294	0.409216	0.974263
3	1.153390	69.74050	7.016256	3.798996	2.837744	6.982175	4.160952	0.871284	1.327012
4	1.652145	59.43419	12.65375	4.538590	2.657359	8.838291	5.128412	1.300559	1.388125
5	2.182012	51.90628	17.16762	4.935648	2.202998	10.01709	5.934538	1.689367	1.393474
6	2.733954	46.15400	20.62335	5.103072	1.719987	10.80948	6.699532	2.027946	1.424292
7	3.300887	41.54967	23.30577	5.117904	1.318282	11.37506	7.416577	2.309800	1.489541
8	3.874161	37.72075	25.47193	5.043195	1.020535	11.80776	8.056737	2.53693	1.570435
9	4.443672	34.44619	29.29730	4.925002	0.811408	12.15925	8.607107	2.716819	1.644350
10	4.999530	31.59280	28.88362	4.791370	0.668396	12.45337	9.072662	2.859217	1.696679
SANITATION	FEMALESCH								
0.00000	0.00000								
1.46345	0.568499								
2.078982	1.186102								
2.292728	1.767998								
2.414481	2.338512								
2.532869	2.905471								
2.656935	3.460465								
2.778897	3.992971								
2.894608	4.497963								
3.005757	4.976124								

Source: Researchers' Computation using E-View 11 (2023)

The forecast error variance decomposition measures the contribution of each type of shock to the forecast error variance. The interpretation of the variance decomposition result is in line with the vector autoregresions estimates. There are two major variables (U5MR itself, which could be strongly endogenous, least exogenous and weakly endogenous) and the other variables (SAVING, FDI, FPIND, PCI, URBANISATION, GHEXP, C02, SANITATION, FEMALESCH) which could be strongly exogenous; least exogenous and weak exogenous also. The standard error (S.E) is the estimation of the accuracy of any prediction within the time horizon (ten period). From the result, in the first period, U5MR is strongly endogenous, however, it decreases in periods 1 and 3; it went further down to 59.43 and 51.91 in periods 4 and 5. This implies least exogeneity of under-five mortality on under-five mortality itself. In the period 6 and 7, it decreased endogenously further. It became weakly endogenous in periods 7, 8 and 9.

National savings was weakly exogenous in periods 1 and 2. However, the contributions to the shock started increasing in period 3 to 5, implying least exogenous. From period 6 to 10, its contribution to the shock to U5MR increase strongly (strong exogenous). Again, from periods 1, 2 and 3, foreign direct investment had weak exogeneity with under-five mortality rate; it

increased from 4,5 and increased the more in 6 to 8 (strong exogenous) and became least exogenous in periods 8 and 9. Food security (food production) index became least exogenous from periods 2 through 5 and became weak exogenous in periods 6 to 8. The shock fell drastically in period 9 and 10 respectively. Per capita income was weakly exogenous in periods 1 and 3, it increased from 3 through 8 and became strongly exogenous in 9 and 10 (strongly exogenous). Similarly, urbanization increased its contribution to the shock of U5MR from 4 to 9 (least exogenous) and became strongly exogenous in period 10. Government health expenditure was weakly exogenous to U5MR in the first three periods, became least exogenous in periods 5 and 6 and remain the same throughout the remaining time horizon. The same results could be inferred on C02 emission, sanitation and female school attainment. The summary from the forecast error variance result is that the shock of under-five mortality rate affects adversely under-five mortality while the shocks of the explanatory variables to U5MR equally affect the variable itself. The implication is that, apart from U5MR itself, national savings, per capita income, urbanization and female school attainment most impact on U5MR adversely. This has policy implications. The complementing impulse response function of the forecast error variance is presented in figure 1.

