Macroeconomic Determinants of Life Expectancy in Nigeria: Long-Run and Short-Run Evidence from Cointegration and Vector Error Correction Analysis

[1]Ogu, Callistus,
callistusogu@imsu.edu.ng;

[2]Ugwuanyi, Stephen Chigozie,
chigozie.s.ugwuanyi@gmail.com

[1,2]Imo State University, Owerri, Imo State, Nigeria

https://doi.org/10.56201/ijssmr.vol.12no11.2026.pg270.290

Abstract
Life expectancy in Nigeria remains an important issue, despite intervals of economic growth and elevated public health spending. This study considers how real GDP per capita; literacy rate, labour force participation, and public health spending have influenced life expectancy in Nigeria from 1991 to 2025, using annual data. The Augmented Dickey-Fuller test shows that all variables are integrated of order one. The Johansen cointegration method identifies two cointegrating relationships, which supports the use of a Vector Error Correction Model (VECM). Over the long term, real GDP per capita, literacy rate, and labour force participation all significantly affect life expectancy, while public health spending does not. In the short term, only the first lag of real GDP per capita has a positive and significant effect on life expectancy, and the second lag of labour force participation has a significant negative effect. Diagnostic tests show no serial correlation or heteroskedasticity, which supports the reliability of the model, although the residuals are not normally distributed. By providing updated time-series evidence with a multivariate cointegration approach, this study clarifies the relative importance of key macroeconomic determinants on life expectancy and addresses a gap in the Nigerian literature, where previous research has often focused on single determinants or shorter time frames. The evidence suggests that steady income growth, improved education, and stronger labour market outcomes contribute more to higher life expectancy than simply increasing public health spending. The evidence suggests that policies should centre on inclusive economic growth, human capital development, productive employment, and effective use of public health resources to realise lasting improvements in population health and guide evidence-based policy in developing countries.
Keywords: *Life expectancy; Macroeconomic determinants; Real GDP per capita; Public health expenditure; Vector Error Correction Model (VECM); Nigeria.*

1 Introduction

Health serves both as an outcome and a driver of economic development. A healthy population increases productivity, labour force participation, and sustained economic growth, while economic prosperity enables improvements to healthcare delivery and general well-being.

Consequently, health outcomes are regarded as essential indicators of development, particularly in developing countries where poverty, inadequate health service systems, and educational disparities continue to be barriers to human welfare. Among various population health indicators, life expectancy at birth is widely recognised as a comprehensive measure, as it reflects mortality conditions across all age groups and captures the cumulative effects of socioeconomic, educational, and healthcare factors over time (Grossman, 1972; Preston, 1975). Nigeria functions as a significant context for analysing the determinants of health outcomes. Despite being Africa's most populous nation and one of its largest economies, Nigeria continues to exhibit relatively poor health indicators. According to the World Bank (2024), life expectancy at birth increased from approximately 37 years in 1960 to about 54 years in 2023. Although this improvement is notable, it remains well below the global average of over 73 years. The United Nations Development Programme (UNDP, 2024) similarly observes that Nigeria's human development performance continues to be constrained by poor health outcomes, even amid periods of economic growth. The relationship between income and health is a central focus in development economics. Grossman's (1972) Health Capital Theory conceptualises health as a form of human capital that increases productivity and earning potential. Preston (1975) demonstrated that higher national income is associated with longer life expectancy, as wealthier societies can provide superior nutrition, sanitation, healthcare services, and living conditions. Similarly, Pritchett and Summers (1996) found that income growth significantly improves population health, while Bloom, Canning, and Sevilla (2004) argued that improved health contributes to economic growth through increased labour productivity and human capital accumulation. Nigeria's real GDP per capita has experienced periods of both growth and decline. Although the oil boom of the 1970s brought about substantial increases in national income and the 2014 GDP rebasing confirmed Nigeria's status as Africa's largest economy, these economic gains have not translated into widespread improvements in welfare. The National Bureau of Statistics (2022) estimated that over 63 per cent of Nigerians were multidimensionally poor, indicating that economic growth has not been sufficiently inclusive. Consequently, the relationship between income growth and health outcomes is a key empirical question. Recent studies show the importance of income in improving longevity. Chewe and Hangoma (2020) found that higher income significantly improves life expectancy by allowing greater healthcare availability and living standards, while Wirayuda and Chan (2021) identified income per capita as a primary macroeconomic determinant of longevity. Education, commonly measured by literacy rate, constitutes another key determinant of health outcomes. Drawing on theoretical and empirical perspectives, education is recognised as enhancing individuals' capacity to access health information, adopt preventive health care practices, and form informed decisions regarding nutrition and medical care. Human Capital Theory and Sen's (1999) Capability Approach both frame education as central for expanding personal capabilities and general welfare, holding that greater educational attainment furnishes individuals with skills and knowledge that support healthier ways of living. Empirically, Cutler and Lleras-Muney (2006) found that persons with higher educational attainment encounter lower mortality risks and better health outcomes than those with less education, providing evidence that supports the theoretical propositions linking education to augmented health. Several educational reforms, including the Universal Primary Education Programme in 1976 and the Universal Basic Education Programme in 1999, have expanded access to schooling. According to UNESCO (2023), adult literacy increased from below 40 per cent after independence to over 62 per cent in recent years, although significant regional and socioeconomic disparities prevail. Empirical evidence supports the contribution of education to

better health outcomes. Sede and Ohemeng (2015) found that literacy positively influences life expectancy by improving health awareness and healthcare utilisation. Similar findings were reported by Chewe and Hangoma (2020) and Wirayuda and Chan (2021), who identified educational attainment as a key determinant of life expectancy in developing countries.

Labour force participation influences health outcomes because employment generates the income necessary to access healthcare, nutritious food, and improved housing. Healthier individuals are also more productive and economically active. Bloom and Canning (2000) argue that health and labour productivity reinforce each other. In Nigeria, labour force participation remains relatively high due to the predominance of informal economic activities; however, unemployment and underemployment continue to restrict household income and access to quality healthcare. Therefore, labour force participation is an important macroeconomic determinant of life expectancy. Public health expenditure constitutes another major determinant of population health, as it finances medical systems, disease prevention, medical personnel training, and medical service delivery. Filmer and Pritchett (1999) argue that government health spending improves health outcomes when resources are efficiently allocated. In response, African Union member states adopted the Abuja Declaration in 2001, committing to allocate at least 15 per cent of annual government expenditure to health. Nigeria's health expenditure has increased substantially, rising from approximately ₦16.7 billion in 2000 to over ₦1.33 trillion in 2024 (Federal Ministry of Finance, Budget and National Planning, 2024). However, health spending remains below the Abuja target, giving rise to substandard healthcare infrastructure, shortages of medical personnel, and high out-of-pocket healthcare costs. The National Population Commission and ICF (2019) report that Nigeria continues to have one of the world's highest maternal mortality rates, and preventable diseases are still widespread. Empirical evidence regularly demonstrates that public health expenditure improves health outcomes. Eneji et al. (2013), Sede and Ohemeng (2015), Osakede (2021), and Owumi and Eboh (2022) found that increased public health expenditure considerably boosts life expectancy in Nigeria. Comparable findings from Sub-Saharan Africa by Chewe and Hangoma (2020), Tsekane et al. (2024), and Serge et al. (2024) confirm that healthcare spending is a key driver of health progress. Marmot (2005) further emphasises that broader social determinants such as income, education, employment, and governance shape health outcomes beyond the healthcare sector, a conclusion also supported by Osakede (2021), Wirayuda and Chan (2021), and Tsekane et al. (2024).

