# Health and Economic Growth: Empirical Evidence from Nigeria

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**Abstract**

This study examined the relationship between health inputs, health outputs and economic growth in Nigeria from 1981-2016. Data were obtained from the World Development Indicators (WDI) of the World Bank, and the Central Bank of Nigeria Statistical Bulletin for various years. The Autoregressive Distributed Lag (ARDL) approach was employed in the study to assess the short-run and long-run relationship between health inputs and outputs and economic growth. The findings indicate that while life expectancy is positively related to economic growth in the long run, infant mortality rate and fertility rate have significant impact on economic growth in the short run. The results further show that public health expenditure had no significant impact on economic growth both in the short run and long run during the period under consideration. Therefore, the study recommends that sound health care services that boost life expectancy, reduce infant mortality rate, and control fertility rate be implemented for sustained economic growth in the country.

**Key words**: Economic growth, Health inputs, Health outcomes, Nigeria

## Introduction

Human capital development plays a significant role in the sustenance of growth in any economy. The conceptualization of human

capital encompasses various spheres such as education, health, migration, and other activities that generally enhance the competitiveness and efficiency of people. Although there have been substantial scholarly investigations in the literature about the relationship between human capital and economic growth (see Mcgivney and Winthrop, 2016; Abugamea, 2017; Kotásková et al, 2018), these studies have focused only on the educational component of human capital to the utter neglect of the health constituent. These authors independently presented conclusions that established a positive link between human capital development and economic growth, using education as a key indicator of human capital development.

It has been argued in the literature that the health component of human capital is vital and enhances the productivity of available resources when combined with advancement in technology, which in turn engenders economic growth. Improved economic growth translates into increased aggregate income, rising earnings for labour, and greater public funding of health care. All these promote adequate nutrition, increased access to better health care services, and improved sanitation. They also serve to enhance the health status of the populace (Bloom, Canning & Sevilla, 2004; Akram, Padda & Khan, 2008). Improvement in health outcomes are indispensable for enhancing the well-being of individuals. To boost human capital levels and consequently the productivity of individuals, as well as a country's economic growth rate, better health outcomes are pivotal.

Unfortunately, the health outcomes for Nigeria have been basically poor. The average global life expectancy estimates from 2010-2015 were 68.4 years for males, and 72.8 years for females. The average life expectancy estimates in Nigeria as at 2015 (WDI, 2017) were 52 years for males and 51 years for females. The World Health Organization (WHO) reports for 2018 indicated that Nigeria had the lowest life expectancy in West Africa. This has earned the country a low global ranking in life expectancy of 178. Although the estimates for 2017 show that female life expectancy improved from 51 years to 55 years, and male life expectancy by 0.8 percent, life expectancy in Nigeria is still far below the global average for both males and females. This low life expectancy in Nigeria is attributed principally to the prevalence of diseases such as influenza and pneumonia, diarrhoea, tuberculosis, HIV/AIDS, malaria, low birth weight, stroke, birth trauma, road accidents, and others (World Data Atlas, 2018). Infant mortality rate declined from 76.2 per 1000 live births in 2012 to 64.6 deaths in 2017. Maternal mortality per 100,000 live births declined from 867 deaths in 2010

to 814 in 2015 (WDI, 2017). The proximate causes of high infant mortality rate include diarrhoea, illiteracy, and incorrect baby care, among others. These poor health indicators stem from the limited amounts of public funds allocated to the health sector. For instance, budgetary allocation to the health sector from 2010 to 2016 averaged 6 percent. This estimate fell below the 15 percent benchmark set in 2001 by African heads of states at the Abuja declaration. Public health expenditure as a percentage of GDP was 0.91 percent in 2010 and 0.92 in 2015 (Global Health Repository, 2017).

Available studies for Nigeria on the link between health and economic growth (Adeniyi and Abiodun, 2011; Onisanwa, 2014) have only examined the long-run impact of health on economic growth and not the short-run dynamics. Also, none of these studies analysed the effect of infant mortality rate on economic growth. This article takes into account the health and well-being of children, since it is a crucial aspect of human capital development. Moreover, the analysis of the effect of infant mortality on economic growth is essential to assessing the latent socio-economic returns of investments on health.

The purpose of this paper is to establish the short-run and long-run impacts of health outcomes and health input on economic growth in Nigeria. Following this introduction, the next section examines the performance of health inputs and outputs in Nigeria. This is followed by a discussion of the literature review and a presentation of the data and methodology used in the study. The results are presented in the subsequent section while the summary and conclusion are comprised in the final section.