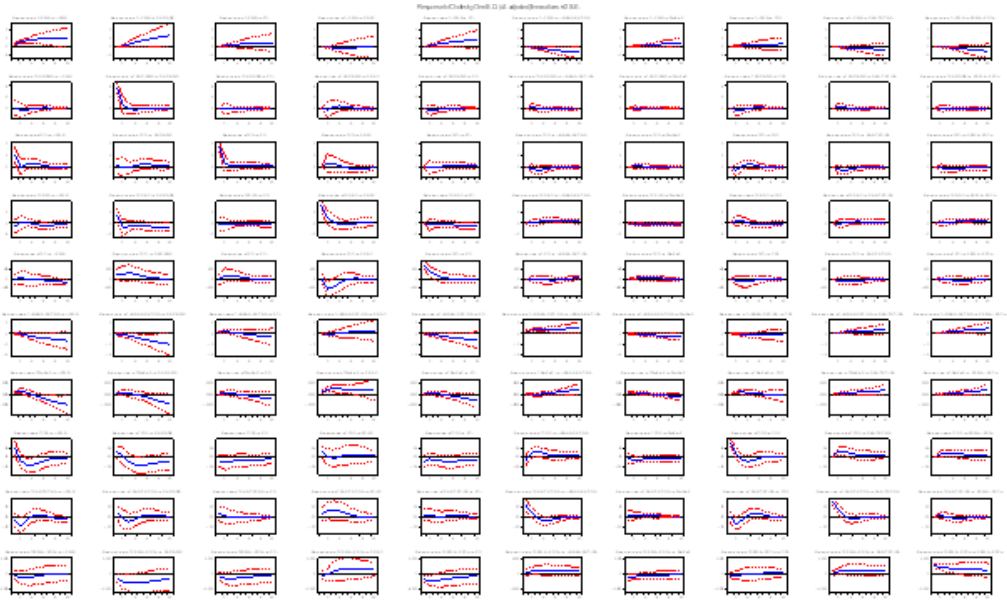


Figure 1: Impulse Response Function
Source: Researchers' computation using EView 11 Software (2023)

These impulse response functions show the impact of one standard deviation shock to under-five mortality rates. In the graph, we examined the initial shock to under-five mortality rate in the first period, and a slight decrease in under-five mortality rate in the remaining periods. The impact converges back to zero after the 10th period. From the remaining impulse responses, it can be deduced that there is period (positive and negative) shock of the included variables on under-five mortality rate. Again, the result showed how important a shock is in explaining the variations of the model of this study, although some shocks may not be responsible for

variations in the short-run but may cause longer-term fluctuations in under-five mortality rates. Table 4.9 presents the residual diagnostic test result.

Table 9: Residual Diagnostic Tests Results

Residual Diagnostic Tests	**Prob.**
Breusch-Godfrey Serial Correlation LM test	0.0934
Jarque-Bera/Normality	0.3558
Breusch-Pagan Heteroskedascity Test	0.4521

Source: Authors' Computation using E-view 11 (2023)

i) Breusch-Godfrey Correlation Test Result

Table 9 gives the results of the Breusch-Godfrey test for serial correlation. It showed a probability value of 0.0934 which is greater than the 0.05 level of significance. This indicates that the residuals of the variables are not serially correlated. This implies that there is no correlation between the residual or error term. Thus, the null hypothesis of no serial correlation is not rejected, which satisfies the assumption of the no serial correlation of the ordinary least square. Consequently, the model shows a good precision, therefore could be used for forecasting.

ii) Breusch-Pagan-Godfrey Heteroskedasticity Test Result

Again, Table 9 showed the result of the Heteroskedasticity test. Given the probability of 0.4521 which is greater than 0.05, indicates that the residuals of the variables are homoscedastic. It implies that the error term is the same across all variables of the independent variable. Therefore, the coefficient of the variables is unbiased and could be used for forecasting.

iii) Normality Test Result

Furthermore, Table 9 shows the result of normality test of Jarque-Bera test. The JarqueBera has a value of 0.3558, which is greater than the 0.05 level of significance. This indicates that the residuals of the variables are normally distributed which satisfies the normality assumption. In order words, it could be used for forecasting and policies. Figures 2 present the stability test using the cumulative residuals.

