

Public Health Expenditure and Infant Mortality Rate in Nigeria

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Abstract

This study investigated the effect of public health expenditure on infant mortality rate in Nigeria from 2002 to 2021. To achieve the above objective, this study utilized data on infant mortality rate, total government expenditure on health and migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries from OECD Health Statistics, 2021, WHO, UNICEF, UNFPA, World Bank Group, the United Nations Population Division and Statistical Bulletin of Nigeria's apex bank. The study employed an Autoregressive Distributed Lag (ARDL) Bounds testing procedure for data analyses. The results revealed that in the long run, total government expenditure on health, as well as migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries have negative and insignificant relationship with infant mortality rate in Nigeria. However, in the short run, total government expenditure on health, as well as migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries have positive and significant relationship with infant mortality rate in Nigeria. What this means is that though there has been expenditures on health sector in Nigeria by the government from 2002 to 2021, but the expenditures are low and couldn't reduce infant mortality rate to a near-zero level in Nigeria. Also, in the short-term, the movement of doctors and nurses from Nigeria to others countries of the world, exacerbated infant mortality rate in Nigeria during the period of study. Based on the forgoing, it is recommended here that government should spend at least 15% of its annual budget on health sector as agreed by African leaders at Abuja in 2015. Government should also reduce the exodus of Nigerian doctors to other countries of the world. This, the government may be able to achieve by increasing budgetary allocation to healthcare sector, enhance doctors' remuneration, ensure a better work environment with modern healthcare facilities together with general enhancements in basic life facilities including housing, health insurance, security, constant power supply and good roads.

Key Words: *Public Health Expenditure, Infant Mortality Rate, ARDL and Nigeria.*

I. Introduction

Good health is very important due to its ability to increase labour productivity, economic growth and well-being of the people. It has been upheld that 'health is wealth'. The reverse implication is that poor health spells poverty and untimely death. Therefore, it is important to minimize the risk of falling ill and to promote health in order to increase productivity and earning capacity. This explains why the proposed United Nations' Sustainable Development Goals (SDGs) target for child mortality aims to end preventable deaths of newborns and children under five by 2030. The continuing government budget allocation on social expenditure, including health, represents one of the key instruments to tackle infant mortality and one of the drivers to meet important elements of the Sustainable Development Goals (SDGs). Indeed, Goals 1 and 3 of the SDGs aim to "substantially increase health financing" through pro-poor social spending towards health, social protection and education investments (Goal 1.b.1); and to promote "healthy lives and wellbeing at all ages" (Goal 3) by reducing the global child mortality rate (UNICEF, 2021).

Therefore, getting the health sector in good state through adequate funding is crucial for delivering quality healthcare to the inhabitants of Nigeria. The transmission channel through which government social spending can influence infant mortality rates is adequate public investment in health care sector. If investments for childcare and healthcare are increase together with resources available for households through direct transfers, then Infant Mortality Rate (IMR) is likely to shrink. Government social expenditure

is more effective in reducing infant mortality if the available resources are allocated effectively and efficiently between different areas and items, influencing the actual living conditions of the most vulnerable groups. Rising inequalities in terms of income and access to services, if not adequately treated, can negatively affect children's health. When households' income shrinks, spending on healthcare is generally also reduced, with harmful consequences for children's health and IMR. Likewise, the lack of provision of services or cash benefits would reduce children's access to care facilities, thus affecting child mortality in a manner that is not praise worthy.

Surprisingly, Nigeria has not been able to deliver quality healthcare to majority of its inhabitants because the health sector in Nigeria suffers poor funding. According to Azuh, Osabohien, Orbih and Godwin (2020), public expenditure on health in Nigeria is very low, leading to poor access to quality health care, high morbidity, and mortality in addition to low productivity and economic growth. In April 2001, African leaders met at Abuja and signed a declaration to spend at least 15% of their annual budget on health sector. Despite this declaration, the federal government budget allocation to the health sector is still far below the minimum bench mark recommended by Abuja declaration (Nuhu, 2022). Available data from the publications of the Central Bank of Nigeria (CBN) on government's expenditure in key primary welfare sectors showed that expenditure on health sector (Per cent of total and GDP) stood at 4.1% in 2013, 5.2% in 2014, 5.8% in 2015, 4.4% in 2016, 4.4% in 2017, 4.7% in 2018 and 4.9% in 2019 (CBN, 2013, 2014, 2015, 2016, 2017, 2018 & 2019).

The inadequate funding of the health sector which reflects in the area of poor state of the infrastructural facilities, inadequate staffing, poor salaries to health workers, etc. has resulted to intermittent strikes by some unions including the Nigerian Medical Association. This scenario has the ability to increase the rate of infant mortality rate (Tubotamuno, Inimino, & Awortu, 2018; Inimino, Akidi & Charles, 2022). As reported by Umo (2012), lack of adequate investment in all components of health infrastructure including personnel to cope with the explosive population growth requiring medical services has affected health outcomes in Nigeria. Also, a large number of healthcare professionals have continuously migrated to more developed countries. Medical brain drain (migration of doctors and nurses trained in Nigeria) has become one of the contributing factors leading to the continuous deterioration of Nigeria's health sector. The shortage of health workers in Nigeria due to brain has negatively affected the nation's health sector. In Nigeria, human health indicators are very poor and these are reflections of grossly inadequate health infrastructure. According to Akpakpan (1999), health facilities are inadequate and also are poorly maintained. Example of health statistics reflecting poor health infrastructure include high infant mortality rate (the probability of dying before the first birthday) (Umo, 2012).