**Performance of Health Inputs and Health Outcomes in Nigeria**

The performance of health inputs and health outcomes and their relationship with economic growth in Nigeria are discussed in this section. Nigeria continues to have some of the worst health indicators in Africa. Life expectancy for Africa in 2010 was estimated at 55 years for men and 58 years for women. In Nigeria, the life expectancy figures were below the estimate for sub-Saharan Africa. Approximately, the figures for life expectancy were 52 years for men and 51 years for women. In 2014, the corresponding figures were 53 years for both men and women (WDI, 2017). Despite the winding down of the Millennium Development Goals (MDGs) and the introduction of the Sustainable Development Goals (SDGs), Nigeria has not achieved the

previously set MDG reduction target in the infant mortality rate. The infant mortality rate per 1,000 live births in 2000 was 112 deaths but by 2014 it declined to 71.5 deaths.

**Table 1: Performance of Health Inputs and Health outcomes in Nigeria**

| Year | Life Expectancy | Infant Mortality Rate | Fertility Rate | Government Health Expenditure as % of GDP | Government Health Expenditure as % of Total Health Expenditure |
|---|---|---|---|---|---|
| 1995 | 46 | 123.8 | 6.26 | 0.66 | 23.76 |
| 2000 | 46 | 112.4 | 6.11 | 0.95 | 33.46 |
| 2005 | 49 | 96.7 | 5.99 | 1.20 | 29.17 |
| 2010 | 51 | 82.6 | 5.84 | 0.91 | 26.18 |
| 2014 | 53 | 71.5 | 5.62 | 0.92 | 25.19 |

Fertility rate in the country declined from 6.11 percent in 2000 to 5.62 percent in 2014. Government health expenditure as a percentage of total health expenditure improved slightly from 0.95 percent in 2000 to 1.2 percent in 2005 but declined again to 0.92 percent in 2014. Government health expenditure as a percentage of total health expenditure was 33.46 percent in 2000 and declined by 8.27 percent in 2014. The relationship between public health and economic growth is shown in Figure 1.

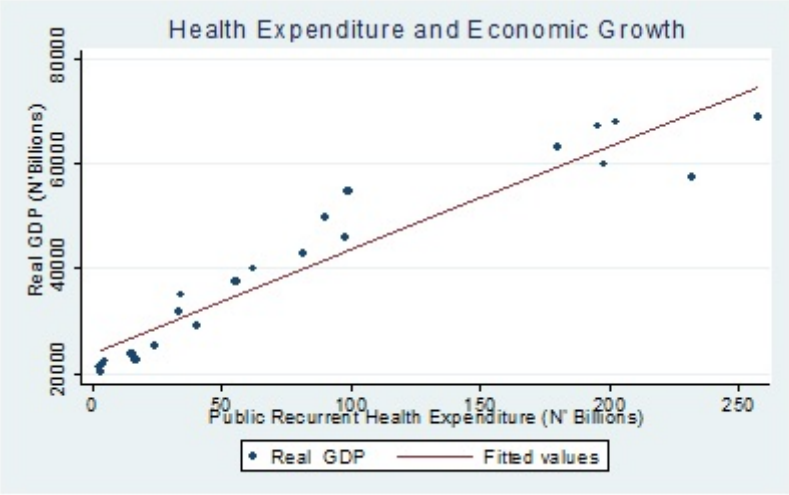


**Figure 1: Public health expenditure and economic growth.**

Figure 1 reveals that a positive relationship exists between real GDP and recurrent public health expenditure. This implies that increased recurrent public health expenditure translated into increased economic growth. This finding should be treated with caution because increased recurrent expenditure if not matched with growing capital expenditure on health care, in the form of increased spending on health infrastructure (such as providing more hospitals and clinics, especially in rural areas), medical equipment, and stock of vaccines and drugs, will eventually result in worsening of health outcomes for the country, which is detrimental for economic growth.

The relationship between life expectancy and economic growth is depicted in Figure 2. The figure shows that a positive relationship exists between life expectancy and economic growth, proxied by real gross domestic product in Nigeria. It can be inferred from the positive relationship between life expectancy and real GDP that improvements in the average life expectancy of the population would result in increased economic growth.