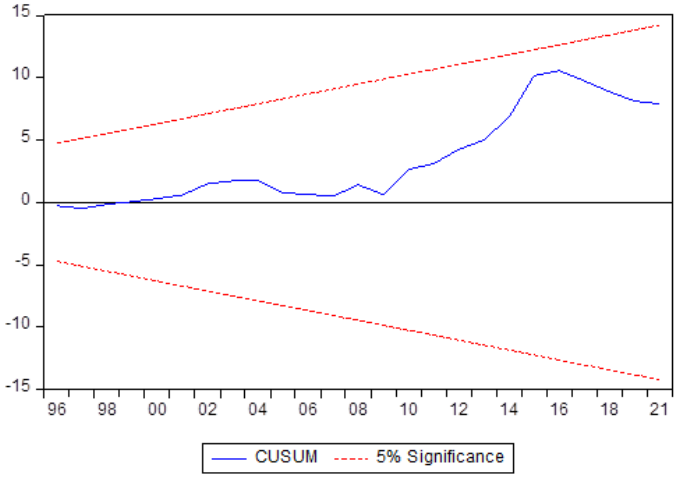
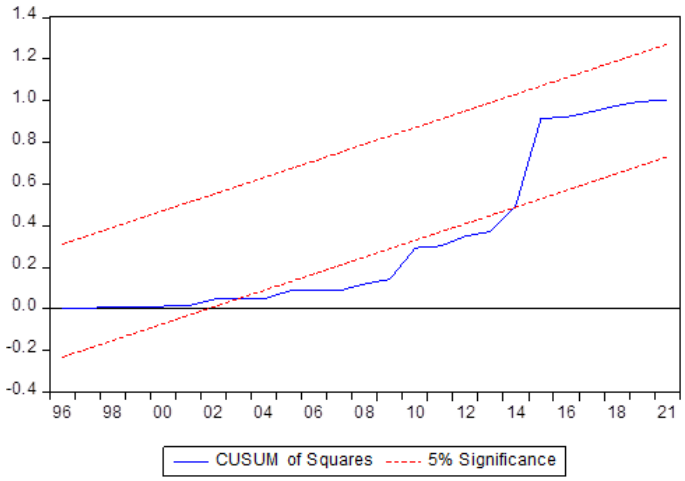


Figure 2: CUSUM
Source: Researchers' plot using Eview



Source: Researchers' plot using EView 11 Software (2023)

Figure 2 showed the stability examination of the model. From the result presented above, it could conclude that the model is stable since the recursive line falls within the 5% level of significance in the CUSUM, although, it goes outside the stability line in the CUSUM squares. This implies the stability of the model.

Discussion of Findings

From the result presented in Table 6, this paper showed that the coefficient of government health expenditure was negative, although significant. Hence, a percentage change in government health expenditure reduces/decreases under-five mortality rate by 0.0032. The negative coefficient of the result is in line with the submission of Meroyi (2018) who attributed

poor funding of the health sector to the increase of diseases in developing countries. According to the author, countries in West Africa are faced with challenges particularly one surrounding health-care infrastructures, issues such as high infant/child mortality rate, poor health-care facilities, poverty and insufficient budgetary allocation are contributing to the West African region health sector challenges (Nwakanma & Nnamdi, 2013). Nevertheless, Ogunsanya *et al* (2018) blamed Nigeria' poor health performance to the fluctuating government revenue from oil price regime. The health sector in Nigeria faced the challenge of poor budgetary allocation. This poor budgetary allocation to health at the federal and states level is a far cry from the famous Abuja declaration. The result of this study is in contrast to other related studies (Adewumi, Acca & Afilayan, 2019) that showed a positive relationship between government health expenditure and under-five mortality rate in Nigeria.

From the result, the coefficient of national savings was negative and insignificant. This implies weak correlation between national savings and health outcome. To promote a reduction in under-five mortality rate, the national savings should be used to health infrastructure provision. Savings promote investment. Investment in health facilities is important for health sector development.