According to the Nigeria Demographic Health Survey (NDHS, 2003), infant mortality rate which is a basic indicator of a country's socioeconomic situation and quality of life was 100 deaths per 1,000 live births in 2003. In the same year, child mortality (age 1 to age 4, i.e., the probability of dying between the first and fifth birthdays) was 112 deaths per 1,000 children surviving to 12 months of age. The overall under-five mortality rate for the period was 201 deaths per 1,000 births. In 2008, child mortality rate was 88 deaths per 1,000 children surviving to 12 months of age, but not to their fifth birthday. The infant mortality rate was 75 deaths per 1,000 live births, and under-five mortality rate in Nigeria was 157 per 1,000 live births (NDHS, 2008).

In 2013, infant and under-5 mortality rates stood at 69 and 128 deaths per 1,000 live births, respectively. At these mortality levels, one in every 15 Nigerian children died before reaching age one, and one in every eight do not survive to their fifth birthday (NDHS, 2013). In 2018, under-five mortality rate in Nigeria was 132 per 1,000 live births meaning that 1 in 8 Nigerian children never reach the age of five. Infant deaths, which account for half of child mortality stood at 67 in 2018. One (1) Nigerian woman dies in childbirth every 10 minutes, and 1 Nigerian child under-5 years of age dies every minute (NHDS, 2018). A report by the World Health Organisation (WHO) tagged "the 2023 Progress Report", ranked Nigeria highest globally in incidences of neonatal and child deaths (Vanguard Newspaper, May 12, 2023).

Furthermore, empirical studies on the effect of public health care expenditure on infant mortality have produced conflicting or mixed results. While some studies including Azuh, Osabohien, Orbih and Godwin (2020) produced evidence of positive and significant relationship between public healthcare expenditure and under-five mortality, others including Issa and Ouattara (2005), Boachie, Põlajeva and Frimpong (2020), Carraro (2021) showed negative relationship between public health care expenditure and infant mortality. That is, public health expenditure reduces infant mortality. The difference in empirical

findings on the effect of public health care expenditure on infant mortality is of serious concern, especially to Nigeria. The above state of affairs raised a pertinent question: what is the relationship between public health care expenditure and infant mortality in Nigeria? An answer to this question was the major concern of this work because infant mortality has been a burning issue in Nigeria. Therefore, ascertaining whether Nigeria's involvement in international trade boosts or hinders domestic investment is very important. The remaining segments of this paper were organized into literature review, materials and methods, results and discussions, conclusion and recommendations.

II. Literature Review

Stylized Facts on Infant Mortality Rate and Public Health Expenditure

Infant mortality is the death of an infant before the infant's first birthday. The occurrence of infant mortality in a population can be described by the infant mortality rate (IMR), which is the number of deaths of infants under one year of age per 1,000 live births. Infant mortality rate which is a basic indicator of a country's socioeconomic situation and quality of life was 100 deaths per 1,000 live births in 2003. In the same year, child mortality (age 1 to age 4, i.e., the probability of dying between the first and fifth birthdays) was 112 deaths per 1,000 children surviving to 12 months of age. The overall under-five mortality rate for the period was 201 deaths per 1,000 births. In 2008, child mortality rate was 88 deaths per 1,000 children surviving to 12 months of age, but not to their fifth birthday. The infant mortality rate was 75 deaths per 1,000 live births, and under-five mortality rate in Nigeria was 157 per 1,000 live births (NDHS, 2003 & 2008). In 2013, infant and under-5 mortality rates stood at 69 and 128 deaths per 1,000 live births, respectively. At these mortality levels, one in every 15 Nigerian children died before reaching age one, and one in every eight do not survive to their fifth birthday (NDHS, 2013). In 2018, under-five mortality rate in Nigeria was 132 per 1,000 live births meaning that 1 in 8 Nigerian children never reach the age of five. Infant deaths, which account for half of child mortality stood at 67 in 2018. One (1) Nigerian woman dies in childbirth every 10 minutes, and 1 Nigerian child under-5 years of age dies every minute (NDHS, 2018).

