




# The life expectancy–economic growth nexus in Nigeria: the role of poverty reduction

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## Abstract

Health improvement is a crucial determinant of economic growth; however, the impact of health on economic growth is affected by the level of poverty in any nation. Previous studies have focused more on the health–growth nexus, but the role of poverty reduction and the threshold of health required to mitigate the effect of poverty on economic growth were missing. This paper, therefore, examined the life expectancy–growth nexus and the role of poverty reduction with the view to determine the contribution of health to growth and poverty reduction and the threshold of health required to mitigate the adverse effect of poverty on economic growth in Nigeria. Based on the endogenous growth theoretical approach, the link between life expectancy, poverty incidence, and economic growth was estimated using the fully modified ordinary least square method. Findings showed that health contributes positively to economic growth and also mitigates the adverse effect of poverty on economic growth in Nigeria. The study determined the minimum threshold of life expectancy of 64.4 years as a health improvement annual benchmark. Therefore, for Nigeria to achieve sustainable economic growth and significant poverty reduction, policies aimed at achieving the newly determined health improvement threshold from the current annual average of 47.8 years are fundamental.

**Keywords** Life expectancy · Poverty · Economic growth · Nigeria · I115 · I32 · O47 · O55

**JEL Classification** I115 · I32 · O47 · O55

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## Introduction

One of the crucial discussions in the economic literature that is of increasing global interest revolves round on: What are the key drivers of economic growth? To advance answers to this question, different reasons have been adduced as growth-induced factors including socioeconomic, cultural and political. The inference that can be drawn from the quest in unearthing these growth drivers is the lack of consensus and inconclusiveness of economic growth factors (Ajide 2014).

Despite the different views on economic growth determinants, the pivotal role of health improvement in fostering economic growth in developing countries including Nigeria has regularly featured in the growth literature (see Lawanson 2009; Dauda 2010; Browser 2010; Acemoglu and Johnson 2007; Barro 2013; Kunze 2014; Atake 2018; Mahumud et al. 2013; Piabou and Tieguhong 2017). Interestingly, further empirical expositions by human capital and development pundits opined that if well maximized, health investment could translate into improved life expectancy, lower under-5 mortality rate, reduce morbidity, and avert killer diseases such as malaria, HIV/AIDS and tuberculosis among others with consequential economic loss (Menzies et al. 2012; Danforth et al. 2017; UNAIDS 2016). More so, good health enhances job productivity and provides the climate for an individual to learn and develop mentally, physically and emotionally (Lee 2019; Umar 2017). Through improved health investment, individuals could harness the gain of living healthier and longer, reduce the urge to have more children and are motivated more to invest in their health and that of their family members, thus, enhancing their health status (Burrows et al. 2017).

Notwithstanding these perceived gains of health improvement, renewed attention on the empirical nexus between health and economic suggests that the effects of health on economic growth are mixed even when similar methodology and data were used in their analysis. For instance, Sharma (2018) and Bloom et al. (2018) showed no positive impact of health on economic growth, while emerging evidence (see Sede and Ohemeng 2015; Serag et al. 2019) showed the existence of a non-linear relationship between life expectancy and economic growth. However, Kunze (2014) discovered that it is not easy to declare in theory which outcome dominates. The mixed outcomes could suggest that the health–economic growth nexus may not be direct, but through some macroeconomic conditionings or channels (see An and Jeon 2006; Sharma 2018; Pakdaman et al. 2019). Besides, available data show that health improvement is at variance with economic growth in Nigeria. For example, while Nigeria life expectancy improved by 3.4 years in the last decade from 50.90 to 54.33 years, income per head declined by – 11.3% from \$2292.4 to \$2032.7 between 2010 to 2018 (World Bank 2019).

Arising from the controversy on health–economic growth linkage, it has been argued that the level of growth in developing countries is a function of the level of poverty. The level of poverty allows for limited economic resources that could inhibit health investment that will trigger economic activities and spur economic growth in developing countries (Mohammad et al. 2014; Omoniyi 2018; World

Bank 2019). According to the popular saying, “health is wealth” and ill health is a dimension of poverty (Sen 1999; Bloom 2003). Improvement in health could translate into poverty reduction (Bloom 2003) and boost the economic growth of nations (Barofsky and Nosair 2015; Lange and Vollmer 2017). Impliedly, health improvement could fast track sustainable development goal no. 1 (no poverty by 2030), hence its explicit inclusion in the sustainable development goals no. 3 as ‘to ensure healthy lifestyle through health investment and promote the well-being of people across all ages’ (United Nations 2017).

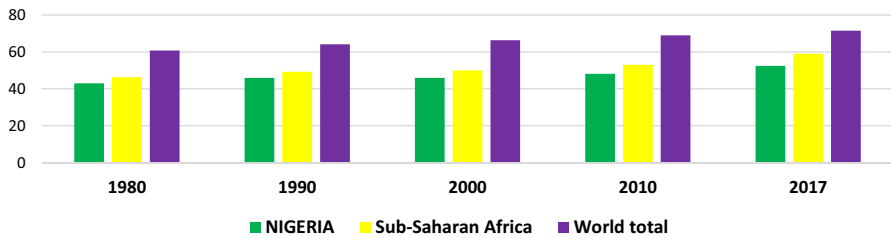
Even though evidence supports that the level of economic growth in developing countries could be a function of the level of poverty, and as well stresses that improvement in health could lead to poverty reduction, most empirical investigation in Nigeria has examined a direct nexus between economic growth and health with mixed results, but neglected the role poverty reduction could play in the relationship. Also, most of the studies mentioned earlier used health expenditure as a proxy for human capital in economic growth literature. However, health expenditure can increase without improvement in health, hence the need for health indicator (life expectancy) that shows improvement in health and its implication on growth. Besides, one thing that is lacking in the empirical investigation of the health–growth repository in Nigeria is that most studies have not been able to determine the optimal level of health necessary to mitigate the adverse effect of poverty on economic growth. Such a threshold is instrumental for policy direction, as figures are important for policies. Consequently, the above issues have raised some vital questions which this study attempts to answer. First, what is the actual impact of health on economic growth in Nigeria? Second, does health improvement play any role in poverty reduction in Nigeria? If it does, what is the interactive effect of health and poverty on economic growth in Nigeria? Finally, if health is pivotal to economic growth in Nigeria, what is the minimum benchmark of health improvement necessary to curb the adverse effects of poverty on economic growth in Nigeria? The answers to these questions could provide a strong platform for health–economic growth nexus in Nigeria. Hence, this study examines the impact of life expectancy on economic growth and the role poverty reduction plays in their nexus, as well as seeks to determine the threshold of health improvement necessary to mitigate the adverse effect of poverty on economic growth in Nigeria as a way of contributing to empirical gaps in health–economic growth nexus in Nigeria.

## Stylized facts

### The trend in health, poverty incidence and economic growth in Nigeria

This section shows the evolution of health, poverty incidence and economic growth in Nigeria within the period 1980–2018.

