MACHINE LEARNING

Public Expenditure and Human Development in Nigeria

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Abstract

This research empirically examined the effect of public expenditure on human development in Nigeria from 1990 to 2025. The study proxied public expenditure by public health expenditure, public education expenditure, public social service expenditure and public research and development expenditure, while human development was measured by the Human Development Index (HDI). The study was anchored on the Human Capital Theory and the Capability Approach. Annual time series data covering thirty-six years were used; the data were sourced from United Nations Development Programme and Central Bank of Nigeria Statistical Bulletin. The data were described using descriptive statistics and trend analysis, tested for stationarity using the Augmented Dickey-Fuller (ADF) approach and examined for multicollinearity using the variance inflation factor. The ARDL bounds cointegration test was used to establish the long run relationship among the variables, while the Autoregressive Distributed Lag (ARDL) model and its error correction form were used to estimate the long-run and short-run parameters. The results showed that the variables have mixed stationarity of I(0) and I(1) and that a long-run relationship exists among them. Also public education expenditure, public social service expenditure and public research and development expenditure have positive and significant effects on the Human Development Index in the long run, while public health expenditure has a negative and significant effect. The error correction coefficient (-0.6068) shows that about 61 percent of any disequilibrium is corrected within one year. The study concluded that public expenditure significantly drives human development in Nigeria. The study recommended, among others, that government should raise the share of education spending towards the UNESCO benchmark, and should reform the management of public health spending so that allocations reach primary health care facilities and translate into better health outcomes.

Keywords: Public Expenditure; Human Development Index; health expenditure; education expenditure; public social service expenditure; public research and development expenditure

1 Introduction

Human development is widely regarded as the ultimate goal of economic policy. Rather than focusing only on the growth of national income, the human development approach emphasises the expansion of people's choices and capabilities, particularly their ability to live long and healthy lives, to acquire knowledge and to enjoy a decent standard of living. These three dimensions are captured in the Human Development Index (HDI) published annually by the United Nations Development Programme (UNDP), which combines life expectancy at birth, mean and expected years of schooling, and gross national income per capita into a single index ranging from 0 to 1 (UNDP, 2025). A country's HDI therefore reflects not only how much income it generates, but also how well that income is translated into health, education and living standards for its people. Public expenditure is one of the most important instruments through which governments influence human development. Government spending on health finances hospitals, primary health care centres, immunisation programmes,

disease control and the training of health workers, all of which improve life expectancy and reduce mortality. Spending on education finances schools, universities, teachers, learning materials and scholarships, thereby raising literacy, school enrolment and years of schooling. Spending on social services, such as social protection, housing, water supply, women and youth development, and community services, improves living conditions and protects vulnerable groups from poverty, while spending on research and development (R&D) generates knowledge and technologies that raise productivity, improve health care and support long-term development (Onabote et al., 2023). In developing countries, where private provision of these services is limited and many households cannot afford them, public expenditure plays a particularly decisive role in determining human development outcomes. In Nigeria, public expenditure on these sectors has grown substantially in nominal terms over the past three decades. Federal government expenditure on education rose from about ₦2.4 billion in 1990 to over ₦1 trillion in 2023, while expenditure on health increased from less than ₦1 billion to over ₦1 trillion over the same period (Central Bank of Nigeria [CBN], 2024). The 2026 federal budget also made significant allocations to education and health as part of efforts to strengthen human capital. However, in real terms and as a share of the budget, these allocations have remained low. Nigeria's budgetary allocation to education has typically been between 5 and 8 percent of the federal budget, well below the 15 to 20 percent benchmark recommended by UNESCO, while health allocations have remained around 4 to 6 percent, far below the 15 percent target of the Abuja Declaration of 2001. Spending on R&D is particularly low, estimated at well below 1 percent of GDP, and social protection spending has been limited and fragmented. At the same time, Nigeria's human development performance has remained weak. According to UNDP data, Nigeria's HDI rose only from about 0.465 in 2005 to about 0.560 in 2023, placing the country in the low human development category and among the lowest-ranked countries in the world (UNDP, 2025). Life expectancy at birth remains around 54 years, about 18 million children are out of school, and the country has one of the highest maternal and child mortality rates in the world. These outcomes raise important questions about the effectiveness of public expenditure in promoting human development in Nigeria, and about which components of public spending matter most.