Furthermore, public expenditure on health is needed to ensure that the health sector is in good condition to deliver quality healthcare services to the inhabitants of Nigeria. In order to ensure that the health sector functions very well in Nigeria at the rate needed to significantly reduce infant mortality rate, successive governments in Nigeria have allocated huge sums of money, often meagre relative to the importance of this sector in various budgets to increase labour productivity, economic growth and well-being of the inhabitants of Nigeria. For instance, in 2013, consolidated federal government spending on key primary welfare sectors indicated that expenditure on health dropped by 12.5 per cent relative to its level in 2012 to N212.4 billion (CBN, 2013). In 2014, analysis of Federal Government expenditure on the primary welfare sectors indicated that outlay on health rose by 11.4 percent to 236.7 billion relative to its level in 2013 (CBN, 2014). In 2015, analysis of total Federal Government spending on the primary welfare sector indicated that the outlay on health increased by 21.7 per cent from the level in 2014 to N288.0 billion (CBN, 2015). In 2016, analysis of total Federal Government spending on the primary welfare sector revealed that outlay on health decreased by 19.3 per cent to N232.5 billion from the level in 2015 (CBN, 2016). In 2017, analysis of total Federal Government spending on the primary welfare sectors revealed that outlay on health increased by 22.7 per cent to N305.6 billion over the level in 2016 (CBN, 2017). In 2018, Analysis of total Federal Government spending on the primary welfare sectors revealed that expenditure on health increased by 22.8 per cent to N367.1 billion compared with the level in 2017 (CBN, 2018). In 2019, Analysis of total Federal Government spending on the primary welfare sectors revealed that expenditure on health increased by 25.6 per cent to N461.3 billion compared with the level in 2018 (CBN, 2019). Yet, the services of the health sector in Nigeria have remained generally poor.

Theoretical Literature

Theoretically, Musgrove (1996) provided evidence that public spending on health is not a factor in reducing child mortality. Musgrove believed that variables such as income, income inequality, women's education and degree of ethno-linguistic fragmentation explain nearly all the variation in child mortality rates. Based on these, Musgrove argued that, rather than increasing public health expenditure, policies that encourage economic growth, reduce poverty and income inequality, and increase the level of women's education should be supported to reduce child mortality. In as much as the idea of Musgrove is commendable, He (Musgrove) failed to understand the important of government expenditure in building hospitals, buying of

hospital equipment, payment of salaries to medical workers, etc. Also, government expenditure plays a crucial role in achieving adequate economic growth, as well as reduction in poverty.

Contrary to Musgrove's view, Keynes (1936) made it clear that fiscal policy instrument (i.e., government expenditure) is an important tool for achieving short-term stability and superior long run growth rate. Therefore, to have a better healthcare system in the economy, Keynes prescribed government interventions in the economy through economic policy specifically fiscal policy (government expenditure in the health sector). To the Keynesians, increased investment in health care by the government will improve health and productivity in the economy. Improved capabilities of health care lead to reduction in infant mortality rate. It will also lower health care costs for families. This has the ability to stimulate or increase output growth of the country. At the same time, expenditure to improve the welfare of medical workers (a good salary scheme and incentives) will boost the morale of the medical workforce for efficiency which in turn will help to reduce infant mortality rate. Following this theory, infant mortality is a function of government expenditure in the health sector.

That is, $IMR = f(GEX)$ (1)

Where; IMR is infant mortality rate, and GEX is government expenditure in the health sector.

Strictly speaking, countries that spend more on health care are likely to have a longer life expectancy and, consequently, a lower mortality rate. An increase in health spending implies broader access to health-care and other services, which helps to reduce child mortality rates. Thus, improving the population's health status through adequate spending in the health sector should foster economic growth and hence reduce poverty and infant mortality rate.

Review of Related Empirical Literature

Empirical findings on the relationship between public health care expenditure and infant mortality rate are uneven. Issa and Ouattara (2005) attempted to answer the question; does health expenditure reduce infant mortality rates (IMRs)? To answer such an important question the researchers disaggregated health expenditure into private and public and divide the countries into two groups according to their level of development (income). The results obtained from employing ordinary least squares (OLS) and panel data techniques on 160 countries showed strong negative relation between health expenditure and infant mortality rate (IMR). However, they discovered that this effect is channeled through public expenditure at low development levels and through private expenditure at high development stages. Their results are robust across different estimation methodologies. They also discovered a strong negative relationship between IMR and per capita income and female education.

Anyanwu and Erhijakpor (2007) provided econometric evidence linking African countries' per capita total, as well as health expenditures by government and per capita income to health outcomes (infant mortality and under-five mortality). This relationship is examined, using a panel data from 47 African countries between 1999 and 2004. Health expenditures have a statistically significant effect on infant mortality and under-five mortality. The magnitude of our elasticity estimates are in consonance to those reported in the literature. For African countries, our results imply that total health expenditures (as well as the public component) are certainly important contributor to health outcomes. In addition, they discovered that both infant and under-five mortality are positively and significantly associated with Sub-Saharan Africa. The reverse is true for North Africa. While ethnolinguistic fractionalization and HIV prevalence positively and meaningfully affect the health outcomes, higher numbers physicians and female literacy meaningfully reduce infant mortality and under-five mortality.

Boachie and Ramu (2016) examined the effect of public health expenditure on health status in Ghana. Annual time-series data on infant mortality rate, real per capita income, literacy levels and female labour force participation rate for the period 1990-2012 were used. Infant mortality rate was used as the output variable. To test the relationship between input-output variables, Ordinary Least Squares and Newey-West regression techniques were used. The regression estimates revealed that real per capita income, expenditure on health, education and female presence in the labour market have negative relationship with infant mortality rate. However, the elasticity coefficients of female participation in the labour market and real per capita income were statistically insignificant at 5% level. This study concludes that public health expenditure and literacy/education improve health status by reducing infant mortality. The favourable effect of education or literacy on health is greater than that of public health spending whereas the effect of real per

capita income on health was found to be weak. The findings provided the impetus for government to raise literacy level and its health spending in the country to promote health.