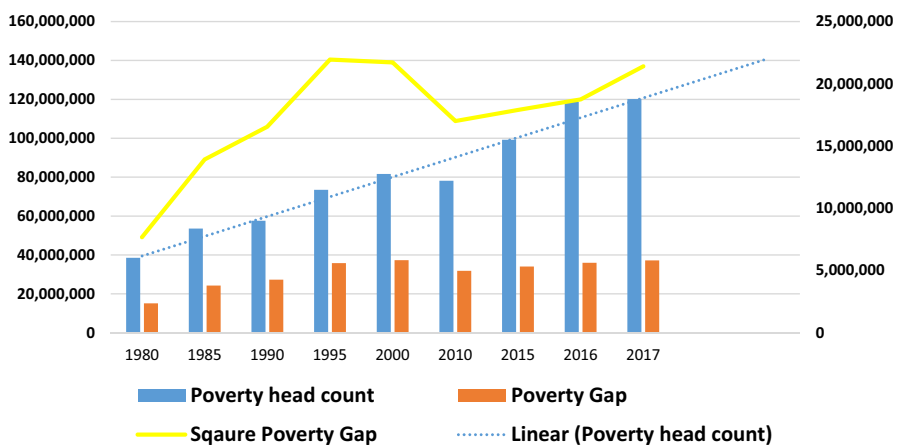
Figure 1 shows the trend in life expectancy in Nigeria, sub-Saharan Africa and the world total between 1980 and 2017 based on 10-year average point interval. Comparing Nigeria’s average life expectancy with the region and the world’s average life expectancy, there has been a marginal improvement in health status as manifested



**Fig. 1** Trend in life expectancy (1980–2017). Source: computed from World Bank Development Indicators, 2018. The trend in life expectancy based on 10-year average point interval

by the indicator. In 1980, life expectancy was 42.9 years in Nigeria at the time when sub-Saharan Africa and the world total was 46.3 and 60.7 years, respectively. However, by 1990, Nigeria had a better percentage increase of 6.8% in life expectancy compared with sub-Saharan Africa (6.3%) and the world total (5.5%). The marginal improvement in health is, however, not enough to alleviate the level of poverty in Nigeria as poverty continue to rise (see Fig. 2); hence, the need to improve health more than the current level. In absolute terms, life expectancy at the world total had been consistent and remained highest, followed by sub-Saharan Africa and Nigeria as revealed in Fig. 1.

The level of health could impact on the level of poverty. Improvement in health could suggest longevity, better employment and an increase in saving due to growth in output per head, impact on people’s well-being and better economic performance (Weil 2007). As exemplified below, Fig. 2 shows the trend in poverty incidence using \$1.90 per person poverty line based on 2011 Purchasing Power Parity. The poverty situation in Nigeria has been degenerating, as demonstrated by the pattern. Available official record as at 1980 put the poverty figure at 46.18% (73 million



**Fig. 2** Poverty trend in Nigeria (1980–2017). Source: computed from World Bank Development Indicators, 2018. The trend in poverty indicators based on 5-year average point interval

people). By 2005, poverty incidence has increased to 92 million (55.81%). Recent estimates have put the figure above 120 million (64.61%) and classified Nigeria as the most impoverished country in the world where 4/10 persons enter and move out of poverty every minute (World Bank 2018). The recent poverty situation may not be unconnected with to the decline in human development indicators which have negative implications for macroeconomics indicators in Nigeria.

Figure 2 shows the trends in poverty indicators in Nigeria. As revealed, poverty head count rises while the squared poverty gap which measures the level of inequality exhibits an inverted U-shaped. The continuous rise in poverty health count and volatility may not be unconnected with the degenerating level of human capital development. As indicated by Sen, human capital development is a means to an end and not an end in itself. The end is development (poverty reduction). Reduction in poverty could mean that people have economic resources to engage in economic activities that will spur economic growth. Other causes include: inefficient use of common resources, weak policy environment, inadequate infrastructure, lack of access to technology and credit facilities. The inverted U-shaped square poverty gap for Nigeria suggests that as the level of income per head in a country rises, at the early stage of development, disparity in income distribution rises and, after reaching its peak at the intermediate level, the disparity in income falls. In otherword, as countries strive to develop, both per capita income and income inequality rise at the initial stage and will begin to decline on reaching the maximum level even as income per head rises further. In other words, disparity in income to some degree depends on the level of per capita national income.

Improvement in human capital development amongst other macroeconomic indicators could help drive down poverty and contribute to economic growth. The trend in economic growth in Nigeria is depicted below. Figure 3 show the average GDP per capita (Constant US\$) and average GDP growth (annual %) based on 10-year point interval. Comparatively, Nigeria’s GDP growth has been volatile within the period under review. By 1980, the economy based on GDP growth has a better outlook of 6.9% compared with sub-Saharan Africa and world total GDP growth of 4.2 and 4.3% respectively. By 1990, while the world total and Sub-Saharan Africa GDP growth remained positive at 3.0 and 1.4% respectively, Nigeria experienced a

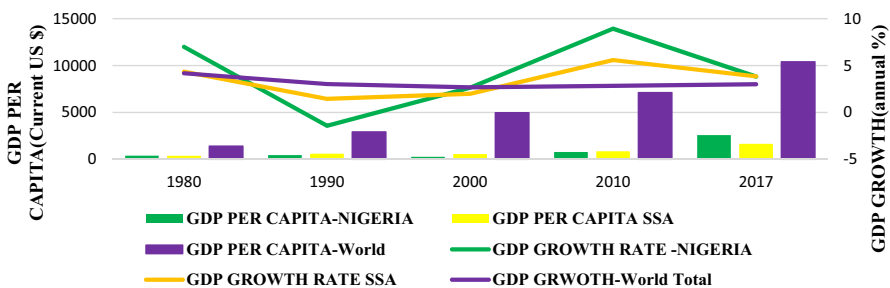


Fig. 3 Trend in GDP per capita and GDP growth rate 1980–2017. Source: computed from World Bank Development Indicators, 2018. The trend in GDP per capita and GDP growth rate based on 10-year point interval

gloomy economic outlook with a negative economic growth rate of  $-1.4\%$ . Since 1990, the economy has maintained a consistently positive outlook. Nigeria GDP growth rate went as high as  $8.9\%$  when the world total and sub-Saharan Africa growth rates were  $2.8$  and  $5.6\%$ , respectively, in 2010. However, the world total had remained relatively stable since 2010 till date, whereas Nigeria and sub-Saharan Africa growth rates have been on a decline.

Similarly, a comparative survey of GDP per capita revealed a consistent and upward increase. The world total has remained consistently high above Nigeria and sub-Saharan Africa. Compared with sub-Saharan Africa, Nigeria's per capita GDP is almost at par except in 2017 when Nigeria overtook sub-Saharan Africa.

Though Nigeria's per capita has been increasing, human development indicators have consistently remained low. Nigeria is classified among the low human development countries and ranked 157 based on 2018 ranking out of 189 countries as suggested by the human development index (United Nations 2018). Improvement in health (life expectancy) is a critical component of the human development index that could have implications for poverty reduction and economic growth in Nigeria.

### Channels through which health translates to poverty reduction and economic growth

The relationships between health improvement, poverty and economic growth are multi-dimensional. As exemplified in Fig. 4, an increase in health investment has a direct impact on economic growth. The main channel considered in this study is the flow through poverty reduction given the assertion that health is wealth. Health investment could indirectly impact economic growth by improving health outcomes such as life expectancy, under-5 mortality and maternal mortality, which improve the level of human capital development and poverty reduction (see Sen 1999).