Given the significant changes in Nigeria's economy, education sector, labour market, and healthcare financing in recent decades, updated empirical evidence is required. At the outset, it is necessary to clarify the scope and limitations of the research design: this study centres on selected macroeconomic determinants of life expectancy, specifically real GDP per capita, literacy rate, labour force participation rate, and public health expenditure. The model does not include other potentially significant variables, such as institutional quality, governance effectiveness, or environmental and healthcare system factors. Such exclusions mean that the findings should be interpreted in the context of these specified determinants, acknowledging that omitted variables may also play important functions in shaping health outcomes. Accordingly, this study considers the effects of real GDP per capita, literacy rate, labour force participation rate, and public health expenditure on life expectancy in Nigeria, with the objective of supplying evidence-based policy recommendations to improve health outcomes and facilitate sustainable development. Despite Nigeria's ample economic potential and increasing public expenditure, health outcomes remain poor. Life expectancy at birth reached only about 54 years in 2023, significantly below the global average of over 73 years (World Bank, 2024). This persistent

disparity invokes questions regarding the effectiveness of socioeconomic and health policies. Economic theory suggests that higher real GDP per capita improves health by enabling better access to medical care and living conditions (Grossman, 1972; Pritchett & Summers, 1996), while higher literacy, labour force participation, and public health expenditure are also projected to boost longevity (Filmer & Pritchett, 1999). However, these improvements have not resulted in proportional gains in life expectancy. Empirical findings remain mixed: Sede and Ohemeng (2015) identified significant socioeconomic effects on life expectancy, whereas Osakede (2021) and Owumi and Eboh (2022) highlighted governance and structural barriers. While existing studies have often focused on individual determinants or have addressed limited time frames, there is a shortage of comprehensive, updated analysis considering the joint effects of multiple macroeconomic factors over an extended period. This study addresses this gap by examining how real GDP per capita, literacy rate, labour force participation, and public health expenditure mutually influence life expectancy in Nigeria, thereby adding to a more subtle understanding of the determinants of longevity in the Nigerian context.

2 Literature Review

Recent empirical literature stresses the importance of macroeconomic and socio-economic factors in accounting for variations in health indicators across developing countries. Life expectancy, a comprehensive measure of population health, is closely linked to income levels, educational attainment, labour market conditions, and healthcare financing. Studies conducted in Nigeria and Sub-Saharan Africa provides evidence that these factors substantially influence health outcomes. Recent literature has progressively focused on health expenditure and institutional quality. Ikpe et al. (2025), employing panel data from Sub-Saharan African countries, found that health expenditure promotes economic growth, but its effectiveness is strongly influenced by governance quality. The study concluded that countries with stronger regulatory systems obtain greater health and economic benefits from public health investment.

Lawal et al. (2023) investigated the long-term relationship between public healthcare expenditure, life expectancy, and economic growth in Nigeria using the ARDL technique. Their analysis shows that life expectancy exerts a positive long-term effect on economic growth and highlights the need for consistent investment in the healthcare sector to achieve persistent improvements in health outcomes. Islam et al. (2025) analysed the determinants of life expectancy across 46 Sub-Saharan African countries using Dynamic Ordinary Least Squares, Driscoll-Kraay estimation, and Quantile Regression. Their results prove that GDP and health expenditure notably raise life expectancy, whereas carbon emissions and rapid population growth diminish longevity. The study shows that sustained economic growth, together with increased healthcare investment, is fundamental to improving health outcomes in the region. Digital infrastructure is increasingly important in furthering health outcomes.

Chewe and Hangoma (2020), utilising panel data from Sub-Saharan Africa, found that income growth significantly improves life expectancy by expanding availability of medical services and raising living conditions. Similarly, Ebhota et al. (2023) reported that economic development positively influences life expectancy through strengthened healthcare investment and improved social welfare. In Nigeria, Alhassan et al. (2021) observed that economic growth contributes to favourable health outcomes, subject to the efficiency of public bodies and medical services. Collectively, these conclusions support the assertion that higher real GDP per capita can improve longevity through enabling access to health-promoting resources.

Education functions as one of the most important determinants of health outcomes. Wirayuda and Chan (2021), in a systematic review of studies on life expectancy, identified educational attainment as a major predictor of longevity across countries. Similarly, Cutler and Lleras-Muney (2006) established that education improves health outcomes by increasing health awareness and facilitating healthier behaviours. In the African context, Tsekane et al. (2024) found that human capital development, particularly educational attainment, notably contributes to improvements in health and well-being. Bl and Vazquez (2025) further demonstrated that investments in education generate long-term health benefits through enhancing human capital formation and reducing vulnerability to health risks that influence health outcomes. Bloom and Canning (2000) argued that healthy individuals are more productive and more apt to participate actively in economic activities. Conversely, labour force participation provides income that enables households to access healthcare services and improve living standards. Olayiwola and Adedokun (2018) found evidence of a positive relationship between health status and labour force participation in Nigeria, suggesting that improvements in health contribute to economic engagement while employment supports better health outcomes. Similarly, Asongu and Odhiambo (2020) reported that enhancements in human development indicators, including employment and economic participation, play a major role in more favourable health impacts across African economies. Public health expenditure is consistently identified as an important determinant of health outcomes. Osakede (2021) found that public health spending positively affects life expectancy in Nigeria, although the efficiency of expenditure is influenced by governance quality. Similarly, Owumi and Eboh (2022) reported that healthcare expenditure meaningfully contributes to improvements in life expectancy at birth in Nigeria. At the regional level, Chewe and Hangoma (2020) identified health expenditure as one of the strongest drivers of health gains in Sub-Saharan Africa. Ranabhat et al. (2018) also demonstrated that augmented healthcare financing and progress toward universal health coverage significantly improve population health outcomes and longevity.

3 Data and Methodology

Model Specification

This study builds a model to analyse the impact of macroeconomic determinants on life expectancy in Nigeria. Life expectancy (LEXP) serves as the dependent variable, while real gross domestic product per capita (RGDPPC) is the primary independent variable. Drawing on accepted theoretical frameworks and prior research, the model includes literacy rate, labour force participation rate, and public health expenditure as control variables. Including these variables tackles potential confounding effects on life expectancy and raises the validity of the study's conclusions. The functional relationship examined is as follows:

$$LEXP = f(RGDPPC, LTR, LFPR, PHE) \quad (1)$$

Here, (LEXP) is represented as a function of real gross domestic product per capita (RCDPPC), literacy rate (LTR, labour factor productivity rate (LFPR), and Public health expenditure (PHE). Equation (**1**) is-specified in the econometric form:

$$LEXPt = \beta 0 + \beta 1 LNRGDPPCt + \beta 2 LTRt + \beta 3 LFPRt + \beta 4 LNPHEt + \varepsilon t \quad (2)$$

Where β_0 = Intercept term; β_1 to β_4 = Parameters to be estimated; μ_t = Stochastic error term of the regression; t = Time period (1991-2025); LEXPt = life expectancy; LNRGDPPCt = natural logarithm form of RGPPPC; LTRt = literacy rate; LFPRt = labour factor productivity rate; LNPHEt = natural logarithm form of PHE. Variables not originally measured in years or

percentages are expressed in natural logarithm form to facilitate interpretation and to reduce potential heteroscedasticity in the data series (Mullahy and Norton, 2022).

4 Estimation Techniques

An ex-post facto research design (Gbenga and Adeniyi, 2023) is adopted using annual secondary time-series data. The Johansen cointegration technique and the Vector Error Correction Model (VECM) are used to examine the long-run and short-run relationships between economic variables and life expectancy in Nigeria from 1991 to 2025. The VECM is chosen because the data are time-series, the variables are cointegrated, and all are integrated of order one, I(1), with at least one long-run equilibrium relationship (Johansen, 1988; Johansen and Juselius, 1990).