Novignon and Lawanson (2017) sought to understand the relationship between child health outcomes and health spending while investigating lagged effects. The study employed panel data from 45 Sub-Saharan African countries between 1995 and 2011 obtained from the World Bank's World Development Indicators. Fixed and Random effect models were estimated. Under-five, infant and neonatal mortality were used as child health outcomes while total health spending was disaggregated into public and private spending. The effects of one and two period lags of expenditure were estimated. The results showed a positive and significant relationship between health expenditure and child health outcomes with elasticities of -0.11 for infant mortality, -0.15 (under-five mortality) and -0.08 (neonatal mortality). Public health expenditure was found to be relatively more significant than private expenditure. Positive and significant lagged effects were also estimated between health expenditure and child health. The findings suggested that, while health expenditure is crucial for the improvement of child health, it is equally important for this expenditure to be sustainable as it also has delayed effects.

David (2018) employed Autoregressive Distributed Lag (ARDL) bounds testing approach to co-integration and Granger causality technique to empirically examines the nature of relationship between infant mortality and public expenditure on health in Nigeria from 1980 – 2016. In addition, the study considered the roles of immunization, private health expenditure and external health resources on infant mortality in Nigeria. Among other things, the empirical results indicated the presence of significant cointegrating (long-run) relationship between infant mortality and government health expenditure (and private health expenditure, immunization and external health resources), coupled with the existence of bi-directional causal relationship between infant mortality and government health expenditure. In addition, the results also demonstrated that, government health expenditure, private health expenditure, immunization, and external health resources significantly influence infant mortality negatively both in the long and short term. Although, private expenditure on health is shown as the major determinant of the reduction of the rate of infant mortality in Nigeria, due to the size of the coefficient of private health expenditure. In essence, the total overhaul of the Nigerian health sector, so as to improve the efficiency of the sector, as well curb the happenings of mismanagement of funds which has plagued the sector overtime, coupled with the intensifying of immunization programs and activities are however recommended.

Kepha, Alex, Will, Fred and Bruno (2018) used Ordinary Least Squares (OLS) method to investigate the relationship between public health spending and under-five mortality rate in Uganda. The results showed that women literacy rate, capital expenditure on health, recurrent expenditure on health and percentage of population living in urban areas are strongly associated with under-five mortality rate.

Azuh, Osabohien, Orbih and Godwin (2020) looked at the contribution of the health expenditure by the government on under-five mortality in Nigeria using an Autoregressive Distributed Lag (ARDL) Bounds Testing approach. The results from the study showed that though public health expenditure is statistically significant but it has a positive relationship with the under-five mortality.

Using the Fully Modified Ordinary Least Square (FMOLS) analytical method, Oluwaseun (2020) examined the influence of health sector expenditure on infant mortality rate in Nigeria spanning 1991 to 2018. Findings revealed that all variables employed positively impacted infant mortality rate except for female literacy rate, Diphtheria, Pertussis, and Tetanus (DPT) immunization. It was therefore recommended that more public enlightenments on the importance of taking DPT immunization for infants should be embarked upon for the target audience to be able to produce a positive effect, nursing mothers should be educated more on the need to take good care of their children especially at the early stage and not leave chance to the faith of the day care, all in the name of being literate and answering the call of their job at the expense of their parental role among others.

In the study of Ray and Linden (2020), the effects of public and private health expenditures on life expectancy at birth and infant mortality were analyzed on a global scale with 195 countries spanning 1995–2014. The global data set was divided into country categories according to growth in life expectancy, decrease in infant mortality rate, and level of gross national income per capita. Some new dynamic panel model estimators, argued to be more efficient with high persistence series and predetermination compared to popular but complex Generalized Method of Moments (GMM) estimators, showed that public health expenditures are generally more health-promoting than private expenditures. However, the health effects are not as great as primary education effects. Although the new estimators provide some new and valuable

information on health expenditure effects on life expectancy and infant mortality on a global scale, they do not show desired robustness.

Boachie, Põlajeva and Frimpong (2020) investigated the effect of public (i.e., government) health expenditure on infant mortality in low- and middle-income countries. They employed fixed effects estimation technique, with three-stage least squares as a robustness check. The data covered the period 1995–2014. The outcome of the analysis revealed that public health expenditure improves health outcomes significantly, as it reduces infant mortality. The results further showed that rising income and access to safe water are some of the reasons for improved health outcomes in low- and middle-income countries. Based on these results and the expected redistributive impact of spending by government, governments in low- and middle-income countries may consider increasing their spending in the health sector for better healthcare systems and improved health.

Ikechukwu, Chidi and Valentine (2020) examined the relationship between capital health expenditure and infant-maternal mortality ratio (IMMR) by adopting the Grossman (1972) theoretical framework. It relied on the Autoregressive Distributed Lag (ARDL) technique using WDI data from 1980 to 2017. The result revealed a positive association between public expenditure on health sector and infant maternal mortality ratio in Nigeria.