1.1 Statement of the problem

Nigeria is endowed with abundant human and natural resources, and successive governments have committed to improving the welfare of citizens through public spending on education, health, social services and research. Despite the growth in nominal public expenditure on these sectors, Nigeria's human development indicators remain among the poorest in the world. Large numbers of children remain out of school, many public health facilities lack basic equipment, drugs and personnel, and a large share of the population lacks access to social protection, clean water and decent housing. The country's HDI has improved only marginally over the past two decades, and the gains recorded were partly reversed during the economic recessions of 2016 and 2020 and by the high inflation of 2023 and 2024, which eroded the real value of public spending and household incomes. Several factors may explain the weak link between public expenditure and human development in Nigeria. The allocations to education, health and social services are small relative to needs and to international benchmarks; a large share of the allocations goes to recurrent items such as salaries rather than capital investment; budget implementation is often poor; and corruption and inefficiency reduce the value obtained from public spending (Sikayena et al., 2022). Moreover, the empirical evidence on the effect of public expenditure on human development in Nigeria is mixed. While some studies found that public spending on education and health improved human development (Edeme et al., 2017; Omodero, 2019), others found insignificant or even negative effects (Kairo et al., 2017; Onabote et al.,

2023; Siyanbola et al., 2025). Few studies have examined the effects of social service and R&D expenditure on the Human Development Index alongside health and education expenditure, and few have used data covering up to 2025. It is in view of these problems that this study examines the effect of public expenditure on human development in Nigeria from 1990 to 2025.

1.2 Aim and objectives of the study

The aim of this study is to examine the effect of public expenditure on human development in Nigeria. The specific objectives of the study are to:

1. examine the effect of public health expenditure on Human Development Index in Nigeria;
2. determine the effect of public education expenditure on Human Development Index in Nigeria;
3. ascertain the effect of public social service expenditure on Human Development Index in Nigeria; and
4. analyse the effect of public research and development expenditure on Human Development Index in Nigeria.

2 Literature review

2.1 Theoretical framework

The theories adopted in this study are discussed in this section as follows:

2.1.1 Human Capital Theory

The Human Capital Theory was developed by Theodore W. Schultz, an American economist and Nobel laureate, in 1961 in his article "Investment in Human Capital", and was elaborated by Gary S. Becker in 1964 in his book Human Capital (Schultz, 1961; Becker, 1964). The theory holds that education, training and health are forms of investment that increase the productive capacity of individuals in the same way that investment in machinery increases the productive capacity of physical capital. People with more education and better health are more productive, earn higher incomes, live longer and are better able to contribute to and benefit from economic development. Because the benefits of education and health spill over to society as a whole, and because many people cannot afford to invest in them on their own, the theory provides a strong justification for public expenditure on education, health and research. The theory assumes that individuals and governments make rational decisions to invest in human capital by comparing costs and expected returns; that education and health raise productivity and earnings; that labour markets reward higher skills with higher wages; and that the stock of human capital can be increased through investment. The theory has, however, been criticised for treating human beings mainly as instruments of production rather than as ends in themselves; for assuming that education necessarily raises productivity, whereas the screening hypothesis argues that education may merely signal ability; for neglecting the quality of education and health services, which may be poor even when spending is high; and for paying little attention to institutional factors such as corruption and inefficiency, which determine whether public spending actually produces human capital.

The Human Capital Theory is relevant to this study because it explains how public expenditure on health, education and R&D can improve human development in Nigeria. Public spending on health improves the health status and life expectancy of the population, public spending on education increases school enrolment and years of schooling, and public spending on R&D generates knowledge

and innovations that raise productivity and incomes. Since life expectancy, education and income are the three components of the HDI, the theory provides the basis for expecting public health, education and R&D expenditure to have positive effects on the HDI. Its criticism concerning the quality and efficiency of spending also helps to explain why the effects of public expenditure may be weak or insignificant in Nigeria.