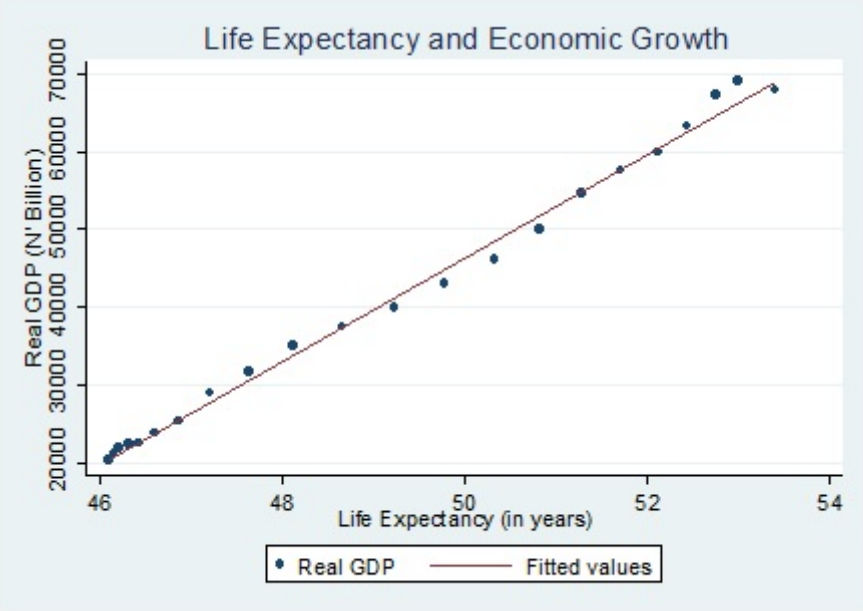


**Figure 2: Life expectancy and economic growth.**

The relationship between infant mortality rate and economic growth is shown in Figure 3. The chart depicts an inverse relationship between infant mortality rate and real GDP. This shows that rising infant mortality figures are detrimental to the growth of the economy. Findings further reveal that health outputs (infant mortality rate and fertility rate) have an inverse relationship with economic growth. Increasing infant mortality reduced economic growth because infant mortality results in the loss of potential human capital.

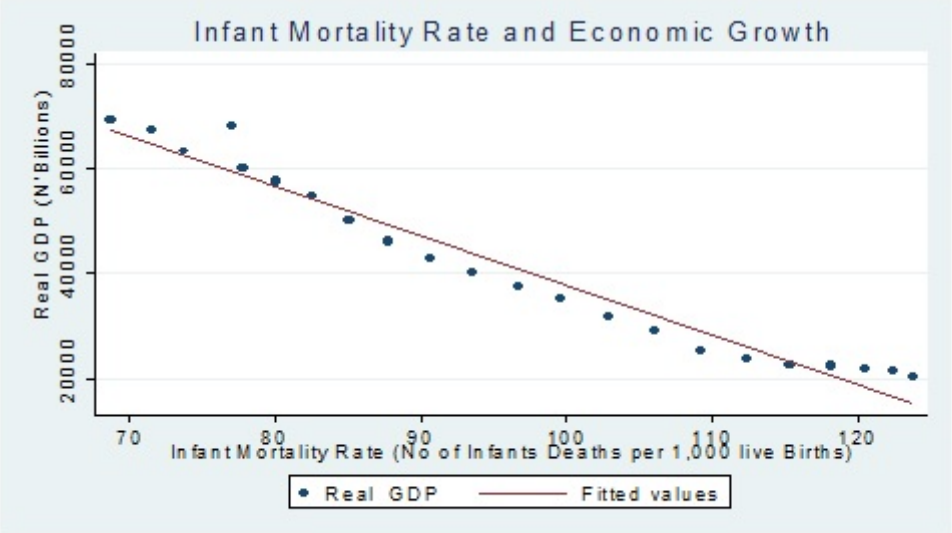


**Figure 3. Infant Mortality Rate and Economic Growth.**

Figure 4 which portrays the relationship between fertility rate and economic growth depicts an inverse relationship between fertility rate and real GDP. This shows that an increase in the number of children per woman is detrimental to the growth of the economy. This is because an increase in population is not a sufficient condition for economic growth. The population must be equipped with the relevant skills sets and education to contribute effectively to the productive capacity of the country. Increased population without relevant development in human capital will greatly alter the population dynamics and produce a dependent population that would burden the working population.

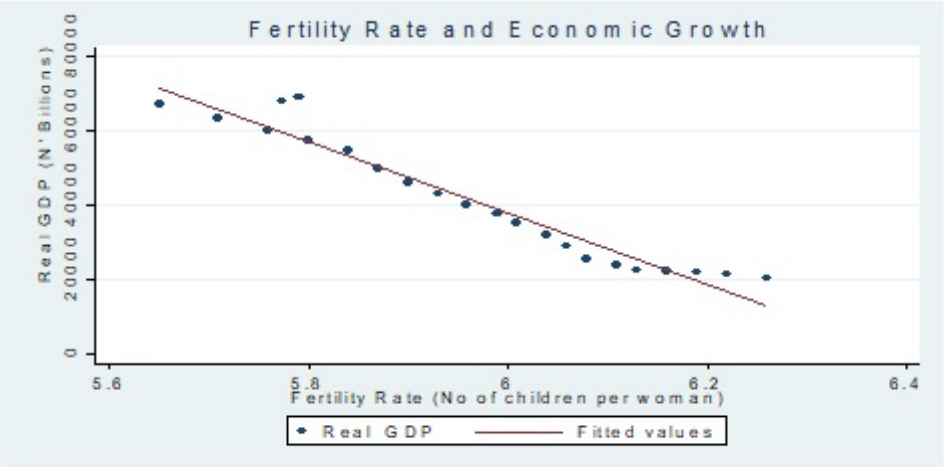


**Figure 4. Fertility Rate and Economic Growth.**

## Literature Review and Theoretical Review

Studies have analysed the relationship between health and economic growth; while some have examined the long-run relationship, others have examined the extent of causality using different economic variables.