Owusu, Sarkodie and Pedersen (2021) examined the influence of health expenditure on infant and maternal deaths for the period 2000–2015 across 177 countries. Using panel Quantile Regression with bootstrapping, this study accounted for the 2007–2008 financial crisis in an empirical relationship between health outcome and health expenditure. The result revealed a negative effect of health expenditure on mortality across all percentiles. Infant mortality rate declines between 0.19% - 1.45% while maternal mortality rate declines ranging from 0.09% - 1.91%. To attain the sustainable development goal of ensuring healthy lives and wellbeing of all people (i.e., SDG 3), this study infers that expenditure on health potentially reduces maternal and infant mortality across lower and middle income countries. The study highlighted the need for an higher health care expenditure, especially in developing countries to reduce the levels of infant and maternal deaths.

Carraro (2021) analyzed whether social expenditure made by the government causally reduces infant mortality and to look into the causal mechanism through which such effects take place. The study used a panel of 19 countries in the Latin American and the Caribbean (LAC) region from 1990 to 2017. The study provided evidence, robust to various methodological changes (i.e., the use of instrumental variable approaches and causal mediation analysis), that, in the last 30 years, increased public expenditure in the social sector was causally linked with infant mortality reduction. The study also looked into causal mechanisms that convey this impact. The study isolated the influence of income inequality reduction from other pathways, finding strong evidence to support the proposition that infant mortality rate reduction is caused by changes in income inequality induced by social expenditure. The study contrasted the impacts of social expenditure in natural resource-rich countries versus poor countries and in countries subject to high versus low commodity terms-of-trade volatility, finding that dependence on natural resources and volatile markets hinder the effects of government social expenditure on infant mortality rates

A careful examination of the previous empirical studies on the effect of public health care expenditure on infant mortality have produced conflicting or mixed results. While some studies including Azuh, Osabohien, Orbih and Godwin (2020) produced evidence of positive and significant relationship between public healthcare expenditure and under-five mortality, others including Issa and Ouattara (2005), Boachie, Põlajeva and Frimpong (2020), Carraro (2021) showed negative relationship between public health care expenditure and infant mortality. That is, public health expenditure reduces infant mortality. Meanwhile, some of these studies adopted the ordinary least squares, others applied Autoregressive Distributed Lag (ARDL) Bound test technique for data analysis, thereby recording incongruent empirical results. In related terms, previous studies have lost touch on current realities of the influence of public health care expenditure on infant mortality in Nigeria. The previous studies ignored the impact of medical brain drain (doctors and nurses trained in Nigeria but working in other countries) on the health sector in Nigeria. That is, none of the above scholars included medical brain drain (using data on migration of doctors and nurses trained in Nigeria but working in other countries) in their models to see how doctors and nurses migration has affected infant mortality rate in Nigeria. In view of the foregoing, this research is unique and differs from others. This study investigated the effect of public health care expenditure on infant mortality rate in Nigeria from 2002 to 2021.

III. Material and Methods

Framework Specification

The research model for this study was founded on the explicit form of the Keynesian theory which made it clear that expenditure to improve the health sector and welfare of medical workers (a good salary scheme and incentives) will boost the morale of the medical workforce for efficiency which in turn will help to reduce infant mortality rate and brain drain. That is, $IMR = f(GEX)$ (1^a see theoretical framework) were; IMR is infant mortality rate and GEX is government expenditure on health sector. Also, the loss of a significant number of skilled healthcare workers through migration has effect on infant mortality rate in Nigerian. Based on this, migration (outflow of doctors and nurses) captured in the model as one of the variables that affect infant mortality rate in Nigeria. Therefore, the model for this study is presented thus:

$$IMR = f(TGEH, MDN) \quad 2$$

The linear form of equation (2) produced;

$$IMR_t = \varphi_0 + \varphi_1 TGEH_t + \varphi_2 MDN_t + \varepsilon_t \quad 3$$

The log form of equation (2) produced;

$$IMR_t = \varphi_0 + \varphi_1 \ln TGEH_t + \varphi_2 \ln MDN_t + \varepsilon_t \quad 4$$

Where; IMR is infant mortality rate, TGEH is total government expenditure on health, and MDN is doctors and nurses trained in Nigeria but working in other countries, ε is error term which denotes other variables not included in the model, t is the period of time and Ln is Natural Logarithm. **Expected Signs:** The parameter estimates are expected to behave in line with $\varphi_1 < 0$.

$$\varphi_2 > 0.$$

Sources of Data

This study sourced for data on total government expenditure on health, infant mortality rate and brain drain (migration of doctors and nurses trained in Nigeria).

Sources of Data: this study sourced for data from World Health Organization (WHO) 2019, Central Bank of Nigeria Statistical Bulletin, OECD Health Statistics, 2021.

Specifically, data on migration of doctors and nurses trained in Nigeria were obtained from OECD Health Statistics, 2021. Data on infant mortality rate were obtained from WHO (UNICEF, UNFPA, World Bank Group, and the United Nations Population Division). Data on total government expenditure on health were obtained from Central Bank of Nigeria Statistical Bulletin of various issues.

Model Estimation Procedures

This study first of all employed the Augmented Dickey Fuller (ADF) unit root test to check the order of integration of the variables in the models. That is, ADF was used to test for the unit root property of the variables included in the models. The general form of ADF is estimated by the following regression

$$\Delta LS_t = \alpha_0 + \alpha_1 LS_{t-1} + \sum \alpha_i \Delta LS_{t-i} + \delta_t + U_t \quad 5$$

Where: y is a time series, t is a linear time trend, Δ is the first difference operator, α_0 is a constant, n is the optimum number of lags in the independent variables and U is random error term.