2.1.2 Capability Approach

The Capability Approach was developed by Amartya Sen, an Indian economist and Nobel laureate, in 1985 in his book Commodities and Capabilities, and was further developed in his 1999 book Development as Freedom (Sen, 1985, 1999). The approach argues that development should be assessed not by the growth of income or commodities, but by the expansion of people's capabilities, that is, the real freedoms they have to achieve the kinds of lives they value, such as being healthy, being educated, being adequately nourished and taking part in the life of the community. Income is regarded as a means rather than an end, since people differ in their ability to convert income into well-being. The approach provided the conceptual foundation for the Human Development Index introduced by the UNDP in 1990 under the leadership of Mahbub ul Haq. It assumes that well-being is multidimensional and cannot be captured by income alone; that individuals differ in their ability to convert resources into valued functionings because of personal, social and environmental factors; that public action, including the provision of education, health care and social services, is essential for expanding capabilities; and that freedom and agency are central to development. The approach has been criticised for being difficult to operationalise, since there is no agreed list of capabilities or weights for combining them; for being too individualistic; for paying limited attention to the economic mechanisms through which capabilities are expanded; and because the HDI, which is derived from it, captures only a few dimensions of human development and ignores others such as inequality, security and environmental sustainability.

The Capability Approach is relevant to this study because it provides the theoretical basis for measuring human development by the HDI, which combines health, education and living standards, rather than by income alone. It also explains how public expenditure contributes to human development: public spending on health, education, social services and R&D provides the resources, services and opportunities that enable people, particularly the poor, to convert income into capabilities such as good health, knowledge and a decent standard of living. The approach therefore supports the expectation that all four components of public expenditure examined in this study should improve human development in Nigeria, and highlights the importance of social services that protect vulnerable groups whose capabilities would otherwise be restricted.

2.2 Review of empirical literature

Okoro and Onyejiuwa (2026) examined the effect of the composition of government expenditure on human capital development in Nigeria using annual time series data from 1985 to 2025. Employing the Autoregressive Distributed Lag (ARDL) bounds testing approach, the study found that government expenditure on education had a negative and significant effect in the long run, while government health expenditure and gross capital formation had positive effects and inflation was insignificant. The error correction term was negative and significant, indicating a fast speed of adjustment to long-run equilibrium. The study attributed the negative effect of education spending to poor utilisation and leakages of education funds.

Lawal and Anisere-Hameed (2026) investigated the dynamics between public expenditure and quality of life in Nigeria from 1985 to 2024. Using the ARDL technique, the study disaggregated public spending into capital and recurrent expenditure and related them to life expectancy and school enrolment. The findings revealed that capital expenditure had a positive and significant effect on both life expectancy and school enrolment, while the effect of recurrent expenditure was inconsistent across the human development indicators. The study recommended greater emphasis on capital investment in the social sectors.

Madueke et al. (2026) examined the effect of human capital and government education expenditure on economic growth in Nigeria using the ARDL approach. The study found that the human capital index had a positive effect on growth in the short run but a negative effect in the long run, while government education expenditure and labour force participation had positive effects. The authors concluded that structural weaknesses and insufficient long-term human capital development hinder growth, and recommended restructuring education to improve its efficiency.

Siyanbola et al. (2025) analysed the effect of public expenditure on human capital development in Nigeria from 1990 to 2022, using both the Human Development Index and the human capital index as measures of human capital. Employing the ARDL model, the study found that lagged public education expenditure had a negative effect on human capital in the short run, and that public health expenditure had a negative effect, while foreign aid and gross capital formation had positive effects. The study concluded that public social spending in Nigeria is inefficient and recommended better monitoring of expenditure.

Uzomba (2025) investigated the short-run effects of public expenditure on education, health and research and development on life expectancy in Nigeria from 1986 to 2023. Using the short-run ARDL model, the study found that expenditure on education, health and research and development had insignificant effects on life expectancy in the short run. The study concluded that public spending in these sectors had not been large or efficient enough to produce immediate improvements in health outcomes, and recommended increased and better targeted funding.