The stationarity properties of the variables are assessed using the Augmented Dickey-Fuller (ADF) unit root test (David et al., 2025) to confirm that none is integrated beyond the first order. The ADF test is selected because it accounts for higher-order serial correlation through lag augmentation, hence improving unit root inference. (Cheung & Lai, 1995, pp. 277-280)

The optimal lag length is determined within a Vector Autoregressive (VAR) framework. Alternative lag structures are evaluated using the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn Criterion (HQ), Final Prediction Error (FPE), and the Sequential Modified Likelihood Ratio (LR) test. (Kilian & Ivanov, 2001) Given the relatively small sample size and the need to avoid over-parameterisation, the most parsimonious and stable lag specification is selected for subsequent cointegration analysis.

The presence of a long-run equilibrium relationship among the variables is assessed using the Johansen maximum likelihood cointegration procedure. Unlike the Engle-Granger two-step approach, the Johansen methodology determines multiple cointegrating vectors within a multivariate system and yields statistically efficient estimates of long-run relationships. (Johansen, 1988) The cointegration rank is established using both the Trace Statistic and the Maximum Eigenvalue Statistic. Upon confirmation of cointegration, the Vector Error Correction Model (VECM) is estimated. The VECM extends the unrestricted VAR by including an error correction term (ECT), which measures the speed at which short-run deviations return to the long-run equilibrium. The general form of the VECM is presented as follows:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \mu + \varepsilon_t \qquad (3)$$

Where Y_t = vector of endogenous variables; Δ = first-difference operator; $\beta' Y_{t-1}$ = long-run cointegrating relationship; α = adjustment matrix measuring the speed of convergence toward equilibrium; Γ_i = short-run dynamic coefficients; μ = deterministic component; and ε_t = vector of white-noise disturbances.

$$\Delta LEXP_t = \alpha_0 + \lambda ECT_{t-1} + \sum_{i=1}^{p-1} \alpha_i \Delta LEXP_{t-i} + \sum_{i=1}^{p-1} \beta_i \Delta LNRGDPPC_{t-i} \qquad (4)$$

$$+ \sum_{i=1}^{p-1} \gamma_i \Delta LTR_{t-i} + \sum_{i=1}^{p-1} \delta_i \Delta LFPR_{t-i} + \sum_{i=1}^{p-1} \phi_i \Delta LNPHE_{t-i} + \varepsilon_t$$

Here, ECT_{t-1} = lagged error correction term from the estimated long-run cointegration equation; λ = speed-of-adjustment coefficient should be negative and statistically significant, indicating convergence towards long-run equilibrium (Pesaran and Shin, 1996); $\alpha_i, \beta_i, \gamma_i, \delta_i, \phi_i$ = short-run dynamics coefficients. The reliability of the estimated VECM is evaluated using several post-estimation diagnostic tests, including the VEC residual serial correlation LM test, the VEC residual heteroskedasticity test, the multivariate Jarque-Bera normality test, and the characteristic

roots stability test. For the VECM to be considered stable, the imposed unit roots must correspond to the cointegration rank, and the remaining characteristic roots must satisfy the model's stability condition. (Mohr, 2019) Collectively, these diagnostics show that the estimated coefficients are statistically reliable and suitable for both long-run and short-run policy analysis (Jacobs and Wallis, 2010).

5 Nature and sources of data

Annual time series data for each variable from 1991 to 2025 are used, reflecting data availability and providing a sufficient period to examine the relationship between the variables of interest and life expectancy in Nigeria. (Nigeria Life Expectancy (1950-2026), 2026) Time series data also help identify trends in the selected variables. (Ezekwu, 2026) The data series used in this study are freely accessible from the following sources:
https://data.worldbank.org/country/nigeria;
https://apps.who.int/nha/database;https://uis.unesco.org/en/data-explorer;
https://www.cbn.gov.ng/documents/statbulletin.asp.

6 Data Description

The selection of variables in this study is anchored in both conceptual models and empirical evidence concerning the determinants of life expectancy. Life expectancy is employed as the dependent variable, inasmuch as it functions as a widely recognised indicator of overall population health and summarises the cumulative effects of socioeconomic, educational, and healthcare conditions (Taherian et al., 2026; Kondo et al., 2025). Real GDP per capita is included as the main explanatory variable, reflecting the role of economic prosperity in improving nutrition, housing, and healthcare availability (Grossman, 1972; Pritchett and Summers, 1996). The literacy rate is incorporated to capture educational attainment, which enhances individuals' health awareness, preventive health behaviours, and access to medical information (Cutler and Lleras-Muney, 2006). Labour force participation rate is considered to account for the influence of employment on health, given its impact on income generation and access to health-promoting resources (Bloom and Canning, 2000). Public health expenditure is also included, based on evidence that deploying resources to health infrastructure and service delivery can improve health outcomes if done efficiently (Filmer and Pritchett, 1999). By selecting these variables, the model strives to provide a comprehensive assessment of the macroeconomic and human capital determinants of life expectancy in Nigeria. The operationalisation of each variable is based on international definitions and availability of consistent annual time series data from 1991 to 2025, permitting robust analysis of trends and relationships (Taherian et al., 2026; Ezekwu, 2026). Life expectancy is widely recognised as a primary indicator of a population's overall health status and is determined by economic, social, demographic, and healthcare factors. (Taherian et al., 2026) In this analysis, life expectancy is the dependent variable used to assess the effects of real GDP per capita, literacy rate, labour force participation rate, and public health expenditure. Kondo et al. (2025) identify health outcomes, particularly life expectancy, as central measures of development. The World Health Organisation (2024) reports that improvements in health care financing and socioeconomic conditions are essential drivers of life expectancy. Similarly, Wirayuda and Chan (2021) highlight income, education, and health resources as significant determinants of longevity across countries. Real GDP per capita measures average economic output per person, adjusted for inflation, and indicates standard of living and financial well-being (Gross domestic product (GDP) per capita and GDP per capita annual growth rate, Vlad and

Mazuru, 2026). Pritchett and Summers (1996) demonstrate that increases in income significantly improve population health and reduce mortality. The literacy rate refers to the proportion of the population able to read and write with comprehension. Cutler and Lleras-Muney (2006) find that subjects with higher educational attainment generally experience better health outcomes and longer life expectancy. The labour force participation rate represents the proportion of the working-age population that is engaged or actively seeking employment. Bloom and Canning (2000) suggest that healthier demographics are more productive and more likely to participate in economic activities. Public health expenditure includes government spending on healthcare services, infrastructure, disease prevention, medical personnel, and health-related programmes. Filmer and Pritchett (1999) argue that public health spending can enhance health outcomes when resources are allocated efficiently and utilised effectively. The World Health Organisation (2024) identifies sufficient healthcare financing as essential for achieving universal health coverage and improving life expectancy.

7 Results

Descriptive Analysis

Figure 1 displays area plots of the study variables across the sample period, offering a preliminary view of their behaviour before formal econometric analysis. LEXP shows a sustained upward trajectory, indicating gradual improvements in population health throughout the study period (Cardona and Bishai, 2018). Despite minor fluctuations in certain years, the overall trend shows continuous advancement in health outcomes, though the pace and consistency of gains varies, with slower progress in the late 1990s and a more pronounced increase from the mid-2000s onward. RGDPPC shows a general upward trend with intermittent declines, suggesting periodic disruption from macroeconomic instability; the significant increase at the end of the period indicates a strong recovery in income levels after earlier economic challenges (Alesina et al., 1992). LTR displays a stepwise pattern, with periods of stability, sharp improvements, temporary declines, and subsequent recovery, highlighting the impact of educational policy interventions as well as possible regional disparities (Shambaugh and Strain, 2021). LFPR records a mild downward trend for most of the sample period, followed by a recovery in later years, indicating potential labour market shocks related to structural changes or economic downturns (Labour Force Participation Rate - 61.5%, 2026). LNPHE shows a pronounced and persistent upward trend, despite occasional short-term fluctuations, reflecting sustained policy interest in increasing health spending and government resource allocation, though uneven year-to-year (Smith et al., 2022).