The variables were integrated of order (0) and (1). For this reason, this study checked for cointegration via ARDL Bounds testing approach. The ARDL cointegration approach was developed by Pesaran and Shin (1999) and Pesaran et al. (2001). Furthermore, the Autoregressive Distributed Lag (ARDL) model which uses a bounds test approach based on unrestricted error correction mechanism (UECM) was employed here to measure the effect of public health expenditure on infant mortality rate in Nigeria and also to test for a long run relationship among the relevant variables. The main advantage of this approach lies in the fact that it can be applied irrespective of whether the variables are 1(0) or 1(1). This approach also allows for the model to take a sufficient number of lags to capture the data generating process in a general-to-specific modeling framework. Also, it provides very efficient and consistent test results in small and large small sizes. Therefore, The ARDL model based on equation 4 is presented thus:

$$\Delta IMR_{t,j} = a_0 + a_1 IMR_{t-1,j} + a_2 LnTGEH_{t-1,j} + a_3 LnMDN_{t-1,j} + \sum_{i=1}^{n1} a_{1i,j} \Delta IMR_{t-1,j} + \sum_{i=0}^{n2} a_{2i,j} \Delta LnTGEH_{t-1,j} + \sum_{i=0}^{n3} a_{3i,j} \Delta LnMDN_{t-1,j} + \mu_t \text{ --- (5)}$$

Please, note the variables as earlier defined.

Post Estimation Tests

Post estimate tests were performed in this study to confirm whether or not the statistical criteria of the estimated models are met, to validate whether parameters are reliable and to determine whether the models are generally fit for policy recommendations. Thus, the WALD test for autocorrelation, and Jarque-Bera test for normality are the various post estimate tests that were conducted in this study.

IV. Results and Discussion

Descriptive Statistics for Underlying Series

This study used descriptive statistics to describe the basic features of the data in the study. Specifically, the essence of the descriptive statistics is to ascertain stability of the time series.

Table 1: Descriptive Statistics for all the Variables

	IMR	TGEH	MDN
Mean	84.69850	100622.5	3938.150
Median	82.45000	108308.4	4439.500
Maximum	103.8000	122400.0	6929.000
Minimum	72.20000	59787.40	180.0000
Std. Dev.	9.280491	16609.45	2368.619
Skewness	0.602181	-1.524384	-0.422308
Kurtosis	2.308082	4.171006	1.918189
Jarque-Bera	1.607697	8.888535	1.569743
Probability	0.447603	0.011746	0.456178
Sum	1693.970	2012451.	78763.00
Sum Sq. Dev.	1636.423	5.24E+09	1.07E+08
Observations	20	20	20

Source: Computed by the researcher using E-Views 10 (2023).

The descriptive statistics reported in Table 1 indicates that infant mortality rate (IMR), total government expenditure on health (TGEH) and migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries (MDN) averaged 84.69850, 100622.5 and 3938.150 respectively. The standard deviation showed that all the variables converged around their mean. The Skewness test result showed positive value for infant mortality rate, meaning that it has high tail. It revealed negative values for infant mortality rate and migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries, which means that their tails are not high.

Furthermore, infant mortality rate and migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries are platykurtic relative to normal, since their values for kurtosis 2.308082 and 1.918189 are less than 3. This suggests that the variables have short and thin tails, and their central peaks are lower and broader. In addition, total government expenditure on health has leptokurtic distributions relative to normal, since its value for kurtosis 4.171006 is more than 3. This indicates a flatter than normal distribution and the variable has large tail. That is, the variable has longer and fatter tail, and its central peak higher and sharper.

In addition, the probability of Jarque-Bera statistics suggests that the alternative hypotheses of normal distribution for infant mortality rate and migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries were accepted at 5% level while the alternative hypotheses of normal distribution for total government expenditure on health was rejected at 5% level. Thus, the researcher concludes from the revealed statistical properties of the time series that all the variables are not normally distributed, which may have resulted from the problem of unit root. This necessitated the unit root test for stationarity as shown in Table 2.

Unit Root Test Results

To avoid spurious regressions which may arise as a result of carrying out regressions on time series data, this study first subjected the data to stationarity test by using the Augmented Dickey Fuller (ADF) test.

Table 2: Augmented Dickey-Fuller Unit Root Test (2002-2021)

Variables	ADF Test Statistic @ Level	ADF Test Critical Value @ 5% (level)	Order of Integration	ADF Test Statistic @ 1 st Difference	ADF Test Critical Value @ 5% (1 st Diff.)	Order of Integration
IMR	-3.467879	-3.052169	Stationary	-	-	1(0)
TGEH	-4.931967	-3.081002	Stationary	-	-	1(0)
MDN	-1.837781	-3.029970	Not Stationary	-5.608647	-3.040391	1(1)

Note: IMR, TGEH and MDN as earlier defined

Source: Computed by the researcher using E-Views 10 (2023).

The stationarity test results presented in Table 2 show that at 5% level of significance, the variables were stationary. For instance, IMR and TGEH were stationary at level 1(0). While MDN was stationary at first difference 1(1). That is, it became stationary at first difference (integrated of order one). Given that the variables were integrated of order 1(0) and 1(1). The requirement to fit in an ARDL model to test for long run relationship is satisfied.