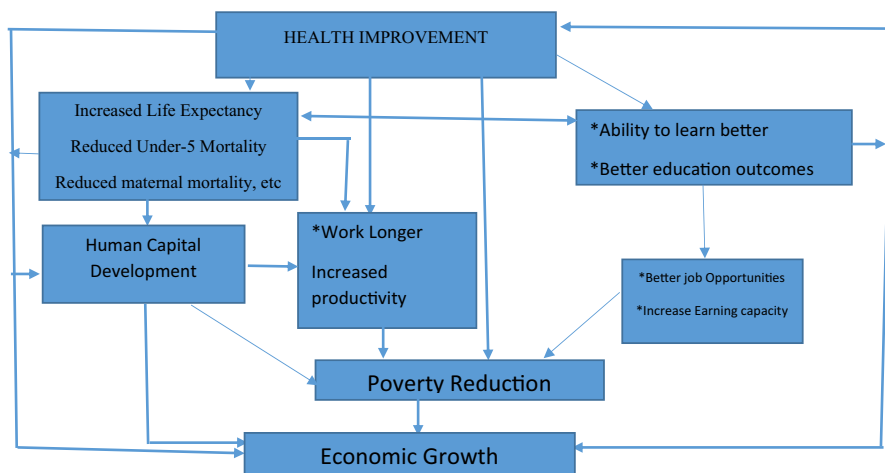


Fig. 4 Transmission channels health flows to poverty and economic growth. Source: Authors Construction, 2019

Moreover, improvement in health could lead to longevity, allows people to work for more extended hours, increase their earnings and assist in proper learning and rational thinking, helping to emancipate people from poverty. Health improvement is a measure of enhancing human capabilities and poverty reduction given that poverty is viewed in a broader spectrum to mean capabilities deprivation (Sen 1999; United Nations 1990). Health can be regarded as output or growth determining factor because it contributes to poverty alleviation by increasing workers' productivity which translates to the possibility of increased earning with positive multiplier consequence on well-being. The level of poverty determines to a greater extent on how productive the population of the country could be.

## Review of literature

### Life expectancy and economic growth

Theoretically, the controversy concerning the role of health as economic growth determinant remains unsettled because health expenditure could have two parallel effects (direct positive and indirect adverse effects). These positive effects are captured by the endogenous growth model postulation (Piabou and Tieguhong 2017). From this, two growth models can be identified: firstly, those who adore health as an integral part of human capital and a catalyst in the production function and, secondly, those that opined that health is a direct determinant of economic growth. One thing that is fundamental to these models is that increase in productivity is a positive function of improvement in health. As long as health (life expectancy) improves, productivity will increase, and this will encourage people to invest in human capital development and expand their pool of knowledge (Ngangue and Manfred 2015). In the theoretical model developed by Buchanan (1965), the motivation to investment in health is its contribution to people's well-being and economic growth. Besides, efforts have been made to model and highlight the role of human capital in economic growth. Romer (1986) and Barro (1991) emphasized the place of human capital as a propelling force in economic growth. The augmented Solow model was emphatic about the importance of human capital in boosting economic growth. In sum, the endogenous growth model is of the assertion that inequalities in economic growth across countries are a function of inequalities in human capital development. In the endogenous paradigm, it is human capital that is responsible for economic development.

On the other hand, the neoclassical and Keynesian economic theories capture the indirect and adverse effects of public expenditure on economic growth. Accordingly, a significant amount of public fund is required for investment in health. To raise this amount, the government increases taxes, which could impact negatively on people well-being and slow down the level of economic activities. From the Keynesian perspective, an increase in saving due to an increase in life expectancy results in contraction of economic activities due to the reduction in aggregate demand. In the neoclassical growth paradigm, economic growth depends on saving and population. Solow (1956) postulated that per capita income growth would increase in countries

where the saving rate and the population are higher. The theory concludes that the difference in economic growth performance across different countries is a function of the amount of saving and population. From the theoretical viewpoints, there are divergent views as to the determinants of economic growth. However, the role of human capital cannot be undermined.

Empirically, several existing studies both in developed and developing countries have examined the implications of health and life expectancy on the economy. However, the results that emanated from these researches were mixed and inconclusive. While some studies firmly alluded to the positive nexus between life expectancy and economic growth, others revealed the relationship between them as inverse whereas others demonstrated their relationship to be ambiguous.

In an econometric panel study of 84 countries, Barro (2013) pointed out that an improvement in life expectancy could propel GDP growth positively from 0.52 to 0.62%, hence encourages investment in health. More so, Kunze (2014) found that life improvement in life expectancy is a portent factor in economic growth. Similarly, Aghion et al. (2012) was able to establish a positive and significant linkage between life expectancy and growth in OECD countries by proposing a unified framework which incorporates the growth impact of health improvement and the level of health between 1960 and 2000. Based on the findings of the study, a conclusion was drawn that life expectancy contributes significantly to income per head. Examining the impact of life expectancy and economic growth involving a panel of 141 developing countries between 2000 and 2013 by employing the generalized method of movement (GMM) estimator, Ngangue and Manfred (2015) revealed that life expectancy impacts economic growth positively, though the result was conflicting when the countries were classified into different income growth. The outcome was positive but insignificant in middle-income countries.

In another study of OECD countries, Ecevit (2013) examined how economic growth responds to improvement in life expectancy by using a panel of data between 1970 and 2010. The study employed panel OLS and fully modified ordinary least square method (FMOLS) to investigate the nature of the relationship between economic growth and life expectancy. The results that stemmed from the investigation were enthralling and upheld a positive and significant relationship between life expectancy and economic growth. Additionally, Orisanwa (2015) investigated the relationship between health expenditure and economic growth in Nigeria covering 1995–2009, in which cointegration and Granger causality tests were deployed in the analysis. Emanated outcomes of the study showed that health expenditure produces health indicators such as life expectancy, which had a positive long-run impact on economic growth in Nigeria. In other words, the finding from the study shows that life expectancy Granger cause economic growth.

Another body of literature, however, found contrary outcomes on the impact of life expectancy on economic growth. For example, Ogunleye et al. (2017) investigated the role of human capital development in economic growth in Nigeria between 1981 and 2015. The study made use of ordinary least square method, and the emanated results showed that life expectancy had an inverse relationship with economic growth in Nigeria. Correspondingly, Acemoglu and Johnson (2007) examined the effect of life expectancy on economic growth by exploiting key international health



enhancement indicators from the 1940s. Constructing a predicted mortality rate by using pre-intervention death from different diseases and the date the intervention was initiated globally, the study revealed that a 1% improvement in life expectancy leads to 1.7–2% increase in population, but found no evidence of growth in per capita income arising from a substantial increase in life expectancy. Implying that life expectancy contributes to population growth rather than improvement in economic growth.

Similarly, Browser (2010) examined the effect of life expectancy on economic growth in the USA between 1970 and 2000 by employing two-stage regression methods in the analysis. The results that originated from the study were ambiguous. When a difference in ordinary least square method was used at the state level, all six models in the survey showed an inverse relationship between life expectancy and economic growth. However, extending the method of analysis to ordinary least squares regressions of log difference in difference, both positive and negative outcomes were obtained. More so, the results of the two-stage least squares were ambiguous all through the models. From the above existing studies, it can be inferred that the debate on the relationship between health and economic growth is mixed and inconclusive, hence the need to identify the actual effects of health on economic growth and the channel through which health flows to poverty.

### **Life expectancy and poverty incidence**

Empirical studies on the impact of life expectancy and poverty exist both in advanced and developing countries. Some studies found health and life expectancy to be of great benefit to poverty reduction with positive multiplier impact on economic performance. For instance, Bloom and Canning (2000) in a study of 31 countries discovered that a 10% increase in life expectancy would reduce income inequality for 25 years and improve economic growth performance.