Djafar and Husaini (2011) observed that causality between GDP and health is more likely to occur in the long-run than in the short-run, indicating that changes in economic growth may promote health and vice versa. The countries may also have only short-run causality or only long-run causality. They further observed that the long-run causality from GDP to health is likely to dominate the causality relationship between GDP and health.

In a study conducted for Sudan to establish the relationship between health and economic growth, Sigar, Amadu and Nor (2013) used data on real GDP per capita (constant, 2000 US$), life expectancy at birth, education expenditure (current US$) as proxy for human capital, total labour force, gross capital formation rate and annual population growth as a percentage. They employed ARDL and Granger causality tests as estimation techniques. It was reported that life expectancy did Granger cause GDP per capita, and that the Granger causality did not run from GDP per capita to life expectancy. The findings of this study contributed substantially to the

understanding of the importance of improved health outcomes in developing countries, especially in Sudan. The authors advocate that minor advancement in health care can make a crucial difference in income level for both individuals and the country.

These findings are similar to the result obtained for Nigeria (see Onisanwa, 2014) using data from the World Bank Development Indicator database covering 1995-2009, on real gross domestic product, gross fixed capital formation, health expenditure, life expectance, and fertility rate at birth. ADF Test, Pairwise Granger causality test, and cointegration test were explored for analysis. The findings show that a bi-directional relationship exists between economic growth and the health indicators. The study further revealed the long-run relationship between GDP, gross capital formation and other measures of health status. This result confirms that health variables play a significant role in the determination of long-run economic growth.

Bloom, Canning and Sevilla (2004) argued that countries with high life expectancies tend to have an older labour force with high experience; so the authors investigated whether this specific effect influenced the relationship between health and economic growth. Also, they attempted to estimate the production function to check the existence of an effect of health on labour productivity. Their findings indicate that health has a positive and significant impact on economic growth. They also showed that a one-year improvement in a population's life expectancy contributes to an increase of four per cent in output.

In analysing the short-run and long-run impacts of health on economic growth, Akram, Padda and Khan (2008), while investigating the effect of health outcomes on economic growth in Pakistan using time series data of Pakistan for the period 1972-2006, established that in the long run, per capita GDP was positively influenced by health indicators, and these health outcomes Granger caused the per capita GDP. However, these health indicators did not have significant impact on per capita GDP in the short run. These findings reveal that health is only a long-run phenomenon and there is no significant relationship between health variables and economic growth in the short run.

While modelling the effect of health on economic growth in a panel data study, Bhargava et al (2001) used data primarily from the Penn World

Table and WDI. Gross domestic product (GDP) series based on official exchange rates (World Development Indicators; WDI), gross domestic product (GDP) series based on purchasing power adjustments (Penn World Table; PWT), and other variables including adult survival rate (since it is less sensitive to child mortality rates), life expectancy and population were employed as key variables. The results show significant effects of adult survival rate (ASR) on economic growth for low-income countries. Thus, for example, for the poorest countries, a one percent change in ASR was associated with, approximately, a 0.05% increase in growth rate.

On the other hand, several studies do not support the positive impact of health on economic growth. Acemoglu and Johnson (2007) investigated the effect of life expectancy on economic growth and they emphasized that the decline in mortality rate is due to new chemicals, drugs, and international health campaigns. Furthermore, population has increased significantly due to the improvement in life expectancy, but birth rate did not decline instantly to balance the increase in life expectancy. They argue that there is no evidence that the increase in life expectancy leads to faster growth of income per capita or output per worker. This indication casts doubt on the view that health has direct and strong impact on economic growth.

Other studies have also examined the relationship between health expenditure, health status, poverty and economic growth. Riman and Akpan (2010) examined the long-run relationship and direction of causality between government health expenditure, poverty and health status in Nigeria. The result shows the existence of a long-run relationship between poverty and health status. They observed nonetheless a non-significant long-run relationship between government health expenditure and health status. The authors therefore posit that for policies aimed at improving health status to be effective, programmes that will improve adult literacy level, reduce poverty, and minimise income disparity should be put in place. This is because an increase in budgetary allocation to fund the health sector alone without reducing poverty level would not be sufficient to strengthen the health status of the country.

## Methodology and Data

### Theoretical framework

In the mid-1980s, a group of growth theorists being increasingly dissatisfied with the neoclassical growth theory, advocated a theory that favoured endogenous factors as long-run drivers of growth instead of exogenous factors. The neoclassical growth theories postulate that the long-run growth rate of an economy depends on two exogenous factors – the rate of population growth and technological progress (which is independent of the saving rate). Authors have advanced several variants of the model of endogenous growth as found in the works of Arrow (1962), Romer (1988) and Lucas (1988). The endogenous growth theory opines that economic growth is primarily the result of endogenous and not exogenous (external) forces. The theory further argues that investment in human capital (education and health), innovation and knowledge are significant contributors to economic growth. The fundamental focus is on how positive externalities in the economy will promote economic growth. The endogenous growth theory primarily holds that the long-run growth rate of an economy depends on policy measures such as subsidies for research and development (R&D), development of human capital in the field of R&D, and the strengthening of appropriate institutions that enforce patent, property right and contracts, as well as promote increased growth rate by creating an enabling environment for innovation (Todaro and Smith, 2011).