Table 3: ARDL Bounds Co-integration Test Result

Model		F-Statistic = 4.721819
IMR = F(TGEH, MDN)		K = 2
Critical Values	Lower Bound	Upper Bound
5%	3.1	3.87

Source: Computed by the researcher using E-Views 10 (2023).

From the ARDL bounds test result presented in Table 3, it is clear that there is a long run relationship amongst the variables (IMR, TGEH and MDN). This is because the computed F-statistic of about 4.721819 is higher than the lower and upper critical bounds at 5% critical value. This provided evidence to reject the null hypothesis of no co-integration at, 5% significance level for the infant mortality rate (IMR) model. It can therefore be concluded from the ARDL bounds test that there is a long-run relationship among the variables. Therefore, this study illustrates that total government expenditure on health (TGEH), as well as migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries (MDN) have long run relationship with infant mortality rate (IMR) in Nigeria. Following the establishment of long-run co-integration relationship among the variables, the long-run and short-run dynamic parameters for the variables were obtained.

Table 4: Estimated ARDL Long Run Coefficients. Dependent Variable: IMR (3, 2, 3)

Long Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TGEH)	-30.93025	30.87067	-1.001930	0.3551
LOG(MDN)	-4.199533	4.585664	-0.915796	0.3951
C	472.8241	320.5133	1.475209	0.1906

Source: Computed by the researcher using E-Views 10 (2023).

The estimated ARDL long run coefficients reveal that total government expenditure on health, as well as migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries have negative relationship with infant mortality rate. What this suggests is that, in the long run, a percentage increase in total government expenditure on health, as well as migration of doctors and

nurses trained in Nigeria will increase infant mortality rate in Nigeria. In addition, recurrent expenditure on health has a negative relationship with infant mortality rate.

Table 5: Error Correction Representation for the Selected ARDL Model ARDL (3, 2, 3).

Regressors	Coefficients	t-Statistic	P-Value
DLOG(TGEH)	10.54387	4.701711	0.0033
DLOG(MDN)	0.848912	2.679181	0.0366
ECM (-1)	-0.416078	-5.322679	0.0018
R-squared = 0.840585		Durbin-Watson stat = 2.691183	
Adjusted R-squared = 0.716596		Akaike info criterion = 1.943327	
Schwarz criterion = 2.335427			

Source: Computed by the researcher using E-Views 10 (2023).

The above tabulated result of the dynamic model suggests that the model is of good fit, as the power of the predictors, captured as the R^2 accounted for about 84 per cent variations in the model. In other words, an estimated R^2 result of 0.840585 disclosed that 84 per cent of the vicissitudes in infant mortality rate were due to changes in total government expenditure on health, as well as migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries. Hence, the explanatory influence of the regressors included in the model is 84 per cent. In terms of autocorrelation problem, the estimated Durbin Watson's (DW) value, which is 2.691183 means that the included variables in the model are not serially correlated. The coefficient of ECM has the hypothesized negative sign (-0.416078). This shows that the variables employed properly adjusted from the short-run dynamics to long-run stability.

The coefficient of total government expenditure on health is positively signed. This outcome is not consistent with the theoretical expectation in economics. This means that one per cent increase in this regressor (total government expenditure on health) will increase infant mortality rate by 10.54387 per cent. That is, a percentage increase in total government expenditure on health did not help to reduce infant mortality rate in Nigeria during the period of study. This is suggestive that released budgetary allocations for the health sector have not been so employed as is blamable on mismanagement and corruption, consequently undermining health workers' productivity in Nigeria. Statistically, the absolute t-statistic value of total government expenditure on health appeared significant; meaning that there is a significant relationship between total government expenditure on health and infant mortality rate in Nigeria. This finding corroborates the empirical work of Azuh, Osabohien, Orbih and Godwin (2020) which produced evidence of positive and significant relationship between public healthcare expenditure and under-five mortality, This also suggests that if this predictor (total government expenditure on health) is properly managed it will reduce Nigeria's infant mortality rate.

The coefficient of migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries is positively signed. This outcome is consistent with the theoretical expectation in economics. This means that one per cent increase in this regressor (migration of doctors and nurses trained in Nigeria) will increase infant mortality rate by 0.848912 per cent. This finding validates the empirical work of Bhargava, Docquier and Moullan (2011) who conducted a panel analysis of 69 developing countries from 1991 to 2004 on the effect of migration and reported that migration reduces the number of doctors in developing countries and contributes to the increase in infant mortality rate. However, the absolute value of the t-statistic of migration of doctors and nurses trained in Nigeria slope coefficient is significant, implying that migration of doctors and nurses trained in Nigeria significantly impacted on infant mortality rate over the sampled period.

Post Diagnostic Test Results

Diagnostic tests were conducted in this study to verify whether or not the estimated model for policy prediction or recommendation purpose is reliable. This study specifically employed the Wald, Heteroskedasticity test (Breusch-Pagan-Godfrey) and normality tests. The Wald test was applied for the confirmation of joint significance of the coefficients of the causal variables utilized in the ECM model. The F-statistic in Tables 6 was utilized to ascertain this. For normality test, the Jarque-Bera statistic was applied to examine whether the error term in the ECM model is normally distributed at 5 per cent significance level or not. The normality result is presented in Figure 1.