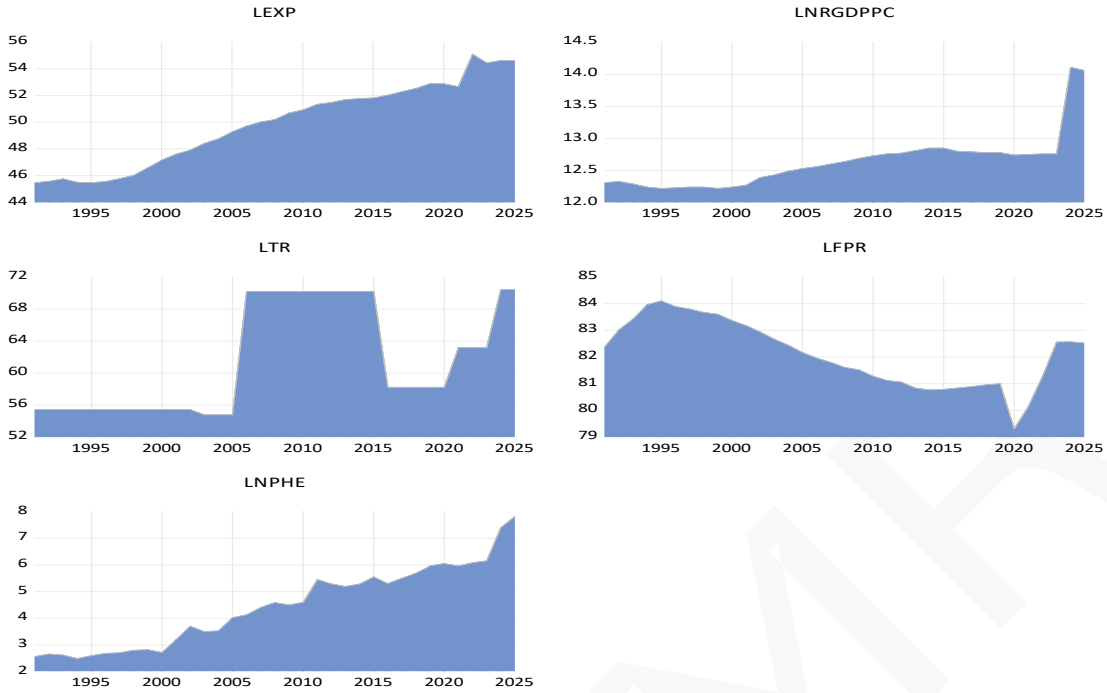

Fig. 1 Trend analysis

Table 1 summarises the descriptive statistics for the variables, including the mean, standard deviation, minimum, and maximum values for the sample period. These statistics indicate moderate variability in life expectancy (LEXP), with a standard deviation of 3.109 years; the mean LEXP is 49.862 years, ranging from 45.480 to 55.120, reflecting improvements but also underlying disparities during the period. LNRGDPPC's non-normality, highlighted by the Jarque-Bera statistic, reflects the asymmetric distribution and volatility in income per capita, most likely due to external shocks, oil price volatility, and episodes of economic crisis. Higher kurtosis in LNRGDPPC also suggests the presence of income distribution outliers. LTR shows a mean of 61.523 per cent with a standard deviation of 6.7581, indicating periodic successes in literacy improvements, but also persistent gaps. LFPR remains relatively stable, with a mean of 82.098 per cent, but exhibits a minimum of 79.310 and a maximum of 84.100, reinforcing the earlier observation of a cyclical trend. LNPHE presents a mean of 4.443, with a relatively wide standard deviation of 1.498, signifying consistent, if sometimes volatile, increases in public health expenditure.

Table 3 displays the correlation matrix, providing an overview of the relationships among the variables analysed in this study. The matrix reveals a strong positive correlation between LEXP and LNPHE (r = 0.973), as well as LEXP and LNRGDPPC (r = 0.789), illustrating that, at a bivariate level, higher income and health spending are associated with increased longevity. The negative correlation between LEXP and LFPR (-0.750) may suggest that times of higher labour force participation coincide with economic or social transitions that temporarily undermine health improvements, though further multivariate analysis is required. For multicollinearity, attention is given to the pairwise correlation coefficients among the explanatory variables. Although the high correlation between LNRGDPPC and LNPHE (r = 0.879) raises concerns, computation of the Variance Inflation Factor (VIF) demonstrates that all explanatory variables have VIF values below critical thresholds (all <10), confirming no severe multicollinearity in the

estimation model. The VIF range indicates that while some correlation exists, it should not significantly bias or destabilise the regression results.

8 Unit Root Testing

To mitigate the risk of spurious regression results (Jutice and Makoni, 2025) from non-stationary time series, apply unit root tests to the variables. Next, report the Augmented Dickey-Fuller (ADF) results in **Table 2**. These results indicate the presence of unit roots (Perron, 1990). None of the variables exhibited stationarity at level (I0). Stationarity was achieved for all variables only after first differencing (I_1) (Kim and Choi, 2017; MÜller, 2008). The consistent integration of the series at (I_1) validates the use of cointegration analysis to investigate potential long-run relationships among variables of interest, and guards against misleading inferences from unstable regressions (Perron, 1990).

Table 1 Descriptive statistics

Variables	**LEXP Yr.'s**	**LNRGDPPC $'000**	**LTR %**	**LFPR %**	**LNPHE $'m**
Mean	49.862	12.636	61.523	82.098	4.443
Median	50.220	12.640	58.220	82.170	4.500
Maximum	55.120	14.110	70.410	84.100	7.820
Minimum	45.480	12.220	54.770	79.310	2.490
Std. Dev.	3.109	0.429	6.7581	1.235	1.498
Skewness	-0.060	2.083	0.404	-0.092	0.282
Kurtosis	1.748	8.144	1.342	2.099	2.117
Jarque-Bera	2.308	63.900***	4.965*	1.234	1.600
Probability	(0.315)	(0.000)	(0.083)	(0.540)	(0.449)

* and *** indicate significance at 10% and 1%, respectively

Table 2 Augmented Dickey-Fuller unit root test result

Null Hypothesis: the variable has a unit root

Variables		LEXP	LNRGDPPC	LTR	LFPR	LNPHE
At Level						
With Constant	t-Statistic	-0.0126 (***0.9507***)	0.2061 (***0.9690***)	-1.4643 (***0.5392***)	-1.1244 (***0.6947***)	1.0744 (***0.9965***)
With Constant & Trend	t-Statistic	-3.1357 (***0.1145***)	-1.6056 (***0.7697***)	-1.9006 (***0.6323***)	0.2443 (***0.9971***)	-2.8171 (***0.2015***)
At First Difference						
		d(LEXP)	d(LNRGDPPC)	d(LTR)	d(LFPR)	d(LNPHE)
With Constant	t-Statistic	-7.8543*** (***0.0000***)	-5.9923*** (***0.0000***)	-5.6519*** (***0.0000***)	-4.4187*** (***0.0014***)	-4.5961*** (***0.0009***)
With Constant & Trend	t-Statistic	-7.7416*** (***0.0000***)	-6.3803*** (***0.0000***)	-5.5670*** (***0.0004***)	-3.2397* (***0.0981***)	-4.9512*** (***0.0019***)

(a) *, **, and *** indicate significant at the 10%, 5%, and 1% respectively
(b) *P*-values are in parentheses

Table 3 Correlation matrix

Covariance Correlation	LEXP	LNRGDPPC	LTR	LFPR	LNPHE
LEXP	9.387725 1.000000				
LNRGDPPC	1.021611 0.789139	0.178527 1.000000			
LTR	12.71932 0.623240	1.762807 0.626361	44.36664 1.000000		
LFPR	-2.796813 -0.750116	-0.212699 -0.413676	-4.210116 -0.519411	1.480845 1.000000	
LNPHE	4.400685 0.972950	0.548110 0.878752	6.236405 0.634244	-1.265288 -0.704344	2.179210 1.000000