### Model specification

This study adopts the model of Mankiw, Romer and Weil (1992) known as the augmented Solow growth model. This (MRW) model emerged from the endogenous growth theory that transforms the traditional Cobb-Douglas model by including the human capital variable.

$$Yt = Kt\ Ht\ (At\ Lt) \tag{1}$$

where:

$Yt$ = output

$Kt$ = capital

$Ht$ = human capital

$Lt$ = labour

$At$ = technology parameter

For this study, $At$ is assumed to be constant. The variables are expressed in natural log except infant mortality rate, fertility rate, life expectancy and labour force participation rate.

$$lnRGDP = \lambda 0 + \lambda 1\ FR + \lambda 2\ IMR + \lambda 3\ LFPR + \lambda 4\ LEXP +$$

$$\lambda 5\ lnGFCF + \lambda 6\ lnPRHEXP + \varepsilon t \quad (2)$$

where:

*lnRGDP* = log of real gross domestic product

*IMR* = infant mortality rate (per 1000 live births)

*LEXP* = life expectancy at birth as proxy of human capital (health component).

*LFPR* = labour force participation rate

*ln*GCFC = log of gross fixed capital formation

ln PRHEXP = log of public recurrent health expenditure

This study employs the Autoregressive Distributed Lag (ARDL) technique as well as the Granger causality test to analyse the relationship between health outcomes and economic growth. The ARDL framework is of the form:

$$Y_t = \rho_0 + \gamma_1 Y_{t-1} + \beta_i \Sigma_{i=0}^{n} X_{t-i} + \varepsilon_t \quad (3)$$

where:

$Y_t$ is the dependent variable

$Y_{t-1}$ is the autoregressive component that indicates the lagged dependent variable

$\Sigma_{i=0}^{n} X_{t-i}$ is the collection of other explanatory variables in their lagged form, beginning from the current level up to the maximum lag length suggested by the lag selection criteria.

Equation (2) is re-specified as follows:

$$\Delta \ln RGDP_t = \rho_0 + \sum_{i=0}^{n} \beta_1 \Delta \ln RGDP_{t-1} + \sum_{i=0}^{n} \beta_2 \Delta FR_{t-1} + \sum_{i=0}^{n} \beta_3 \Delta IMR_{t-1}$$
$$+ \sum_{i=0}^{n} \beta_4 \Delta LEXP_{t-1} + \sum_{i=0}^{n} \beta_5 \Delta LFPR_{t-1} + \sum_{i=0}^{n} \beta_6 \Delta \ln GFCF_{t-1}$$
$$+ \sum_{i=0}^{n} \beta_7 \Delta \ln PRHEXP_{t-1} + \gamma_1 \ln RGDP_{t-1} + \gamma_2 FR_{t-1} + \gamma_3 IMR_{t-1}$$
$$+ \gamma_4 LEXP_{t-1} + \gamma_5 LFPR_{t-1} + \gamma_6 \ln GFCF_{t-1} + \gamma_7 PRHEXP_{t-1} + \varepsilon_t \quad (4)$$

$\beta_1$ to $\beta_7$ refers to the short-run parameters and $\gamma_1$ to $\gamma_7$ are the long-run parameters.

This study investigates the relationship between health outcomes and economic growth in Nigeria from 1981- 2016. The data for the study were sourced from the World Bank's *World Development Indicators* (WDI) and the *Central Bank of Nigeria Statistical Bulletin* of various years.

**Presentation and Analysis of Results**

**Stationarity test**

The results of the Augmented Dickey-Fuller test and the Kwiatkowski-Phillips-Schmidt-Shin test, which serve as a complementary test of stationarity, suggest that the variables in the model are of a mixed order of integration. The ADF test shows that fertility rate (FR) and the infant mortality rate (IMR) are stationary at level. This implied that including these variables in the estimation of the models does not produce spurious outcomes. The log of gross fixed capital formation (LGFCF), labour force participation rate (LFPR), log of real gross domestic product (LRGDP) and recurrent public health expenditure (LPRHEXP) were all stationary after first differencing them. They are integrated of order one I(1). The order of the life expectancy variable (LEXP) could not be established using the ADF test, consequently using the KPSS test, it was established that the LEXP became stationary at first difference.