Table 6: Wald Test for Coefficient of Restrictions

Test Statistic	Value	Df	Probability
F-statistic	18060.95	(4, 20)	0.0000
Chi-square	72243.79	4	0.0000

Source: Computed by the researcher using E-Views 10 (2023).

The result organized in Table 6 revealed that the F-statistic value is approximately 18061, and its probability value of 0.0000 is less than 0.05 at the conventional 5 per cent level. Thus, it follows that all the explanatory variables included in the model are collectively significant in explaining the infant mortality rate condition of Nigeria over the sampled period of this study.

Normality Test Result

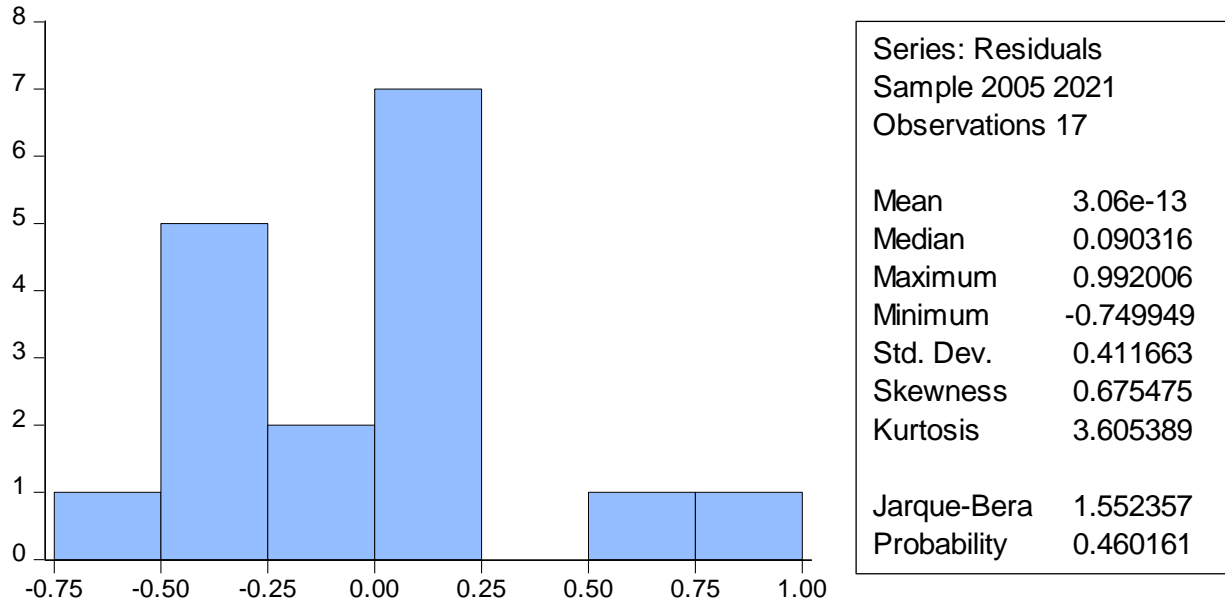


Figure 1: Normality Test Result

Source: Computed by the researcher using E-Views 10 (2023).

The result shown in Figure 1 depicts that the error term is normally distributed at the conventional level (i.e., 5%). This is because the probability value of the Jarque-Bera statistic of approximately 0.46 is greater than the 0.05% conventional level. This implies that the Jarque-Bera statistic hypothesis of normally distributed residuals in the parsimonious ECM model is accepted.

V. Conclusion And Recommendations

Examined in this study is the effect of public health expenditure on infant mortality rate in Nigeria from 2002 to 2021. To achieve this goal, the study utilized data on infant mortality rate, total government expenditure on health and migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries from OECD Health Statistics, 2021, WHO, UNICEF, UNFPA, World Bank Group, the United Nations Population Division and Central Bank of Nigeria Statistical Bulletin of various issues. The study employed an Autoregressive Distributed Lag (ARDL) testing procedures for data analyses. The result revealed that in the long run, total government expenditure on health, as well as migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries have negative and insignificant relationship with infant mortality rate in Nigeria. However, in the short run, total government expenditure on health, as well as migration of doctors and nurses trained in Nigeria - doctors and nurses trained in Nigeria but working in other countries have positive and significant relationship with infant mortality rate in Nigeria. What this means is that though there has been expenditures on health sector in Nigeria by the government from 2002 to 2021, but the expenditures are low and couldn't reduce infant mortality rate to a near-zero level in Nigeria. Also, in the short-term, the movement of doctors and nurses from Nigeria to others countries of the world, exacerbated infant mortality

rate in Nigeria during the period of study. Based on the forgoing, it is recommended here that government should spend at least 15% of its annual budget on health sector as agreed by African leaders at Abuja in 2015. Government should also reduce the exodus of Nigerian doctors to other countries of the world. This, the government may be able to achieve by increasing budgetary allocation to healthcare sector, enhance doctors' remuneration, ensure a better work environment with modern healthcare facilities together with general enhancements in basic life facilities including housing, health insurance, security, constant power supply and good roads.

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