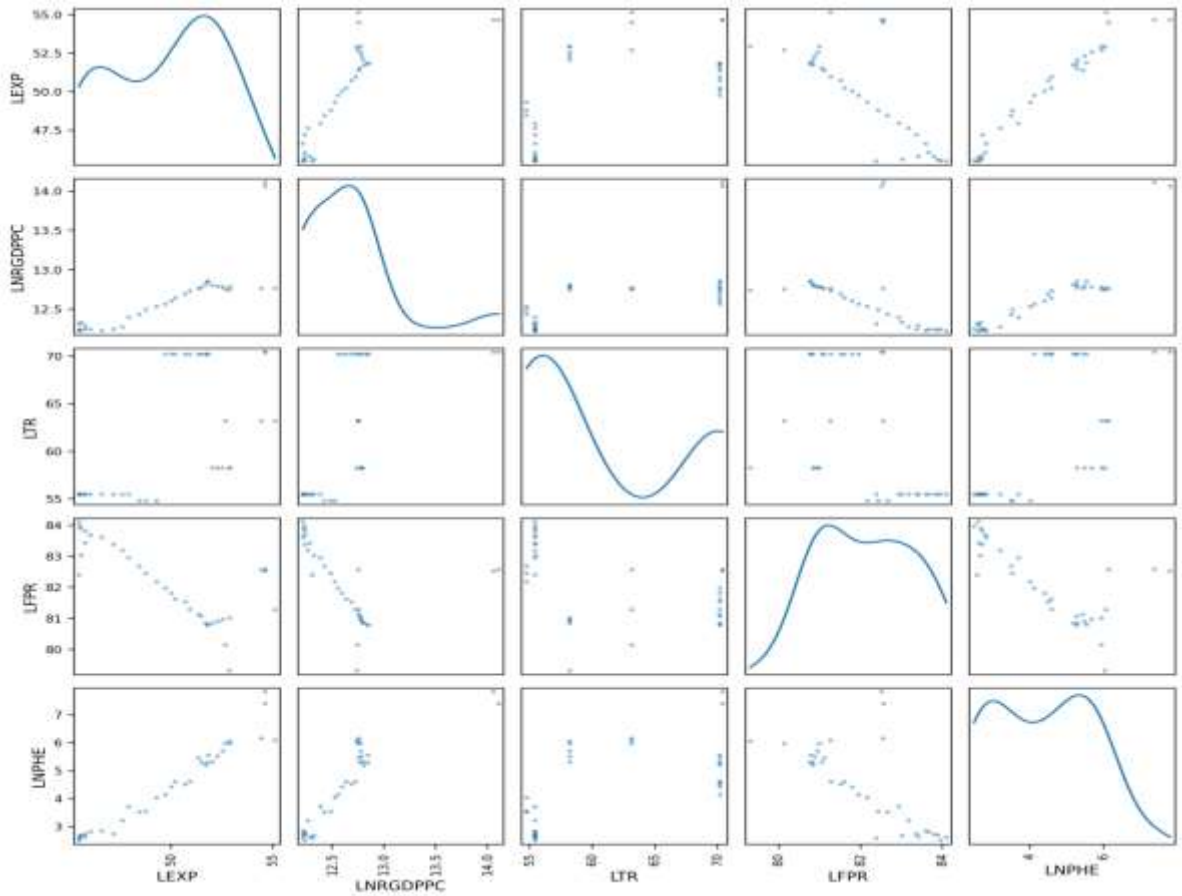

Fig. 2 Scatterplot

9 Presentation of Regression Results

The unit root tests show that the variables become stationary after first differencing, justifying the Johansen cointegration test, as evidenced by the Augmented Dickey-Fuller (ADF) results in **Table 2** (Diniz et al., 2020). The evidence confirms that all variables are integrated of order one (I_1) (Choi et al., 2009). This supports identifying multiple cointegrating vectors in a multivariate context and provides a basis for estimating the Vector Error Correction Model (VECM).

The VAR lag length was established before the Johansen cointegration test, as shown in **Table 4**, to assess a long-run equilibrium relationship among the selected variables (Qu and Perron, 2007). The Trace test identifies two cointegrating equations, while the Maximum Eigenvalue test identifies one. Consistent with Johansen (1995), the Trace statistic is used to determine the cointegration rank. These results support estimating a VECM to capture both the long-run and short-run dynamics of the system (Obamuyi, 2009).

Table 4 Johansen Cointegration Test

Hypothesized No. of CE(s)	Trace Statistic	5% Critical Value	Prob.**	Max-Eigen Statistic	5% Critical Value	Prob.**
None *	105.8581	69.81889	0.0000	56.51876	33.87687	0.0000
At most 1 *	49.33936	47.85613	0.0360	26.53512	27.58434	0.0676
At most 2	22.80424	29.79707	0.2558	12.77614	21.13162	0.4730
At most 3	10.02810	15.49471	0.2786	8.368708	14.26460	0.3425
At most 4	1.659392	3.841465	0.1977	1.659392	3.841465	0.1977

Table 5 reports the VECM results. The normalised long-run cointegrating equation is statistically supported by real GDP per capita, LTR, and LFPR, while LNPHE lacks statistical significance. The error correction term (ECT) is positive (0.0610) and statistically insignificant (t = 0.5504), suggesting that deviations from the long-run equilibrium are not corrected through life-expectancy adjustments during the study period. In the short run, only the first lag of real GDP per capita and the second lag of the labour force participation rate exert statistically significant effects on life expectancy; the remaining explanatory variables are not significant. (Lin et al., 2012).

Table 5 VECM Estimates: Long-run Cointegrating Equation (Normalized on LEXP)

Cointegrating Eq:	CointEq1
LEXP(-1)	1.000000
LNRGDPPC(-1)	-3.520849 (1.08324) [-3.25028]
LTR(-1)	0.042157 (0.00991) [4.25590]

LFPR(-1)	1.562045 (0.19647) [7.95044]
LNPHE(-1)	-0.041012 (0.18985) [-0.21602]
C	-136.1568

Table 6 Short-run Dynamic Estimates (Dependent Variable: ΔLEXP)

Variable	Coefficient	Std. Error	t-Statistic
ΔLEXP(-1)	-0.2020	0.1659	-1.2177
ΔLEXP(-2)	0.1133	0.2246	0.5045
ΔLNRGDPPC(-1)	0.9384***	0.2988	3.1413
ΔLNRGDPPC(-2)	-2.1835	1.4600	-1.4955
ΔLTR(-1)	-0.0053	0.0109	-0.4829
ΔLTR(-2)	-0.0078	0.0109	-0.7210
ΔLFPR(-1)	0.2290	0.1440	1.5904
ΔLFPR(-2)	-1.0084***	0.1031	-9.7845
ΔLNPHE(-1)	-0.1355	0.1746	-0.7763
ΔLNPHE(-2)	-0.0093	0.1814	-0.0511
Constant	0.3147***	0.1161	2.7118

(a) *** indicate statistically significant at 1%

Table 6 shows the short-run dynamic estimates, where only the first lag of real GDP per capita exerts a positive and statistically significant effect on life expectancy (coefficient: 0.9384; t-statistic: 3.1413; $p<0.01$). Conversely, the second lag of the labour force participation rate has a significant negative effect (coefficient: -1.0084; t-statistic: -9.7845; $p<0.01$). These results underscore the importance of recent changes in income and employment structure in shaping short-term health improvements, while other short-term effects of literacy rate and public health expenditure are statistically insignificant in the short run.