**Table 2: Unit root result**

| **I(0)** | **ADF** | | **KPSS** | |
|---|---|---|---|---|
| **Variables** | **Intercept** | **Trend and Intercept** | **Intercept** | **Trend and Intercept** |
| FR | -1.487423 | -5.915742*** | 0.697712 | 0.186910 |
| IMR | -3.978045** | -3.626736** | 0.641235 | 0.176655 |
| LFPR | -0.662342 | -1.677684 | 0.511690 | 0.095622*** |
| LGFCF | -0.170170 | -1.279268 | 0.412997 | 0.189034 |
| LEXP | 3.005101 | -1.718167 | 0.600595 | 0.184312 |
| LRGDP | 0.097324 | -2.391879 | 0.681047 | 0.194789 |
| LPHEXP | -1.204122 | -0.272234 | 0.690154 | 0.171569 |
| **First Difference I(1)** | **Intercept** | **Trend and Intercept** | **Intercept** | **Trend and Intercept** |
| FR | -4.337269 | -5.802185 | 0.272426 | 0.096342 |
| IMR | -2.674433 | 2.151921 | 0.307844** | 0.175635 |
| LFPR | -5.223867*** | -5.173659*** | 0.105727 | 0.091684 |
| LGFCF | -5.812720*** | -6.364328*** | 0.392205 | 0.500000** |
| LEXP | 0.023022 | -2.807168 | 0.476664 | 0.107078*** |
| LRGDP | -3.229346** | -3.116056 | 0.373121** | 0.121548 |
| LPHEXP | -9.677024*** | -5.100559*** | 0.500000 | 0.500000*** |

*Source:* E-views output.

*Note :* For the ADF statistic; the I(0) critical values for 1%, 5% and 10% are -3.661, -2.960 and -2.619 while the I(1) critical values for 1%, 5% and 10% are 3.632, -2.948 and -2.612.

Due to the mix of integration, the Autoregressive Distributed Lag Approach (ARDL) estimation technique is employed. Evidently, to ascertain the long-run relationship among the variables in the models, the ARDL bound testing approach to co-integration is leveraged on. The initial process involves determining the optimal lag length of the model. The optimal lag length is found based on diverse information criteria, namely Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), Hannan-Quinn Information Criterion (HQ), Final 13 Prediction Error (FPE), and Sequential Modified LR test Statistic (SMLR). The optimal lag length for the models of ( L) is 2.

**Long-run impact analysis**

To determine if the series co-integrate, a comparison is made between the F-statistic and the lower bound results, as well as the upper bound (I1bound) result. The results are presented in Table 3. The series are co-integrated if the F-statistic is greater than the upper bound test statistic at 1%, 2.5%, 5% and 10% and vice versa.

**Table 3: ARDL Bounds Test for Cointegration**

| F statistic | No. of Parameters | Decision |
|---|---|---|
| 8.674260 | 6 | Co-integrated |
| Critical Values | Lower Bound | Upper Bound |
| 10% | 2.12 | 3.23 |
| 5% | 2.45 | 3.61 |
| 2.5% | 2.75 | 3.99 |
| 1% | 3.15 | 4.43 |

The computed value of the F-statistic (8.67) is greater than the upper bound critical values. This implies that the null of no long- run relationship is rejected. Therefore, there exists a long-run relationship among the variables in the model.

**Table 4: Lag Order Selection**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -184.2407 | NA | 0.000181 | 11.24945 | 11.56370 | 11.35662 |
| 1 | 128.4752 | 478.2713 | 3.54e-11 | -4.263244 | -1.749239 | -3.405897 |
| 2 | 344.7003 | 241.6634* | 2.80e-15* | -14.10002* | -9.386258* | -12.49249* |

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

The result reported in Table 4 shows that 2 is the optimal lag length.

**Table 5: Long-run coefficient of the ARDL (2, 0, 2, 1, 1, 2, 2) model**

**Dependent variable (LRGDP)**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LPHEXP | -0.010820 | 0.007658 | -1.412903 | 0.1757 |
| LEXP | 0.200899 | 0.092379 | 2.174736 | 0.0441 |
| LGFCF | -0.030906 | 0.018191 | -1.698979 | 0.1075 |
| LFP | 0.024546 | 0.033092 | 0.741758 | 0.4684 |
| IMR | 0.011264 | 0.012911 | 0.872386 | 0.3952 |
| FR | -0.762537 | 0.097537 | -7.817922 | 0.0000 |
| C | 2.697051 | 6.011432 | 0.448654 | 0.6593 |

The long-run result obtained from Table 5 indicates that there is a positive and significant relationship between life expectancy at birth and the real GDP. Furthermore, fertility rate is found to be significant and has a negative relationship with real GDP. However, public recurrent health expenditure, infant mortality rate, gross fixed capital formation, and labour force participation rate were insignificant in the long run and therefore do not drive long-run economic growth in the country.