The relationship between foreign direct investment and under-five mortality was negative and insignificant. This implies that foreign direct investment has no predicting power on under-five mortality rate. This is at variance with the theoretical postulate and at variance with the findings of Okafor and Osaghale (2019) who showed a positive relationship between government health expenditure and under-five mortality rate. Meanwhile, there has been little work done on FDI and health in Nigeria except the works of Rodolphe and Celine (2008) which looked for FDI and health in Sub-Saharan African Countries (SSA) while Agboghasem (2017), examined the relationship for selected developing countries. The result of this study is in contrast with the popular observation that FDI is expected to yield a positive impact on the populace, specifically on the health sector by raising the level of demand for all medical/health related services and goods and by raising the rate at which such related goods and services are supplied to the populace. FDI induced capital profits are expected to drive greater private and public spending on balanced diet with high calorie intake, drinkable water, accesses to medical output with availability of increased medical goods and services that is available to the populace at an affordable price. FDI is also known as a strong driver of globalization which has been connected to rise in income differences among skilled and unskilled labours in industrialized and emerging economies (Dierk *et al,* 2015).

The coefficient of food security measured by food production index was positive but insignificant. As such a percentage increase in food security will reduce under-five mortality rate to 11 percent on average. This finding is similar to the result of Beyene (2023) which concluded that 1% increment in average dietary energy supply reduces infant mortality by 0.0139 points. Food insecurity adversely affects human health, which means food security and nutrition are crucial to improving people's health outcomes. Both food insecurity and health outcomes are the policy and agenda of the 2030 Sustainable Development Goals. Food security is essential to people's health and well-being. However, lack of food is one of the

factors which affect health outcomes including under-five mortality rate. Like in many developing economics the twin issues of urbanization and poor health are taking the center of developmental problems and policies. In tandem with rapid population growth, the urbanization process in Nigeria has taken a major profile (United Nations, 2021). Urbanization in Nigeria is also characterized by a high level of socioeconomic inequalities (Akerele *et al.,* 2012; Deinne & Ajayi, 2021). A continuous unabated influx of people to urban centers with limited socioeconomic opportunities has led to a rise in unemployment, crimes, pollution, overcrowding, and acute housing problem with consequences on infrastructure (Aliyu & Amadu, 2017; Amao, 2012, Momoh et al., 2018).

Empirical evidence (Twrok & McGrahaman, 2013) has identified various channels through which urbanization impact on population health (under-five mortality rate) inclusive, especially in low and middle-income countries. For instance, due to an increase in income arising from higher productivity employments in urban centers, more people can afford better living conditions and noted that the social determinants of health, such as poverty and food insecurity are associated with some of the most sever and costly health problems in a nation (FRAC, 2017).

The coefficient of per capita income was negatively but significantly related to under-five mortality rate. This result is supported by the findings of Fatukasi and Ayeomoni (2015). This result implies that there exist income inequalities which negatively affect the under-five mortality rate in Nigeria. According to Najealabbaf *et al* (2013), high income improves good health via cleaning water, hygienic principles-basic needs of human being such as shelter, clothing and food. In support of the above conclusion, Drabo (2011) suggested that environmental quality is a good channel through which income inequalities affect under five mortality rate. However, Alawode and Lawal (2014) argued that richer people have better health status because they can afford goods and services, medical care facilities, adequate nutrition, cleaning environment and housing that inevitably promote health while low-income people are more likely to fall ill due to malnutrition, inability to attend schools which resulted to unemployment.

The coefficient of urbanization is negative but significant, this implies that urbanization correlates and can predict under-five mortality rate. Urbanization means the shift from rural to the urban area (World Bank, 2018; UN-Habitat, 2010). In another vein, urbanization in low-income African countries, including Nigeria as seen in our result (Table 4.6; PCI = -28.58779) is not growth driven; hence, many poor urban residents live in sub-standard conditions. These challenges have resulted to overcrowding in most urban centers in Nigeria with the substantial implications of inadequate ventilation, the quick spread of infectious diseases, poor sanitation, of which heightens poor health in Nigeria (Jemiluyi, 2020).