Examining the implication of health improvement on economic growth and poverty reduction, WHO (2002) revealed that increase in health spending could imply positive health indicators such as life expectancy, under-5 mortality which could contribute to saving and investment, improvement in well-being and poverty reduction and by implication contribute to economic growth positively. Again, Riman and Akpan (2010) studied the direct causality between health expenditure and poverty incidence in Nigeria by employing the Granger causality test and vector error correction model (VECM) method of analysis. The study found strong causal bi-directional connections between life expectancy and poverty in Nigeria. The study drew an inference based on the finding that improvement in life expectancy could lead to poverty reduction and stimulate economic growth in Nigeria. More so, poverty reduction could lead to an improvement in life expectancy and improve output per head and general performance of the economy.

Atake (2018) investigated the impact of health shocks in three sub-Saharan African countries (Burkina Faso, Niger and Togo) on poverty. The study made use of house surveys and adopted a three-step generalized feasible least square methods of analysis and findings that emanated from the study showed that health shocks

resulted in poor health indicators and aggravated poverty incidence by 9.04, 33.69 and 69.03% in Burkina Faso, Niger and Togo, respectively. The study based on outcome concluded that poverty arising from health shocks is the cause of economic or growth loss in sub-Saharan Africa. Interestingly, the above reviewed study still points to the fact that the debate on life expectancy–poverty nexus is inconclusive. Therefore, it is imperative to determine the actual impact of health improvement on poverty incidence and as well determine whether or not the interaction of health with poverty helps to mitigate the adverse effects of poverty on economic growth.

## Theoretical framework and methodology

Arrays of growth theories have stressed that output is a function of input factors such as labour and capital and saving rate, but few have anchored economic growth on the wheel of human capital. From the neoclassical growth pavilion, health or life expectancy will have restricted impact on economic growth because of the limiting assumption of diminishing return. Hence, economic growth will be disadvantaged if human capital increases. However, respite came in a quest to determine the factors that propelled economic growth with the discovery of endogenous theory, as it laid to rest the limiting assumption (diminishing return) of the neoclassical growth theory. The endogenous theory, therefore, opens the lid that life expectancy can be a vital force in propelling economic growth in the long run. The impact of life expectancy on the economy has been well documented in the literature.

In this milieu, the endogenous growth model by Lucas (1998) and popularized in empirical works (Acemoglu and Johnson 2007; Maddsen 2012) will be used as the anchor to introduce health as a potent driver of economic growth. Human capital according to Lucas (1998) is a direct factor in production like labour and capital. Health investment according to this theory is a fundamental factor in human capital development. Human capital is assumed to have a direct positive internal impact and indirect positive spillover effects on economic growth. Besides the fact that human capital is key among other factors of economic growth, the place of poverty reduction in creating the climate for human capital to have easy access to economic growth is sacrosanct. The impact of poverty reduction on economic growth has earlier been expounded in literature. Poverty according to Sen (1999) is capability deprivation. Health according to the United Nations (1990) is a form of basic human capability. Therefore, improvement in health or life expectancy helps to reduce the level of human deprivation and contribute to economic growth.

## Methodology

The growth–life and expectancy–poverty relationships will be analysed by using fully modified ordinary least square (FMOLS). This method is adopted for this study because it addresses possible problem of endogeneity, a common problem with time-series data unlike the ordinary least square (OLS) method which does solve the problem of endogeneity. Besides, variables in time series data are often correlated,

hence the need for a method that addresses this problem. Fully modified ordinary least square helps to solve this problem. It also solves the problem of biasness usually associated with ordinary least square method of analysis.

## The model

Traditionally, to determine the level of output growth in the economy, the growth accounting equation in line with the endogenous growth model by Lucas (1998) and empirical works of Omran and Bolbol (2003), Hermes and Lensink (2003), Acemoglu and Johnson (2007) and Maddsen (2012) could be stated as

$$PCGDP = \theta + a_1M + a_2N + a_3T + e, \quad (1)$$

where  $M$  is a vector of variables that usually explains growth (such as initial per capital income, gross capital formation and labour force) and  $N$  is the vector of variable under consideration and may affect economic growth, whereas  $T$  is the vector of control variable such as health expenditure, education expenditure and expected years of schooling and  $e$  is the error term (see Omran and Bolbol 2003). Therefore, to verify the impact of health on economic growth in line with the first objective of this study, Eq. (1) can be expanded as:

$$PCGDP = \theta + a_1 \text{LEXP} + a_2 \text{HEXP} + a_3 \text{EDEXP} + a_4 \text{EYS} \\ + a_5 \text{CAP} + a_6 \text{LF} + \mu, \quad (2)$$

where PCGDP is per capita GDP (constant of US\$). It serves as a measure of economic performance in a country, LEXP is the life expectancy at birth, HEXP is the health expenditure as a percentage of GDP, EDEXP is the education expenditure as a percentage of GDP, EYS is the expected years of schooling as a proxy for educational attainment, CAP is the gross capital formation as a proxy for capital, LF is the labour force as a proxy for total labour for age 15 years and above,  $\theta$  represents the constant, and  $\mu$  is the disturbance term. The parameters  $a_1, a_2, a_3, a_4, a_5, a_6, a_7$  are the coefficients or elasticities, which measure changes in the dependent variable due to changes in the explanatory variables. Life expectancy is the variable of interest in this study. Labour and capital are variables which naturally impact on economic growth, whereas other variables serve as the control variables. All the variables will be transformed into their logs to make for their easy interpretation as elasticities.

More so, the study seeks to examine the effect of health on poverty in Nigeria as captured in objective two of this study. This is captured in Eq. (3) as:

$$POV = \theta + a_1 \text{LEXP} + a_2 \text{EYS} + a_3 \text{EDEXP} \\ + a_4 \text{INT} + a_5 \text{POL} + a_6 \text{REGU} + a_7 \text{DEBT} + \mu, \quad (3)$$

where POV is the poverty measure as earlier defined, LEXP is the life expectancy, EYS is the expected years of school, EDEXP is the education expenditure, INT is the log of real interest rate, POL is the political instability and terrorism, REGU is the institutional quality measured by control of regulation and DEBT is the debt stock.

To examine the mitigating effect of health improvement on the adverse impact of poverty on economic growth in Nigeria, we expand Eq. (2) by incorporating the interaction of health (life expectancy) with poverty incidence in line with objective three of this study. Thus, our Eq. (4) becomes:

$$\begin{aligned} \ln \text{PCGDP} = & \theta + a_1 \ln \text{LEXP} + a_2 \ln \text{HEXP} + a_3 \ln \text{EYS} + a_4 \text{POV} \\ & + a_5 \ln \text{LEXP.POV} + a_6 \ln \text{EDEXP} + a_8 \ln \text{CAP} + a_9 \ln \text{L.F} + \mu. \end{aligned} \quad (4)$$

Equation (4) captures the impact of the interaction variable LEXP.POV. This seeks to analyse whether or not health improvement helps to mitigate the adverse effect of poverty on economic growth: that is, the role of poverty reduction through health in the health–economic growth nexus.

Having established the interactive effect of health and poverty on economic growth, it is imperative to determine the level of health improvement required to check the adverse effect of poverty on economic growth in line with the objective four of this study. Consequently, following Omran and Bolbol (2003), the threshold of life expectancy required to curb the adverse effect of poverty on economic growth in Nigeria can be determined by differentiating Eq. (4) and setting the resulting equation equal to zero:

$$\frac{\partial \text{PCGDP}}{\partial \text{POV}} = a_4 + a_5 \text{LEXP} = \frac{-a_4}{a_5} = \text{LEXP}. \quad (5)$$

Equation (5) will be used to determine the threshold of life expectancy in this study.