These results reveal that a one-year improvement in life expectancy will lead to about 20 percent increase in economic growth and improved health status of the population vis-à-vis better life expectancy will boost economic growth. This finding is in tandem with that of Sigar, Amadu and Nor (2013), and Onisanwa (2014). While the results support the postulation that improved life expectancy strengthens economic growth, the findings of the study show that a unit increase in fertility rate, on the other hand, will cause the economic growth to plummet by about 76 percent. This outcome could be attributed to the oversaturation of the labour market and low level of productivity. Consequently, rising fertility rate imposes excessive burden on already depleted resources, hence economic growth is hindered. This finding is similar to Bhargava et al (2001) but contrary to the conclusion of Onisanwa (2014) for Nigeria. Again, infant mortality rate, though positive with a coefficient of 0.01, was not significant in propelling economic growth. In the same vein, labour force participation does not have any significant impact on economic growth in the long run. The implication of this finding is that population growth and the current labour force in Nigeria, due to low productivity, do not engender long-run economic growth.

The long-run results further indicate that recurrent health expenditure by the government, gross fixed capital formation exert negative (-0.01, -0.03) but insignificant influence on economic growth during the period under consideration. This could be attributed the mismanagement of the financial resources available to the sector that has weakened its contribution to the overall growth of the economy. This argument is akin to the conclusion drawn by Akram, Padda and Khan (2008) for Pakistan. As regards investments in Nigeria, the underutilisation of capacity and hostile business environment have inhibited its potentials to trigger long-run economic growth. Akram, Padda and Khan (2008) and Sigar, Amadu and Nor (2013) advanced similar arguments for inability of investments to boost economic growth in the long run.

Table 6 shows the estimated results of the short-run ARDL model.

**Table 6: Short-run coefficient of the ARDL (2, 0, 2, 1, 1, 2, 2) model**

**Dependent Variable (LRGDP)**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(LRGDP(-1)) | 0.335269 | 0.160217 | 2.092590 | 0.0517 |
| D(LPRHEXP) | -0.009669 | 0.006983 | -1.384622 | 0.1841 |
| D(LEXP) | 1.255816 | 0.751450 | 1.671191 | 0.1130 |
| D(LEXP(-1)) | -0.774140 | 0.503981 | -1.536051 | 0.1429 |
| D(LGFCF) | 0.013439 | 0.005812 | 2.312385 | 0.0335 |
| D(LFR) | 0.079150 | 0.025310 | 3.127251 | 0.0061 |
| D(IMR) | 0.040940 | 0.016245 | 2.520175 | 0.0220 |
| D(IMR(-1)) | -0.043026 | 0.028423 | -1.513799 | 0.1484 |
| D(FR) | 1.009846 | 0.327183 | 3.086490 | 0.0067 |
| D(FR(-1)) | -2.908517 | 0.627014 | -4.638676 | 0.0002 |
| CointEq(-1) | -0.893630 | 0.229116 | -3.900341 | 0.0012 |

*Source:* E-view output.

The results presented in the table reveal that the error correction term is negative and significantly different from zero. Its coefficient of -0.89, suggests that the speed of adjustment of disequilibrium between the short run and long run is about 89 percent. This finding indicates that the recovery process for the growth model is rapid, and it could take a short period of time for equilibrium to be restored. Other estimated short-run

coefficients reveal that the coefficient of the public recurrent health expenditure (-0.0096) was negative and had no significant impact on economic growth. The life expectancy coefficient (1.25), though positive had no significant effect on economic growth. On the other hand, gross fixed capital formation (investment), labour force participation rate, infant mortality rate and fertility rate, with coefficients of 0.013, 0.04 and 1.00 respectively, exerted positive and significant impact on economic growth. The implication of these findings is that high levels of investment and improvement in health outcomes are pivotal to sustaining economic growth, especially in the short run.

**Post-estimation test result**

The test statistics for the various robustness tests (Table 7) show that the estimates are reliable and plausible. The Breusch-Godfrey LM test indicates that there is no serial correlation because the probability value of the F- statistic (0.112) is greater than 0.05 level of significance. Thus, the null hypothesis of no serial correlation is accepted at 5 percent significance level. The probability value of the F statistic 0.161 is greater than 0.05. This suggests that the null of no heteroscedasticity is accepted at the 5 percent better level. This suggests that there exists in the model a minimum variance, thereby validating the consistency argument of the estimates. The Jarque-Bera estimate also reveals that the null hypothesis of normality is accepted. The stability of the ARDL model is tested using cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ) stability testing technique. The CUSUM and CUSUMSQ plots are shown in Figures 5 and 6 respectively. Since both plots are within critical bounds at 5 percent level of significance, it is concluded that the model is structurally stable.

**Table 7: Residual robustness test**

| Test Statistic | | |
|---|---|---|
| Breusch-Godfrey Serial | F –stat | 2.539 |
| | | **(0.112)** |
| Heteroscedasticity Test | F- stat | 1.638 |
| | | **(0.161)** |
| Normality Test | Jarque-Bera | 0.259 |
| | | (0.878) |

*Source:* Authors' estimation from the research data.