The coefficient of C02 (carbon emission) was negative with under-five mortality rate. This implies a negative relationship with under-five mortality rate. This result is in line with earlier studies (e.g. Osabohien *et al.*2022). Anecdotal evidence has shown that under-five mortality rate in Nigeria stands at average of 147.7% of 1000 live births (United Nations Inter-Agency

Group for Child Mortality Estimation (UN IGME, 2019). This assertion was supported by the World Health Organization-WHO (2004) which reported that indoor smoke originated from solid fuel kills 100 children every hour in one hand and urban air pollution kills 1800 people on the other hand in developing countries. Similarly, studies have shown that life threatening ailments have been associated with the spill-over of energy consumption in Nigeria (Matthew *et al.,* 2018; Oguntoke and Adeyemi, 2017). The coefficient of sanitation was negative although statistically significant. Although negative, the result implies that sanitation correlates or predicts under-five mortality rate. Access to unimproved water and sanitation among children under 5 years old is a serious public health problem in many developing countries, including Nigeria (UNICEF/WHO, 2019). Unimproved water and sanitation are major causes of diarrhea, which globally accounts for approximately 1.4 million child death each year. The majority of these deaths occur in Sub-Saharan African (SSA) where nearly half of the population lacks access to improve water and sanitation (UNICEF/WHO, 2012). Children are more vulnerable to the health hazards associated with unimproved water supply and sanitation, their immune, respiratory, and digestive systems are still developing and child play in areas where contaminants may accumulate (Fayehien, 2010, WHO, 2003). The significant result of this study is not in tandem with the submission of Mona *et al* (2022) for Namibia. The coefficient of female school attainment was positive and significant in line with theoretical and empirical evidence (Moradhvay & Samir, 2023). Furthermore, there is ample reason to believe that the degree of association between under-five mortality rate and maternal education. Education affects child mortality through various pathways, which may vary between rural and urban areas due to different socio-economic, cultural, environmental, healthcare and political condition (Webber, 2014; Yang, 2017).

An educated woman is more likely to have gainful employment, be empowered, and have autonomy in making healthcare choices (Keats, 2018; Badaoui & Rebiere, 2013). Increasing maternal education helps improve child health by altering behaviour and habits that positively impact both women and their children through a shift from traditional practices to modern medicine. The educated women increase the use of the ANCs (anti-natal cares) during pregnancy and shift from traditional to modern care providers (Wong et al., 1987). More educated women are more likely to utilize effect healthcare facilities to treat their children's illnesses and prevent diseases that are fatal among under-five children (Basu & Stephenson, 2005).

From Table 7, this paper showed that there is a unidirectional causality between government health expenditure and under-five mortality rate. In order words, government health expenditure drives health outcome (under-five mortality rate), all things being equal. Improving healthcare expenditure has greater impact in reducing under-five mortality in Nigeria like any other developing country. This implies that economic policies that make healthcare available, accessible and affordable in low-income countries including Nigeria, have mitigating impact on under-five mortality rate (Owusi, 2020). This result is not in tandem with the submission of Ngwu, Azike and Eze (2023) that submitted that there is no-causality between government health expenditure and under-five mortality. This study showed a unidirectional causality from government expenditure on health to under-five mortality rate in

accordance with theoretical assumptions. However, Ngwu *et al* (2023) recommended that Nigerian government should improve allocation and release of funds to the health sector and monitor same to ensure effective utilization of such fund. Meanwhile, the level of government expenditure on health determines the level of human capital development, which leads to a productive investment in other sectors of the economy (Muhammad & Khan, 2017).

From the result presented in Figure 1, in the first period horizon under-five mortality rate was strongly endogenous and decreased continuously throughout the periods (weak endogenous). Following the submission of Dauda and Iwegbu (2022), fiscal policy shock appears to be the main determinant of human development outcomes. This underscores the importance of government as an institution in improving the welfare of the citizenry. According to the authors, the fiscal policy tool employed is the government capital expenditure, and this crucial in human capital development.

The policy implication of the shock of government expenditure on health outcome of under-five mortality rate is that policymakers must make efforts to ensure the full implementation of government capital spending on health, as any shock from such a plan engenders the human development outcome. Further inference from the result on the impulse response function and variance decomposition is that foreign direct investment, food security, income, urbanization, C02 emission, sanitation and women education shocks significantly contribute to the human development outcome. External shocks from foreign direct investment inflows is also significant determinant of the human development outcome; the decline of FDI in the long-run implies that a well-coordinated policy on FDI attraction and retention in the form of ease of doing business, stable exchange rate, and infrastructure development and maintenance will improve the health development outcome in Nigeria. Although ease of doing business, stable exchange rate and infrastructure development are outside the scope of this study.