## Data, source and a priori expectation

This empirical research makes use of time series data from 1980 to 2018 to investigate the impact of life expectancy on economic growth, and the role of poverty reduction plays in their relationship. Data from World Bank Development Indicators (2018), National Bureau of Statistics (NBS) were used. The World Development Indicators are used since not all the data used for this study are readily available at the country level; however, it is the most dependable source of data.

The empirical work of Mandiefe and Tieguhong (2015), Ogunleye et al. (2017) that considered GDP per capita as a measure of economic growth serves as the motivation for the choice of this variable. It is the dependent variable in the model that expresses the relationship between economic growth, life expectancy and the interaction variable. Life expectancy is the leading independent variable of interest. It is the number of years a child born in Nigeria today is expected to live if all the conditions remain unchanged. Life expectancy is likely to contribute to economic growth positively and exhibit a negative correlation with poverty incidence. Health expenditure as a percentage of GDP is used as the health input variable. Besides, expected years of schooling is used as an educational outcome which is likely to impact on economic growth positive in line with

Ogunleye et al. (2015). Other variables: gross fixed capital formation is used as a proxy for capital, a variable which naturally should contribute positively to economic growth.

The labour force is used as a proxy for the total labour force. The total labour force is expected to have a positive relationship with economic growth. Another important variable is poverty incidence, which is defined as capability deprivation or inability to meet the necessity. Three measures of poverty will be used. The first is the poverty headcount ratio which measures the percentage of the population said to be poor based on \$1.90 using 2011 prices. The second poverty measure is the poverty gap which measures the intensity of poverty instead of taking an absolute figure as in the poverty headcount ratio. The third variable is the squared poverty gap which measures the severity of poverty. It estimates how poor is the poor below the poverty line. Poverty is expected to impact on economic growth negatively. These are conventional measures of poverty used by the World Bank and are easy to understand. The use of these three measures is important for government depending on the policy direction on poverty reduction.

In the third model involving poverty and life expectancy, poverty measures become the dependent variables. This model tends to analyse how poverty responds to changes in life expectancy. An inverse relationship is expected between life expectancy and poverty incidence (see Atake 2018). Poverty and life expectancy have already been defined earlier. Other variables include expected years of school as a measure of educational attainment. Again, an inverse relationship is assumed between poverty and educational attainment. Educational attainment is proxied by expected years of school (the number of years an entrance child is likely to spend in school throughout his life cycle if the condition at the time of entrance remains the same).

Other variables that naturally should impact on the level of poverty are access to finance represented by the interest rate. This is defined as the real interest rate and expected to have a directly proportional relationship with poverty. Increase in interest rate implies low access to finance and worsening poverty situation. Regulatory quality is another variable believed to impact on the level of poverty. Regulatory quality is the perception of the ability of the government to make sound policies that will lead to private sector development. This is expected to contribute to poverty reduction positively. The stock of debt is another variable which is considered important in the model. A proportional relationship is expected between debt stock and poverty reduction. The final variable in this model is Political Stability and Absence of Violence/Terrorism. This measures the possibility of political instability or the possibility of politically motivated violence. Model (7) is extended to capture the interaction variable. This is depicted in the model (9). The interaction variable captures the potential effect, the interaction between life expectancy and economic growth. A positive relationship is expected between the interaction variable and economic growth.

## Presentation of empirical results and discussions

We first present the descriptive statistics of some of the key variables of interest in this study in Table 1. The mean value of per capita income is \$937.88. The maximum value is \$3221.68, whereas the minimum value is \$153.65. Similarly, the

**Table 1** Descriptive statistics. Source: authors' computation, 2019, based on data from World Bank Development Indicators (WDI)

	LAB	LEXP	PCGDP	CAP	EYS	EDUEXP	HEXP	HEAD-COUNT
Mean	37,744,710	47.86545	937.8845	8.84E+08	8.260526	7.072368	6.328423	72,866,824
Median	36,573,819	46.11450	452.8003	2.99E+08	7.950000	7.065000	6.089088	73,103,899
Maximum	58,958,901	54.53200	3221.678	3.05E+09	10.00000	17.59000	9.193356	1.20E+08
Minimum	20,867,112	45.33100	153.6467	1.09E+08	6.700000	1.090000	3.727967	33,930,105
Std. Dev.	10,955,725	2.718901	923.9014	1.00E+09	1.129109	3.686930	1.350701	23,636,004
Skewness	0.274856	1.052220	1.252036	1.107679	0.305151	0.418005	0.141106	0.383323
Kurtosis	1.987932	2.662430	3.123212	2.530492	1.631213	3.071513	2.472470	2.548115
Jarque–Bera	2.100237	7.192490	9.952132	8.119730	3.556238	1.114711	0.566726	1.253914
Probability	0.349896	0.027427	0.006901	0.017251	0.168956	0.572722	0.753246	0.534215
Sum	1.43E+09	1818.887	35,639.61	3.36E+10	313.9000	268.7500	240.4801	2.77E+09
Sum Sq. Dev.	4.44E+15	273.5196	31,582,968	3.71E+19	47.17079	502.9579	67.50252	2.07E+16
Observations	38	38	38	38	38	38	38	38

average value of life expectancy is 47.86 years. The maximum and minimum values are 54.53 and 45.33 years, respectively, whereas the deviation from the mean stands at 2.7 years. In respect to poverty, the number of the poor on the average over the period reviewed is about 73 million with a minimum value of 33 million. The maximum value of poverty is about 120 million, whereas the volatility as measured by measures of dispersion is 24 million. This shows the escalating poverty incidence in Nigeria.

More so, other statistics can be observed from the table aside from the first-moment statistics. As can be seen, the kurtosis statistics which mirrors whether the variables are normally distributed shows that except for per capita GDP and education expenditure that has kurtosis value of 3, all other variables mirror a normal distribution as they have kurtosis values of less than 3. Variables with the kurtosis value of 3 show that these are Mesocratic. One obvious feature of time series data is that they are not usually stationary, hence using them in the analysis might produce results that are not dependable for the forecast.

To solve this problem, we conduct the unit root test to determine the point of stationarity of the data. This helps to detect the change in value in absolute terms and any potential cyclical change. We detrended the data until we arrived at stationary level. All the data were transposed into their log form before conducting the test.