Table 7 reports the results of the VECM residual serial correlation LM test. The null hypothesis of no serial correlation is not rejected at lag 1 ($p = 0.150$) or lag 2 ($p = 0.900$). The joint test for lags 1 and 2 is also insignificant ($p = 0.353$), indicating that the residuals are serially uncorrelated and the estimated VECM is correctly specified. (Lütkepohl and Krätzig, 2006)

Table 8 presents the heteroskedasticity test results, showing that the null hypothesis of homoskedastic residuals is not rejected. The joint Chi-square statistic is 323.024 ($p = 0.598$), which is insignificant at the 5% level. This indicates the absence of heteroskedasticity in the model residuals. Therefore, the residual variance remains constant, confirming that the estimated VECM satisfies the homoskedasticity assumption. (Baum, 2001)

Table 7 VECM Residual Serial Correlation LM Test

Null Hypothesis	Lag	LM Statistic	p-value
No serial correlation	1	32.296	0.150
No serial correlation	2	16.41	0.900
No serial correlation (Lags 1-2)	2	53.174	0.353

Table 8 VECM Residual Heteroskedasticity Test

Chi-sq	**df**	**Prob.**
323.0237	**330**	**0.5977**

Table 9 reports the multivariate normality test, which rejects the null hypothesis of normally distributed residuals. The joint skewness statistic is not significant ($\chi^2 = 6.698$, $p = 0.244$), whereas the joint kurtosis statistic ($\chi^2 = 73.037$, $p < 0.001$) and the joint Jarque-Bera statistic ($\chi^2 = 79.735$, $p < 0.001$) are significant. These results suggest that the residuals deviate from multivariate normality mainly because of excess kurtosis. Nevertheless, the VECM estimates remain valid, as the Johansen cointegration and VECM framework do not require strict residual normality for consistent parameter estimation. (Burke and Hunter, 2017).

Table 9 VECM Residual Normality Test

Test	**Chi-square Statistic**	**df**	**p-value**
Joint Skewness	6.698	5	0.244
Joint Kurtosis	73.037	5	0.000
Joint Jarque–Bera	79.735	10	0.000

These results establish a robust long-run equilibrium between life expectancy and key macroeconomic determinants in Nigeria, reinforcing the validity of the methodological approach applied. (Sede and Ohemeng, 2015) Specifically, the findings indicate that higher income, increased educational attainment, and favourable labour market conditions each drive sustained improvements in life expectancy, a pattern consistent with previous research emphasising the critical roles of income and human capital in promoting health outcomes (Arikpo et al., 2019, Chewe and Hangoma, 2020). In comparative terms, while these macroeconomic factors have a measurable and significant association with longevity, public health expenditure does not display a comparable long-term effect. This absence of significance mirrors recent studies suggesting that, unlike inclusive income growth or education, the impact of health spending on life expectancy is conditional and largely governed by how resources are allocated and the efficiency of health systems, rather than by the volume of expenditure alone (Paul and Agada, 2024; Osakede, 2021). Thus, the study's findings make explicit that economic growth and investments in human capital contribute more substantially to long-term health improvements than increased public health spending when considered in isolation.

10 Conclusion and Recommendations

This study examined the macroeconomic determinants of life expectancy in Nigeria from 1991 to 2025 using the Johansen cointegration technique and the Vector Error Correction Model (VECM). Empirical analysis confirmed that all variables are integrated of order one and that a stable long-run equilibrium relationship exists among them, thereby validating the VECM approach. (Ogungbenle et al., 2013) The main empirical findings indicate that real GDP per capita, literacy rate, and labour force participation are statistically significant determinants of life expectancy in the long run, while public health expenditure does not demonstrate a significant long-run effect. In the short run, only the first lag of real GDP per capita exerts a positive and statistically significant effect on life expectancy, and the second lag of labour force participation has a significant negative effect. (Sede and Ohemeng, 2015) These results demonstrate that economic growth, educational attainment, and labour force dynamics are primary contributors to improvements in longevity, whereas increased health spending alone is insufficient to produce statistically significant long-term gains in life expectancy. However, it is important to emphasise that the results reflect statistical associations rather than definitive causal relationships, due to the observational nature of the time-series data and reliance on cointegration and VECM techniques. While the analysis reveals meaningful relationships among the studied variables, the presence of unobserved confounders and inherent methodological limitations prevents conclusive inference of causality. The estimated model meets key diagnostic requirements, including absence of serial correlation and homoskedasticity, supporting the reliability of the policy inferences, despite residual non-normality linked to excess kurtosis. (A., 2023, pp. 200-215)

Taken together, the results suggest that economic prosperity and human capital development are the principal drivers of increased longevity in Nigeria. (Okpala et al., 2025) The positive association between real GDP per capita and life expectancy indicates that sustained income growth enhances households' access to nutrition, healthcare services, housing, and other health-promoting resources. (OBELE et al., 2022) In turn, the significance of the literacy rate underscores the role of education in improving health awareness, preventive healthcare practices, and informed health-seeking behaviour. (Alao et al., 2025) Conversely, the absence of a significant long-run effect of public health expenditure indicates that increased government health spending alone has not produced measurable improvements in life expectancy during the study period. (A et al., 2017) This finding suggests that the developmental impact of health expenditure depends not only on the amount allocated but also on the efficiency of resource utilisation. (Ogunjimi and Adebayo, 2019, pp. 130-139)

Beyond its empirical findings, this study contributes to the literature on health and development by jointly analysing income, education, labour market participation, and public health expenditure within a multivariate Johansen-VECM framework, using annual data from 1991 to 2025. (Osaretin and Olele, 2026, pp. 1-15) By capturing both long-run equilibrium relationships and short-run dynamic adjustments, the analysis provides updated evidence on the macroeconomic determinants of longevity in Nigeria. (Popoola and Mohammed, 2024) As a result, it expands the limited time-series evidence available to inform policy formulation. (Lawal et al., 2023) Policy recommendations should prioritise the macroeconomic determinants that exert the strongest influence on life expectancy, as indicated by the study's results. Specifically, the most important recommendation is to implement policies that promote inclusive economic growth, as higher real GDP per capita has the most significant long-run effect on longevity. Second, efforts to expand educational access and improve education quality particularly via enhanced adult literacy and basic education are essential for sustained health improvements.

Third, targeted labour market reforms that encourage productive employment and skill development should be emphasised, given the positive impact of labour force participation. Since public health expenditure does not have a significant long-run effect, policy should shift from increasing spending volumes to enhancing the efficiency and effectiveness of current health expenditures through improved budget implementation and transparency. Ultimately, an integrated policy approach that aligns inclusive economic growth, human capital development, and robust labour markets with efficient healthcare resource allocation represents the best strategy for achieving meaningful and lasting improvements in life expectancy in Nigeria.

While this study provides robust evidence on the macroeconomic determinants of life expectancy in Nigeria, certain limitations persist. Specifically, the analysis is limited to selected macroeconomic variables. It does not explicitly incorporate institutional quality, governance effectiveness, environmental conditions, or healthcare efficiency indicators, all of which may influence health outcomes. Enhancing longevity in Nigeria requires implementing policies that simultaneously foster inclusive economic growth, reinforce human capital development, improve labour market productivity, and optimise healthcare delivery efficiency. An integrated development strategy is likely to produce more sustainable improvements in population health than isolated, sector-specific interventions. (Predmore et al., 2019)

Accordingly, future research could address these gaps by including these factors, exploring nonlinear or asymmetric relationships, or conducting comparative panel analyses across Sub-Saharan African economies to yield broader insights into the determinants of longevity. Such extensions would further strengthen the evidence base for designing effective and sustainable health and development policies.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for profit sectors.

Data Availability

Data can be made available on the behavior of the request

Declaration of interest statement

The authors declare no competing interests.