**Stability test**

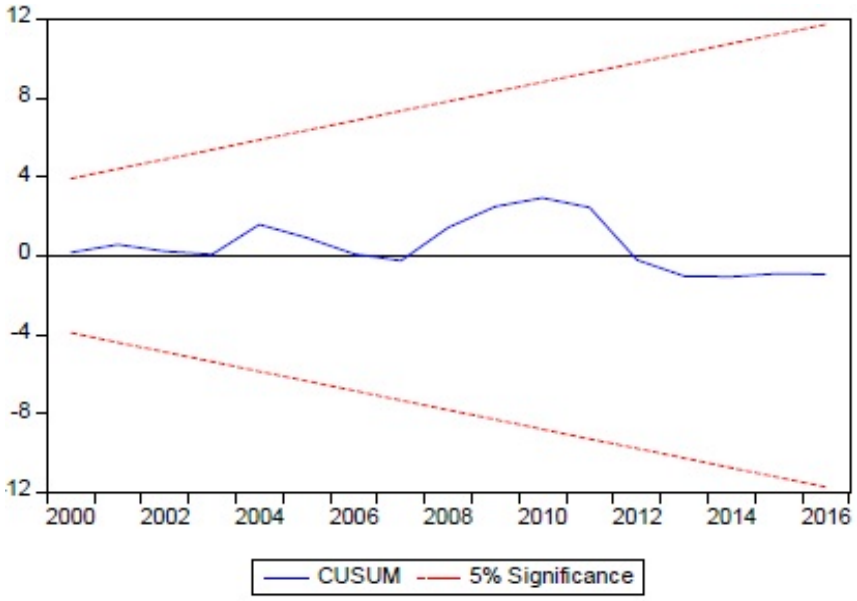


**Figure 5: Cumulative sum of recursive residuals (CUSUM).**

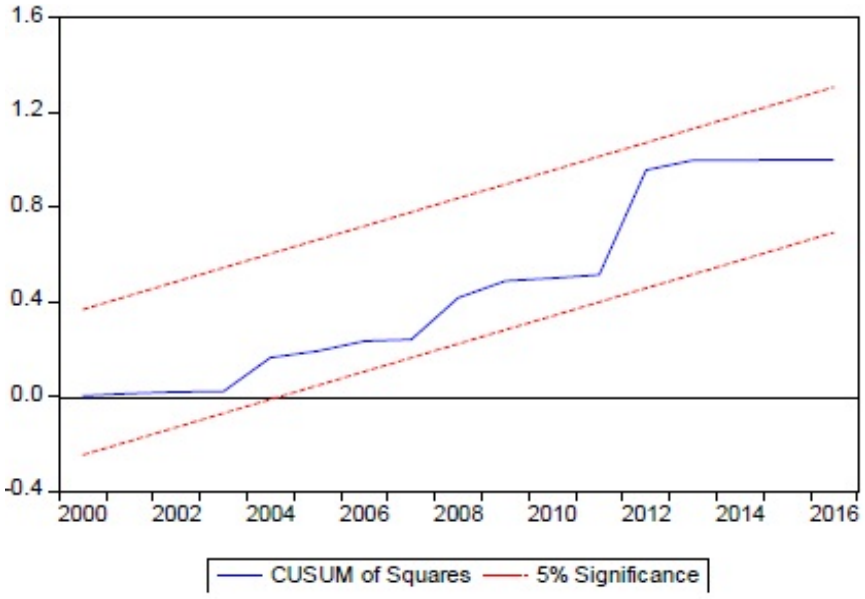


**Figure 6: Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ).**

## Summary and Conclusion

This study was aimed at determining the impact of health outcomes and health inputs on economic growth in Nigeria. The Autoregressive Distributed Lag (ARDL) approach was leveraged on as the estimation technique. The empirical findings show that while life expectancy plays a significant role in driving long-run economic growth, infant mortality rate and public health expenditure are not major long-run drivers of growth. The results indicate that improvements in life expectancy will in turn lead to an immense rise in economic growth. Furthermore, in the short run, the results show that infant mortality rate and fertility rate have significant impact on economic growth. Meanwhile, recurrent public health expenditure in Nigeria was not a key driver of growth in both the short run and long run. This occurred because health expenditure was not spent on capital health projects such as funding of research and development in the health sector, building of hospitals and providing health institutions with state of the art medical equipment. These are vital for improved health delivery and human capital development, which would translate into improved economic growth.

The findings of the study confirm that better health care services that boost life expectancy, reduce infant mortality rate and fertility rate are essential for ensuring sustained economic growth in the country. These can be achieved through increased public funding of the health sector in line with the Abuja 2001 declaration. All these will ensure that there is a functional public health care system that guarantees improved health outcomes with their attendant positive impact on economic growth in Nigeria.

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