### Unit root test

The results of the Augmented Dickey–Fuller (ADF) test to test for unit root for all the variables in the two models are presented in Table 2. The outcomes show

**Table 2** Unit root results. Source: authors' computation based on data from World Bank Development Indicators (WDI) 2019

Variables	Augmented Dickey–Fuller test	Levin, Lin and Chu t (1999)	PP—Fisher Chi-square (1932)	Stationary
PCGDP	− 5.318315	− 2.945842	− 2.611531	I(1)
CAP	− 2.673294	− 2.948404	− 2.612874	I(1)
LAB	− 3.127814	− 2.945842	− 2.611531	I(1)
LEX	− 2.908752	− 2.948404	− 2.612874	I(1)
HEXP	− 8.787281	− 2.945842	− 2.611531	I(1)
EYS	− 5.811144	− 2.945842	− 2.611531	I(1)
EDEXP	− 8.970298	− 2.945842	− 2.611531	I(1)
PHC	− 5.701651	− 2.945842	− 2.611531	I(1)
PGAP	− 5.789587	− 2.945842	− 2.611531	I(1)
SPGAP	− 5.8104	− 2.945842	− 2.611531	I(1)
REGU	− 7.176363	− 2.945842	− 2.611531	I(1)
POL	− 5.818264	− 2.945842	− 2.611531	I(1)
INT	− 7.246196	− 2.948404	− 2.612874	I(1)
DEBT	− 6.232245	− 2.945842	− 2.611531	I(1)

Keys: *PCGDP* per capita gross domestic product, *CAP* capital formation, *LAB* labour force, *LEX* life expectancy, *HEXP* health expenditure, *EYS* expected years of schooling, *EDEXP* education expenditure, *PHC* poverty headcount, *PGAP* poverty gap, *SPGAP* squared poverty gap, *LEX*, *REGU* Government regulations, *POL* political instability, *INT* interest rate, *DEBT* debt servicing

that all the variables are at stationarity at first difference. We, therefore, reject the hypothesis of no unit root at 5% level of significance.

Since the data attained stationarity at the first difference, it means the variables can be studied to make predictions beyond the period under consideration. It is, therefore, pertinent to investigate whether there exist long relationships among the variables. This will be achieved by conducting the unrestricted cointegration rank test (trace) and unrestricted cointegration rank test (maximum eigenvalue). Since they are two main models to be analysed, two cointegration results will be presented for each of the models.

The cointegration results of the variables involved in model 2 and 3 are shown in Table 3. The emanated outcomes show that there are five cointegrating equations based on the rank test (trace) statistics and four cointegrating equations from the rank test (maximum eigenvalue) at 5% level of significance for the model depicting the relationship between per capita GDP and life expectancy. Also, it can be seen from the table that they are four cointegrating equations based on the rank test (trace) statistics and four cointegrating equations from the rank test (maximum eigenvalue) at 5% level of for the model depicting the relationship between poverty and life expectancy.

We, therefore, reject the null hypothesis of no cointegration at 5% level of significance and accept the alternate hypothesis that there exists a long-run relationship between the dependent and independent variables. The study, therefore,

**Table 3** Cointegration results for the relationship between PCGDP and life expectancy. Source: authors' computation, 20

Unrestricted cointegration rank test (trace)				Unrestricted cointegration rank test (maximum eigenvalue)							
Hypothesized no. of CE(s)	Eigenvalue	Trace statistics	0.05 Critical value	Prob.**	Hypothesized no. of CE(s)	Eigenvalue	Maxi-eigen statistics	0.05 Critical value	Prob.**		
None*	0.962300	473.0393	219.4016	0.0000	None *	0.962300	118.0118	61.03407	0.0000		
At most 1*	0.950882	355.0275	179.5098	0.0000	At most 1 *	0.950882	108.4871	54.96577	0.0000		
At most 2*	0.867298	246.5404	143.6691	0.0000	At most 2 *	0.867298	72.70731	48.87720	0.0000		
At most 3*	0.759495	173.8331	111.7805	0.0000	At most 3 *	0.759495	51.30049	42.77219	0.0046		
At most 4*	0.676409	122.5326	83.93712	0.0000	At most 4	0.76409	40.61789	36.63019	0.0162		
At most 5	0.076449	14.91469	18.06141	0.0663	At most 5	0.496449	24.92692	26.43961	0.0634		
At most 6	0.081137	16.98777	24.17493	0.0729	At most 6	0.481137	23.62012	24.15921	0.0590		
At most 7	0.051543	7.36765	8.27596	0.0498	At most 7	0.351543	15.59374	17.79730	0.1041		
At most 8	0.240577	11.77391	12.32090	0.0616	At most 8	0.240577	9.907057	11.22480	0.0845		
At most 9	0.050535	1.866851	4.129906	0.2022	At most 9	0.050535	1.866851	4.129906	0.2022		
Trace test indicates 5 cointegrating eqn(s) at the 0.05 level. * Denotes rejection of the hypothesis at the 0.05 level. **MacKinnon–Haug–Michelis (1999) <i>p</i> values											
Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level. * Denotes rejection of the hypothesis at the 0.05 level. **MacKinnon–Haug–Michelis (1999) <i>p</i> values											
Cointegration results for the relationship between poverty incidence and life expectancy				Unrestricted cointegration rank test (trace)				Unrestricted cointegration rank test (maximum eigenvalue)			
Hypothesized no. of CE(s)	Eigenvalue	Trace statistics	0.05 Critical value	Prob.**	Hypothesized no. of CE(s)	Eigenvalue	Maxi-eigen statistics	0.05 Critical value	Prob.**		
None*	0.991623	446.6882	197.3709	0.0000	None*	0.991623	172.1625	58.43354	0.0000		
At most 1*	0.927663	274.5257	159.5297	0.0000	At most 1*	0.927663	94.55094	52.36261	0.0000		
At most 2*	0.781301	179.9747	125.6154	0.0000	At most 2*	0.781301	54.72213	46.23142	0.0050		
At most 3*	0.759411	125.2526	95.75366	0.0001	At most 3	0.659411	37.28795	35.07757	0.0219		
At most 4	0.440832	48.96466	50.81889	0.0225	At most 4	0.520832	26.48537	33.87687	0.2919		
At most 5	0.436959	47.47928	47.85613	0.0542	At most 5	0.436959	20.67849	27.58434	0.2961		



**Table 3** (continued)

Cointegration results for the relationship between poverty incidence and life expectancy									
Unrestricted cointegration rank test (trace)					Unrestricted cointegration rank test (maximum eigenvalue)				
Hypothesized no. of CE(s)	Eigenvalue	Trace statistics	0.05 Critical value	Prob.**	Hypothesized no. of CE(s)	Eigenvalue	Maxi-eigen statistics	0.05 Critical value	Prob.**
At most 6	0.347222	26.80079	29.79707	0.1066	At most 6	0.347222	15.35463	21.13162	0.2648
At most 7	0.270977	11.44616	15.49471	0.1855	At most 7	0.270977	11.37779	14.26460	0.1363
At most 8	0.001898	0.068376	3.841466	0.7937	At most 8	0.001898	0.068376	3.841466	0.7937

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level. \* Denotes rejection of the hypothesis at the 0.05 level. \*\*MacKinnon–Haug–Michelis (1999) *p* values

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level. \* Denotes rejection of the hypothesis at the 0.05 level. \*\*MacKinnon–Haug–Michelis (1999) *p* values

proceeds to determine the nature of long-run relationship using fully modified ordinary least square (FMOLS).

### Fully modified ordinary least square of per capita GDP (PCGDP) equation

The results of the long-run relationship between economic growth, life expectancy and other intervening variables are presented in Table 4.

As revealed, all the variables in the model except capital formation, education expenditure and health expenditure significantly impact economic growth in the long run. Besides, all the variables conformed to their theoretical expectations as revealed by the signs of their coefficients. With respect to our key variable, a positive and significant relationship between life expectancy and economic growth was reviewed in this study. This implies that any economic policy that will lead to an increase in life expectancy in Nigeria will contribute to economic growth by 14%. Though health expenditure influences economic growth positively, the effect is weak at 2.8%. This means that an increase in health expenditure may not necessarily translate directly to economic growth. The result is consistent with findings of Oni (2014) that health expenditure could contribute to economic growth. Moreover, education expenditure and expected years of schooling were found to be beneficial to economic growth; however, the expected years of schooling have greater impact and are statistically significant, unlike education expenditure. Any policy that will increase education expenditure and expected years of schooling has the potential of contributing to economic growth by 2.7 and 8.5%, respectively.