References

Alesina, A., Ozler, S., Roubini, N., & Swagel, P. (1992). Political instability and economic growth *(NBER Working Paper No. 4173). National Bureau of Economic Research*. https://doi.org/10.3386/w4173

Alhassan, G. N., Adedoyin, F. F., Bekun, F. V., & Agabo, T. J. (2021). Does life expectancy, death rate and public health expenditure matter in sustaining economic growth under COVID-19? *Empirical evidence from Nigeria. Journal of Public Affairs*, 21(4), e2302. https://doi.org/10.1002/pa.23022

Alao, J. O., Olowoshile, O. P., James, T. A., Okezie, C. C., Adebayo, Z. P., & Ogbonna, S. C. (2025). Socioeconomic and educational influences on malaria prevention and treatment behaviours in rural Nigeria. *BMC Public Health*, 25, Article 24326. https://doi.org/10.1186/s12889-025-24326-3

Arikpo, D., Eke, F., & Obafemi, F. (2019). Determinants of life expectancy in Nigeria: A macroeconomic analysis. *International Journal of Social Science and Economic Research*, 4(4), 2722-2730. https://doi.org/10.5281/zenodo.333019358

Asongu, S. A., & Odhiambo, N. M. (2020). Human development thresholds for inclusive development in Africa. *Social Indicators Research*, 151(2), 635-663. https://doi.org/10.1007/s11205-020-02343-3

Baum, C. F. (2001). Residual diagnostics for cross-section time series regression models. *The Stata Journal*, 1(1), 101-104. https://doi.org/10.1177/1536867X0100100108

Behrman, J. R., & Vázquez, C. (2025). Early life human-capital investments in Sub-Saharan *Africa. International Journal of Educational Development*, 112, Article 103157.

Bloom, D. E., & Canning, D. (2000). *The health and wealth of nations*. Science, 287(5456), 1207-1209. https://doi.org/10.1126/science.287.5456.1207

Burke, S. P., & Hunter, J. (2017). *Testing for cointegration: Standard and non-standard conditions*. In S. P. Burke & J. Hunter (Eds.), Multivariate modelling of non-stationary economic time series (pp. 145–204). Palgrave Macmillan. https://doi.org/10.1057/978-1-137-31303-4_4

Cardona, C., & Bishai, D. (2018). The slowing pace of life expectancy gains since 1950. *BMC Public Health*, 18, Article 5058. https://doi.org/10.1186/s12889-018-5058-9

Chewe, M., & Hangoma, P. (2020). Drivers of health in Sub-Saharan Africa: A dynamic panel analysis. *Health Policy Open*, 1, Article 100013. https://doi.org/10.1016/j.hpopen.2020.100013

Cheung, Y., & Lai, K. S. (1995). Lag order and critical values of the augmented Dickey-Fuller test. *Journal of Business & Economic Statistics*, 13(3), 277-280. https://doi.org/10.1080/07350015.1995.10524601

Choi, I., Park, J. Y., & Yu, B. (2009). Canonical cointegrating regression and testing for cointegration in the presence of I(1) and I(2) variables. *Econometric Theory*, 25(1), 1-25. https://doi.org/10.1017/S0266466600006290

Cutler, D. M., & Lleras-Muney, A. (2006). Education and health: Evaluating theories and evidence (NBER Working Paper No. 12352). *National Bureau of Economic Research*. https://doi.org/10.3386/w12352

Diniz, M. A., Pereira, C. A., & Stern, J. M. (2020). Cointegration and unit root tests: A fully Bayesian approach. Entropy, 22(9), *Article 968*. https://doi.org/10.3390/e22090968

Ebhota, O. S., Hongxing, Y., & Sampene, A. K. (2023). *Air pollution and life expectancy: New*

evidence from the MINT economies. Heliyon, 9(12), e22645. https://doi.org/10.1016/j.heliyon.2023.e22645

Eneji, M. A., Dickson, V. J., & Onabe, B. J. (2013). Health care expenditure, health status and national productivity in Nigeria (1999-2012). *Journal of Economics and International Finance*, 5(7), 258–272. https://doi.org/10.5897/JEIF2013.0541

Ezekwu, C. B. (2026). How long do we live? An analysis of economic factors and life expectancy in Nigeria. *Research Journal of Economics and Sustainable Development*, 14(1). https://doi.org/10.5281/zenodo.18373485

Filmer, D., & Pritchett, L. (1999). The impact of public spending on health: Does money matter? *Social Science & Medicine*, 49(10), 1309-1323. https://doi.org/10.1016/S0277-9536(99)00150-1

Gbenga, A. N., & Adeniyi, A. M. (2023). Impact of Annuity on The Economic Development of Nigeria. *Revista Activos/Revista Activos*. https://doi.org/10.15332/25005278.9769

Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy*, 80(2), 223-255. https://doi.org/10.1086/259880

Ikpe, M., Madueme, S. I., Ojike, R. O., Agbanike, T. F., Anochiwa, L. I., & Odionye, J. C.
(2025). Health expenditure and economic growth in Sub-Saharan African countries: The role of governance quality. *Review of Development Economics*, 29(2), 1144-1169. https://doi.org/10.1111/rode.13158

Islam, S., Roshid, M. M., Bhowmik, R. C., Dhar, B. K., Raihan, A., & Karim, R. (2025). Policy pathways for renewable energy, health, and sustainability in Sub-Saharan Africa: An empirical assessment of energy access and life expectancy. *Energy Policy*, 206, Article 114801. https://doi.org/10.1016/j.enpol.2025.114801

Jacobs, J., & Wallis, K. (2010). Cointegration, long-run structural modelling and weak exogeneity: Two models of the UK economy. *Journal of Econometrics*, 158(1), 108-116. https://doi.org/10.1016/j.jeconom.2010.03.017

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 12(2-3), 231-254. https://doi.org/10.1016/0165-1889(88)90041-3

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on Cointegration with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52(2), 169–210. https://doi.org/10.1111/j.1468-0084.1990.mp52002003.x

Justice, M., & Makoni, P. (2025). Bridging the Green Infrastructure Gap: Determinants of Renewable Energy PPP *Financing in Emerging and Developing Economies. Sustainability*, 17(20), 9072.

Kilian, L., & Ivanov, V. (2001). *A practitioner's guide to lag-order selection for vector autoregressions*. CEPR Discussion Paper No. 2685. https://doi.org/10.2139/ssrn.229062

Kim, J. H., & Choi, I. (2017). Unit roots in economic and financial time series: A re-evaluation at the decision-based significance levels. *Econometrics*, 5(3), Article 41. https://doi.org/10.3390/econometrics5030041

Kondo, T., Mutsvangwa, S., & Mandishekwa, R. (2025). Causality between foreign aid and life expectancy in Zimbabwe. *Journal of Social, Humanity, and Education*, 5(3), 179-193. https://doi.org/10.35912/jshe.v5i3.2704

Lawal, N., Opeloyeru, O., & Adegbola, O. (2023). Life expectancy, public healthcare expenditure
and economic growth: The Nigerian experience. *Studies of Applied Economics*, 41(3), Article e9277. https://doi.org/10.25115/sae.v41i3.9277

Lin, R., Chen, Y., Chien, L., & Chan, C. (2012). Political and social determinants of life expectancy in less developed countries: *A longitudinal study. BMC Public Health*, 12, Article 85. https://doi.org/10.1186/1471-2458-12-85

Lütkepohl, H. (2005). *New introduction to multiple time series analysis*. Springer.