Policy Implication of Results

Policy inferences drawn from this study are summarized as follows:

i. Government health expenditure on under-five mortality rate was negative, although insignificant. This reinforces poor government funding on the health sector in Nigeria.
ii. The relationship between FDI and under-five mortality rate was negative and insignificant. This implies the no correlation between FDI and under-five mortality rate in Nigeria.
iii. The coefficient of food security was positive but insignificant. This implies policy measures to promote food security and nutrition so as to reduce under-five mortality rate.
iv. Urbanization was shown to be negatively but significantly related to under-five mortality rate. This implies and calls for policy measures to address the challenges of urbanization in Nigeria so as to impact positively on health outcome of under-five mortality rate.
v. The coefficient of female school attainment was positive and significant in line with theoretical and empirical evidence. This implies that there is policy need to improve girl-child and women education in Nigeria.

Conclusion

From the empirical evidence, especially the key findings in relation to the objective, the following can be concluded about this study, (i) countries in Africa and Nigeria in particular faces the challenges of healthcare infrastructure, poor healthcare facilities and insufficient budgetary allocation. The yearly budgetary allocation to health is far below the signed health accords and agreements. The scenario has seriously affected health outcome in Nigeria especially child health. Improving healthcare expenditure has greater impact in reducing under-five mortality rate in Nigeria like any other developing country. We can also infer from the results that the level of government expenditure on health determines the level of human capital development including under-five mortality rate, which leads to a productive investment in other sectors of the Nigerian economy.

The results also underscore the importance of government as an institution in improving the welfare of the citizenry and therefore, fiscal policy is crucial in human capital development. Government and policymakers must make efforts to ensure full implementation of government capital spending, as any shock from such a plan engenders child health.

Policy Recommendations

The following policy measures are suggested:

i. Strategic investment to improve quality of life through female education will have the greatest impact on under-five mortality rate reduction in Nigeria.
ii. Government allocating and releasing at least 15% of general government budget to the health sector will be impactful. For health financing, the Government should monitor and appraisal the effectiveness of the health insurance scheme for easy accessibility and to remove the bottlenecks.
iii. Economic policies like subventions that makes healthcare available, accessible and affordable have mitigating impact on under-five mortality rate and therefore must be pursued by the government.
iv. Government and policy makers must take efforts to ensure full implementation of government capital spending, as any shock from such a plan engenders the human development outcome including under-five mortality rate.

References

Akerele, D., Monoh, S., Adewuyi, S. A., Philip, B. B., & Ashaolu, O. F. (2012). Socioeconomic determinants of poverty among urban households in South-West Nigeria, *International Journal of Social Economics,* 39 (3), 168-181. https://doi.org/10.1108/03068291211199341.

Alawode, O. O. & Lawal, A. M. (2014). Income inequality and self-rated health in rural Nigeria. *Peak Journal of Agricultural Science,* 2 (3), 36-50.

Aliyu, A. A. & Amadu, L. (2017). Urbanization, cities and health: The challenges to Nigeria-A review, *Annals of African Medicine, 16* (4), 149-158. https://doi.org/10.4103/aam.amm-1-17.

Amad, F. L. (2012). Urbanization, housing quality and environmental degeneration in Nigeria. *Journal of Geography and Regional Planning,* 5(16), 422-429. https://doi.org/10.5897//JGRP12.60

Ataguba, J. E. O. & Akazili, J. (2010). Healthcare financing in South Africa: moving towards universal coverage, *Continue Medical Education,* 28 (2), 74-78.

Azuh, E. D., Osabohien, R., Obih, M. & Godwin, A. (2022). Public health expenditure and under-five mortality in Nigeria: An overview for policy intervention, *Journal of Medical Sciences,* 8 (E), 353-362.

Beyene, S. O. (2023). The impact of food insecurity on health outcomes: empirical evidence from Sub-Saharan African Countries, *BMC Public Healt*h (2023) 23, 338.