Furthermore, the level of capital has a positive but insignificant impact on economic growth. This means that having capital is not a guarantee for economic growth, but the capital does. This outcome confirms the position of Onyenye et al. (2017), which found no significant impact of capital formation on economic growth

**Table 4** FMOLS of per capita GDP (PCGDP) equation. Source: authors' computation, 2018

Variable	Coefficient	Std. error	t Statistic	Prob.
C	37.67048	3.63547	10.36193*	0.0000
LCAP	0.016637	0.01263	1.3173	0.3127
LEDEXP	0.027089	0.04106	0.6597	0.2905
LEYS	0.085130	0.02351	3.620531*	0.0011
LHEXP	0.028110	0.23521	0.1195	0.4361
LLEXP	0.140123	0.04203	- 3.33416*	0.0001
LLAB	0.07034	0.0296	2.37414*	0.0021
R-squared	0.947156	Mean dependent var		6.432859
Adjusted R-squared	0.936928	SD dependent var		0.918467
SE of regression	0.230665	Sum squared resid		1.649695

Keys: *PCGDP* per capita gross domestic product, *LCAP* log capital formation, *LEDEXP* log education expenditure, *Log EYS* expected years of schooling, *LHEXP* log health expenditure, *LEXP* log life expectancy, *LAB* labour force

\* Denotes significance at 5%. \* Denotes insignificance at 5%

in Nigeria. Also, the labour force plays a significant and positive impact on economic growth. Any policy that will increase labour productivity will increase economic growth by at least 7% in Nigeria.

### FMOLS of poverty incidence (poverty measures) equation

We then examine the impact of life expectancy on poverty. Three poverty indicators (poverty headcount, poverty gap and squared poverty gap) were used as independent variables, respectively, and their results are presented in Table 5.

The results of the impact of life expectancy and other conditioning variables on poverty in Nigeria as presented in Table 5 A, B and C show that first life expectancy has a negative and significant relationship with poverty irrespective of the poverty indicators used. Any economic policy aimed at increasing life expectancy will take 16 people out of every 100 from poverty. Similarly, it will reduce the depth of poverty by 14% and reduce the level of inequality by 12%. This is consistent with existing outcomes of studies (Riman and Akpan 2010; World Bank 2017; Atake 2018) on the inverse relationship between poverty reduction and life expectancy. Also, increase in health expenditure has an inverse relationship with an insignificant relationship with poverty incidence in this study. This implies that an increase in health expenditure may not directly translate to poverty reduction but through other mechanisms. It can also be seen that variables which naturally impact on the level of poverty are consistent in their character. An increased educational attainment (EYS) contributes to a reduction in poverty headcount, poverty gap and poverty squared gap by 12, 7 and 9% ,respectively, and are statistically significant. In other words,

**Table 5** FMOLS of poverty indicators as dependent variables. Source: authors' computation, 2019

Variable	PHC	PGAP	SPGAP
	Panel A	Panel B	Panel C
<i>C</i>	2.4238 (0.0079)*	1.02951 (0.0142)*	1.34082 (0.01825)*
LHEXP	- 0.02526 (0.1481)	.0192 (0.1627)	- 0.0233 (0.1636)
LLEXP	- 0.1672 (0.0006)*	- 0.1401 (0.0011)*	- 0.1223 (0.0026)*
LDEBT	0.03013 (0.2305)	0.01720 (0.3431)	0.02023 (0.4417)
LEYS	- 0.1234 (0.0003)*	- 0.07013 (0.0019)*	- 0.06521 (0.0023)*
LINT	0.02726 (0.3010)	0.01017 (0.5621)	0.02412 (0.6681)
LPOL	0.02213 (0.2346)	0.01912 (0.4165)	0.0162 (0.6375)
REGU	- 0.02425 (0.5401)	- 0.0137 (0.6515)	- 0.0210 (0.7769)
<i>R</i> -squared	0.92781	0.92311	0.91267
Adjusted <i>R</i> -squared	0.90812	0.91341	0.89256
SE of regression	0.08236	0.081892	0.72012

Keys: *LHEXP* log health expenditure, *LDEBT* log stock of debt, *LEYS* log expected years of schooling, *LINT* log interest rate, *LPOL* log political instability, *LREGU* log government regulation, *LEXP* log life expectancy

\* Denotes significance at 5%

there is a significant negative relation between educational attainment and poverty incidence. Again, the impact of variables like debt stock (BEDT), real interest rate (INT), political instability, violence/terrorism (POL) and regulation (REGU) all contribute to increase in poverty as symbolized by signs of their coefficient; however, they are not the real cause of poverty given that they are statistically insignificant. For example, an increase in real interest rate (an indicator of access to finance) contributes by worsening poverty incidence. It has the potential to worsens poverty headcount ratio, poverty gap and squared poverty gap by 2, 1 and 2% respectively. In the same vein, the stock of debt increases the absolute, depth and magnitude of poverty by 3, 1 and 2%, respectively. Among these variable, political instability, violence/terrorism has the potential of escalating poverty incidence in Nigeria by 2% (poverty headcount), 1% (poverty gap) and 1% (square poverty gap). Regulatory control has the potential to contribute to poverty reduction as shown by the inverse signs. It has the potential to reduce poverty headcount by 2%, poverty depth by 1 and 2% of poverty severity.

### The interactive effect of life expectancy and poverty on economic growth

The impact of life expectancy on economic growth was extended to capture the role poverty reduction plays in their nexus and the results are presented in Table 6.

**Table 6** FMOLS estimates of per capita GDP (PCGDP) equation and interaction variables. Source: authors' computation, 2019

Variable	Coefficient	Std. error	<i>t</i> Statistic	Prob.
C	7.4312	1.6115	4.6113*	0.0000
LCAP	0.0254	0.0497	0.5110	0.7101
LEDEXP	0.0289	0.08052	0.3589	0.4482
LEYS	0.1009	0.04032	2.5023*	0.0021
LHEXP	0.0291	0.08119	0.3584	0.1378
PHC	- 0.2142	0.0704	3.0426*	0.0002
LLAB	0.0270	0.04819	0.5602	0.1783
LLEXP*PHC	0.1184	0.05305	2.2316*	0.0098
PGAP	- 0.1254	0.0574–2.1842*		0.0058
SPGAP	- 0.0918	0.04659	- 1.9701*	0.0042
LLEXP	0.1502	0.05983	2.5101*	0.0000
R-squared	0.9623	Mean dependent var		6.2311
Adjusted R-squared	0.9420	SD dependent var		0.1029
SE of regression	0.28037	Sum squared resid		0.8570

Keys: *PCGDP* per capita gross domestic product, *CAP* capital formation, *LEDEXP* log education expenditure, *LEYS* log expected years of schooling, *LHEXP* log health expenditure, *LLEXP* log life expectancy, *PGAP* poverty gap, *PHC* poverty headcount, *SPGAP* squared poverty gap, *LLAB* log labour force

\* Denotes significant at 5%

Here, life expectancy interacts with the poverty measures (poverty headcount). The results of the analysis were quite interesting, as the interaction variable had a positive and significant impact on economic growth. More intriguing is that poverty indicator as earlier reported had retarding effects on economic growth. However, when this indicator interacted with life expectancy, the joint impact becomes positive. This implies that any policy that enhances health status has the potential of mitigating the adverse effect of poverty on economic growth. All the intervening variables had the same impact on economic growth as earlier reported.