Lütkepohl, J. M., & Krätzig, M. (2006). Residual autocorrelation testing for vector error correction models. *Journal of Econometrics*, 134(2), 579-604. https://doi.org/10.1016/j.jeconom.2005.07.006

Marmot, M. (2005). Social determinants of health inequalities. *The Lancet*, 365(9464), 1099-1104. https://doi.org/10.1016/S0140-6736(05)71146-6

Mohr, F. X. (2019). An introduction to vector error correction models (VECMs). https://www.r-econometrics.com/timeseries/vecintro

Mullahy, J., & Norton, E. C. (2022). Why transform Y? A critical assessment of dependent-variable transformations in regression models for skewed and sometimes-zero outcomes (NBER Working Paper No. 30735). *National Bureau of Economic Research*. https://doi.org/10.3386/w30735

MÜller, U. K. (2008). The impossibility of consistent discrimination between (I_0) and (I_1) processes. *Econometric Theory*, 24(3), 616-630. https://doi.org/10.1017/S0266466608080250

National Bureau of Statistics. (2022). Nigeria multidimensional poverty index survey 2022. *National Bureau of Statistics*. https://nigerianstat.gov.ng

National Population Commission (NPC) [Nigeria] & ICF. (2019). Nigeria demographic and health survey 2018. *NPC and ICF*. https://dhsprogram.com

Obamuyi, T. M. (2009). An investigation of the relationship between interest rates and economic growth in Nigeria, 1970 - 2006. *Journal of Economics and International Finance*. https://doi.org/10.5897/jeif.9000012

Obele, T. E., Haruna, S., & Leo, C. N. (2022). Analysis of public health spending, per capita income and life expectancy at birth in Nigeria. *Journal of Economics and Allied Research*, 6(2). https://jearecons.com/index.php/jearecons/article/view/580

Ogungbenle, S., Olawumi, O., & Obasuyi, F. (2013). Life expectancy, public health spending and economic growth in Nigeria: A vector autoregressive (VAR) model. *European Scientific Journal*, 9(19). https://doi.org/10.19044/esj.2013.v9n19p%25p

Ogunjimi, J. A., & Adebayo, A. O. (2019). Health expenditure, health outcomes and economic growth in Nigeria. *Asian Journal of Economics and Empirical Research*, 6(2), 130-139. https://doi.org/10.20448/journal.501.2019.62.130.139

Olayiwola, S. O., & Adedokun, A. S. (2018). Health and labour force participation: Empirical evidence from Nigeria. *Journal of Economic and Policy Analysis*, 10(1), 59-76.

Okpala, C. J., Nwokoye, E. S., Nwogwugwu, U. C., Metu, A. G., & Kalu, C. U. (2025). Capital inflows and life expectancy in Nigeria: Does quality of institutions matter? *Journal of Economic Studies*. https://doi.org/10.36941/mjss-2025-0029

Osakede, U. A. (2021). Public health spending and health outcome in Nigeria: The role of governance. *International Journal of Development Issues*, 20(1), 95-111. https://doi.org/10.1108/IJDI-10-2019-0169

Osaretin, O. S., & Olele, E. H. (2026). Human capital development and labour market outcomes in Nigeria, 1980-2025. *Jalingo Journal of Social and Management Sciences*, 7(2), 1-15. https://doi.org/10.66490/jjsms.v7i2.2274

Owumi, B. E., & Eboh, A. (2022). An assessment of the contribution of healthcare expenditure to life expectancy at birth in Nigeria. *Journal of Public Health*, 30(9), 2143-2151. https://doi.org/10.1007/s10389-021-01546-6

Paul, J., & Agada, M. (2024). Public health expenditure and life expectancy in Nigeria. *Journal of Economics and Allied Research*, 9(2). https://jearecons.com/index.php/jearecons/article/view/400

Perron, P. (1990). Testing for a unit root in a time series with a changing mean. *Journal of Business & Economic Statistics*, 8(2), 153-162. https://doi.org/10.1080/07350015.1990.10509786

Pesaran, M. H., & Shin, Y. (1996). Cointegration and speed of convergence to equilibrium. *Journal of Econometrics*, 71(1/2), 117-143. https://doi.org/10.1016/0304-4076(94)01697-6

Popoola, T. O., & Mohammed, O. A. (2024). Macroeconomic and socio-demographic determinants of longevity in Nigeria. *Lapai Journal of Economics*, 8(2). https://doi.org/10.4314/lje.v8i2.2

Preston, S. H. (1975). The changing relation between mortality and level of economic development. *Population Studies*, 29(2), 231-248. https://doi.org/10.1080/00324728.1975.10410201

Pritchett, L., & Summers, L. H. (1996). Wealthier is healthier. *Journal of Human Resources*, 31(4), 841-868. https://doi.org/10.2307/146149

Qu, Z., & Perron, P. (2007). A modified information criterion for cointegration tests based on a VAR approximation. *Econometric Theory*, 23(2), 307-340. https://doi.org/10.1017/S0266466607070284

Ranabhat, C. L., Atkinson, J., Park, M. B., Kim, C. B., & Jakovljevic, M. (2018). The influence of universal health coverage on life expectancy at birth (LEAB) and healthy life expectancy (HALE): A multi-country cross-sectional study. *Frontiers in Pharmacology*, 9, Article 960. https://doi.org/10.3389/fphar.2018.00960

Ray, D., & Linden, M. (2019). Health expenditure, longevity, and child mortality: Dynamic panel
data approach with global data. *International Journal of Health Economics and Management*, 20, 45-79. https://doi.org/10.1007/s10754-019-09272-z

Sede, P. I., & Ohemeng, W. (2015). Socio-economic determinants of life expectancy in Nigeria (1980-2011). *Health Economics Review*, 5(1), Article 2. https://doi.org/10.1186/s13561-014-0037-z

Shambaugh, J. C., & Strain, M. R. (2021). The recovery from the Great Recession: A long, evolving expansion. *The ANNALS of the American Academy of Political and Social Science*, 695(1), 28-48. https://doi.org/10.1177/0002716221990190

Sen, A. (1999). *Development as freedom*. Oxford University Press.

Serge, B., Ebongue, M., Alexandra, S. T. U., & Humphrey, K. (2024). Atlas 2022 of African health statistics: Key results towards achieving the health-related SDGs targets. *Health Policy Open*, 5, Article 100116. https://doi.org/10.1016/j.hpopen.2024.100116

Smith, S. D., Newhouse, J. P., & Cuckler, G. A. (2022). Health-care spending growth has slowed: Will the bend in the curve continue? *American Journal of Health Economics*, 12(1), 1-23. https://doi.org/10.1086/734328

Taherian, R., Ghahfarokhi, M. K., & Zayeri, F. (2026). A study of trends and projection of life expectancy and its association with socio-demographic index: Results from GBD study 2023. *PLOS One*, Article e0347865. https://doi.org/10.1371/journal.pone.0347865

Tsekane, P. N., Bessala, J. M. N., Tedga, P. N., & Samba, M. C. (2024). Access to energy and women's human capital in Sub-Saharan Africa. *Heliyon*, 10(15), e34556. https://doi.org/10.1016/j.heliyon.2024.e34556

UNESCO Institute for Statistics. (2023). Nigeria literacy statistics. *UNESCO Institute for Statistics*. https://uis.unesco.org

United Nations Development Programme. (2024). Human development report 2023/2024: Breaking the gridlock: Reimagining cooperation in a polarised world. *United Nations Development Programme*. https://hdr.undp.org

Vlad, B. P., & Mazuru, L. (2026). Mapping European Countries' Resilience to Cognitive Warfare. *Administrative Sciences*, 16(3), 160.

Wirayuda, A. A. B., & Chan, M. F. (2021). A systematic review of sociodemographic, macroeconomic, and health resources factors on life expectancy. *Asia Pacific Journal of Public Health*, 33(4), 401-412. https://doi.org/10.1177/1010539520983671

World Bank. (2024). World development indicators. *World Bank*. https://data.worldbank.org

World Health Organisation. (2023). Global health expenditure database. *World Health Organisation*. https://apps.who.int/nha/database

World Health Organisation. (2024). World health statistics 2024: Monitoring health for the SDGs. *World Health Organisation*. https://www.who.int/data/gho/publications/world-health-statistics