Campell, A. A., Saskia, de, P., Kai, S., & Kraemer, A. (2009). Relationship of household food insecurity of neonatal, infant, and under-five child mortality among families in rural Indonesia, *Food and Nutrition Bulletin, 30* (2), 113-119.

Dauda, R. O. & Iwegbu, O. (2022). Human development and macroeconomic shocks in Nigeria: An empirical investigation, *Journal of social, behavioural & Health Science,* 16 (1), 371-391. https://doi.org/10.5590/JsBHS.2022.16.1.25

Giller, K. E. (2020). The food security conundrum of Sub-Saharan Africa, *Glob Food Security* 26:10043/

Hamid, S., Saber, Z. S. & Sadra, S. (2022). Human development index and under-five mortality in the Middle East and North African Countries, *Middle East Journal of Rehabilitation Health Study,* 9 (3).

Jemiliyi, O. O. (2020). Urbanization and child health outcomes in Nigeria, *Journal of Population and Social Studies,* 29, 586-603, https://doi.org/10.25133/JPSSV292021.036.

Muhammed, M. C. & Khan, J. (2017). Public financing and health expenditure, insurance and health outcome, *Journal of Applied Economics,* 34 (2), 2105-2113.

Nejadlabbat, S., Jari, A., & Mohammad, H. (2013). The effect of inequality distribution of income on health indicator in developing countries, *World Applied Sciences Journal* 28, 216-221.

Ngwu, J. C., Azike, L. C. & Eze, C. G. (2023). Impact of government health expenditure on under-five mortality in Nigeria: Error correction model, *International Journal of Advanced Multidisciplinary Research and Studies,* 3(2), 384-391.

Nwakanma, P. C. & Nnamdi, K. C. (2013). Taxation and national development. *Research Journal of Finance & Accounts,* 19 (4), 2222-2847.

Ogunsanya, M. E., Nduaguba, S. O. & Brown, C. M. (2018). Incremental healthcare services and expenditures associated with depression among individuals with cutaneous lupus erythematosus (CLE), LUPUS 27(7), 1107-15, https://doi.org/10.1177/096120331862604.PMid:29514557.

Oguntoke, O. Adeyemi, A. (2017). Degradation of urban environment and human health by emissions from fossil fuel combusting electricity generator in Abeokuta Metropolis, Nigeria, *Indoor and Built Environment,* 26 (4).

Okafor, J. & Osaghale, B. I. (2019). Foreign direct investment and the performance of health outcomes in Nigeria, *Amity Journal of Healthcare Management* 4(1), 15.3%.

Olarinde, M. O. & Bello, A. A. (2014). Public healthcare expenditure and health sector performance in Nigeria: Implications for Sustainable economic development, *IOSR Journal of Economics and Finance (IOSR – JEF)* 4(3), 39-45.

Rima, H. B. (2012). Healthcare financing and health outcomes in Nigeria: A State level study using multivariate analysis, *International Journal of Humanities and Social Sciences*, 2 (15), 296-305.

Rodolphe, D., & Celine, A. (2008). Public governance, health and foreign direct investment in Sub-Saharan Africa, *Journal of Political Economy*, 8 (3), 322-350.

Turok, I. & McGranahan, G. (2013). Urbanization, and economic growth: The arguments and evidence for Africa and Asia, *Environment and Urbanization,* 25 (2), 465-482. https://doi.org/10.1177/0956247813490908

UN_Habitat (2010). State of the World cities 2010-2011. Bridging the urban divide-overview and key findings. https://sustainabledevelopment.un.org/index.php? Page = view & type = 400&nr=1114&m%09enu=35.

UNICEF/WHO (2012). Progress on drinking water and Sanitation Joint Monitoring Programme, Geneva, Switzerland.

UNICEF/WHO (2019). Diarrhoea: Why children are still dying and what can be done. Geneva, Switzerland.

Untied Nations (2021). *World urbanization project*, The 2018 Revision. https://population.un.org/wup/publications/files/wup2018.Report.pdf.

WHO (2003). *The physical school environment*, An essential elements of a health promoting school.