### The threshold of life expectancy in Nigeria

Policies are usually driven by figures, hence the need determine the optimal level of health needed to mitigate the adverse effect of poverty on economic growth. Following Omran and Bolbol (2003), this study proceeds to determine the minimum threshold of life expectancy as earlier stated. Using poverty indicator (poverty headcount), our threshold can be calculated as:

$$-0.2142 + 0.1184LLEXP = 0,$$

$$LLEXP = -\frac{-0.2142}{-0.1184} = 1.8091,$$

$$LEXP = 64.43 \text{ years.}$$

The calculated threshold is more than the national average of 47.9 years. This implies that life expectancy in Nigeria should improve at least by 64 years to overcome the scourging effect of poverty on economic growth in Nigeria.

### Discussion and summary of findings

Having considered the effects of health on economic growth and the role of poverty reduction in their nexus, the results suggest health improvement through the lens of life expectancy positively and statistically impacts on economic growth, whereas poverty negatively and statistically impacts on economic growth in Nigeria. The possible interpretation is that health is fundamental to economic growth, especially in developing countries like Nigeria, because healthy people can live longer, work more, increase per capita output, earn more income and engage more in economic activities that will propel economic growth. The effect of health is better appreciated by the effect of a sick person on the economy. For a sick person in Nigeria, it takes an average of two or three members of the family to stay with him/her in the hospital, in which case the economic loss is not that of the sick person alone. but of the other family members staying and assisting the sick person in the hospital. The current coronavirus pandemic has brought to a halt and even reversed economic growth downward across the globe. It has contributed to rising cases poverty as the sick could not go to work. Besides, it has contributed to the escalating incidence on

unemployment, as workers were sacked and lost income, thereby aggravating poverty and retarding economic growth. Improvement in health could translate to better economic fortune through poverty reduction. The outcome of this study, however, contradicts the studies of Sharma (2018), Bloom et al. (2018), Sede and Ohemeng (2015) and Serag et al. (2019), which concluded that there is no positive impact of health on economic growth, whereas it supports other studies (see Arora 2001; Lawanson 2009; Dauda 2010; Browser 2010; Acemoglu and Johnson 2007; Barro 2013; Kunze 2014; Onisanwa 2014; Atake 2018; Mahumud et al. 2013; Piabou and Tieguhong 2017) which strongly support the positive impact of health on economic growth.

Given the impact of health expenditure on economics, it could be deduced that even though health expenditure increases, it could have a negligible impact on economic growth if it is not maximized effectively to produce improved health outcomes (John and Shirin 2015; Appiah 2017). Given the magnitude of corruption and mismanagement of public fund in Nigeria, it is not certain that increase in health expenditure will guarantee the improvement in human capital development that will propel economic growth unless the fund is judiciously maximized. This is consistent with the finding of Olayinka (2018) on the effect of corruption and mismanagement on human capital and economic development in Nigeria.

More so, the outcomes of this study found poverty level to be endemic to the level of economic growth. Though the impact of health on economic growth is positive, the magnitude of growth would have been greater if not for the adverse effect of poverty. The effect of poverty on economic growth confirms the position of Aigbokhan (2000) Mohammad et al. (2014), Dauda (2016a, b), Omoniyi (2018) and World Bank (2019) and the stark reality in Nigeria that poverty retards the level of economic growth.

A novel revelation from this study is that even though health contributes to the level of economic growth in Nigeria, the result of the interactive effect of health and poverty does not only prove to be stronger and positive on economic growth, but also suggests the ability of health improvement to arrest the adverse effect of poverty on economic growth. Hence, this provides the motivation for the increase in health investment in a country like Nigeria that is ranked the poorest country in the world currently (see Brookings Report 2018). The outcomes support the assertion that ‘health is wealth’ and that ill health is a dimension of poverty (Sen 1999; Bloom 2003). According to Sen (1999), human capital development is not an end in itself but a means to an end (poverty reduction). Therefore, if Nigeria government increases spending on health to address the problem of poverty, economic growth becomes eminent.

More so, this study did not only reveal that health improvement helps to mitigate the adverse effect of poverty on economic growth in Nigeria, but was also able to determine the minimum threshold of health needed to meet the development goal of poverty reduction in Nigeria. Policies are driven by figures and what they portend, hence the need for benchmark or threshold level of health need to mitigate the adverse effect of poverty on economic growth in Nigeria. This study, therefore, computed a threshold of life expectancy which should drive policies with respect to

health improvement. This is an advancement over previous empirical studies on the nexus between health and economic growth in Nigeria.

Achieving economic growth is not dependent on health improvement and poverty reduction alone, but other intervening variables as revealed in this study. For instance, education expenditure and expected years of schooling were found to be important determinants of economic growth and poverty reduction, but the impact is, however, stronger through expected years of school. The implication is that increased education expenditure may not necessarily translate to poverty reduction and economic growth, unless it produces better education outcomes. The outcome is a function of how well the expenditure is utilized. This is in tandem with the findings of Umar (2017). More so, other conditional variables like the quality of government regulations, political instability and terrorism were identifiable factors, which contributed to the level of poverty and could have positive multiplier effect on economic growth. This confirmed the findings of Olayinka (2018). Additionally, the study revealed that increase in debt stock may not be the main cause of poverty incidence in Nigeria as insinuated, given the insignificant effect on poverty incidence in Nigeria. If the debt or borrowing is used to finance development, it could translate to poverty reduction and economic growth. However, in theory, countries with high debt profile and high-interest rate might suffer macroeconomic distortions and slow growth (Olayinka 2018).

## Conclusion and policy recommendation

The emerging literature on health stipulates that life expectancy's positive effect on economic growth depends on macroeconomic conditions prevailing on an economy. Essentially, this condition is the level of poverty. This study provides support for this hypothesis in the context of Nigeria given the escalating poverty situation by examining life expectancy–economic growth nexus and the role of poverty reduction in their relationship. The study shows that, though both health and poverty could have independent impact on economic growth, health improvement helps to mitigate the adverse effect of poverty on economic growth in Nigeria. This implies that improving health to curb the escalating level of poverty will lead to better economic performance. This can be achieved at the threshold level of life expectancy of 64 years. The results suggest that government should initiate policies targeted at improving health to achieve the minimum threshold of life expectancy of 64.4 years above the current 47.8 years to curb the impact of poverty incidence on economic growth in Nigeria.

Also, issues of escalating debt profile and rising interest rate are worrisome. Apart from repayment of principal which form a chunk of the annual budget, a huge amount is committed to service these debts annually. This has a potential negative effect on poverty in Nigeria. As debt increases, resources that would have been used for development and address poverty crisis are used to service the debt. While debt in itself is not bad, the need for polices by the Nigerian government to ensure it is spent on projects that will improve well-being is imperative. More so, the increasing interest rate is making access to finance difficult for millions of Nigerians involved

in small- and medium-scale business with important bearing on employment generation, increase earning and poverty alleviation. Again, issues of political instability and violence/terrorism should urgently be curbed because they portend grave danger for poverty reduction, as revealed by this study, and to smoothen the path to the realization of sustainable development goals (SDGs). Finally, the government needs to make policies to strengthen the laws and regulations in this country to create investment climate confidence, because it has the potential to reduce poverty in Nigeria and usher greater economic fortune.

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