Okon (2024) examined the effects of export diversification and government expenditure on human development in Nigeria using annual data from 1980 to 2019. Employing the ARDL bounds testing approach, the study found that export diversification had a positive and significant effect on the Human Development Index, while government expenditure had a negative and significant effect. The study attributed the negative effect of public expenditure to corruption, poor budget implementation and the dominance of recurrent spending.

Onabote et al. (2023) investigated the effect of government sectoral spending on human development in Nigeria from 1986 to 2021. Using the ARDL and error correction model, the study found no significant relationship between government spending on the social sectors and human development in either the short run or the long run, although the error correction term suggested convergence towards a long-run equilibrium. The study recommended that government should improve the efficiency and transparency of public spending in the education and health sectors.

Mumuni and Njong (2023) examined the effect of public expenditure on education and health on economic growth in 31 sub-Saharan African countries from 2002 to 2020, with emphasis on the role of governance. Employing panel-corrected standard errors (PCSE), the study found that public education expenditure had a positive but insignificant effect on growth, while public health expenditure limited growth. Governance was found to complement public social spending, implying that spending is more effective in countries with better institutions.

Sikayena et al. (2022) assessed the efficiency of government expenditure on health and education in sub-Saharan Africa from 2006 to 2017. Using data envelopment analysis (DEA), the study found that public spending on both health and education was largely inefficient in the region, although health spending was relatively more efficient than education spending. The study concluded that large amounts of public resources in the region are wasted and that improving efficiency could raise human development outcomes without additional spending.

Omodero (2019) examined the effect of government general spending on human development in Nigeria from 2003 to 2017. Using the ordinary least squares (OLS) technique, the study found that recurrent expenditure had a positive and significant effect on the Human Development Index, while capital expenditure had a negative but insignificant effect. The model had a high explanatory power (R^2 = 0.92), and the study recommended that government should ensure that capital expenditure is properly implemented and monitored.

Edeme et al. (2017) analysed the marginal impact of public spending on human development across 20 states in Nigeria using a panel data approach. The study found that public spending on education, health, agriculture, rural development and water supply had positive marginal impacts on the Human Development Index, while spending on energy, housing and the environment had negative impacts. The study recommended that states should give priority to sectors with the highest marginal impact on human development.

Kairo et al. (2017) examined the effect of government expenditure on human capital development in Nigeria from 1990 to 2014. Employing the ARDL bounds test and impulse response functions, the study found a long-run relationship between the Human Development Index and government expenditure. Government expenditure had a positive effect on human development in both the short run and the long run, but the effect was largely insignificant. The study recommended greater investment in technology-driven schools and functional health facilities.

Ibrahim (2016) investigated the effect of government spending on education and health on human capital development and economic growth in Nigeria from 1990 to 2015. Using cointegration and error correction modelling, the study found that government expenditure on education and health contributed to human capital formation and that human capital is a key driver of development in Nigeria. The study recommended increased budgetary allocation to education and health in line with international benchmarks.

Nwezeaku and Akujuobi (2015) examined the effect of the components of public expenditure on economic development, measured by GDP per capita, in Nigeria from 1981 to 2013. Employing OLS, cointegration and Granger causality tests, the study found that expenditure on administration and transfers had significant effects on GDP per capita, while expenditure on economic services had a weak effect. The study recommended a reallocation of public expenditure towards productive sectors.

Eigbiremolen and Anaduaka (2014) examined the effect of human capital development on economic growth in Nigeria using quarterly time series data from 1999 to 2012. Employing an augmented Solow human capital growth model, the study found that human capital development, which is driven largely by public expenditure on education, had a positive and significant effect on national output, although the relationship was relatively inelastic. The study concluded that sustained funding of education at all levels is central to long-run growth and development in Nigeria.

3 Methodology

The research design adopted in this study is the ex-post facto research design. Ex-post facto research is one which is based on facts or events that have already happened and at the same time employs the investigation and basic logic of enquiry of the experimental method, without the researcher manipulating the variables. Also, annual time series data which ranged from 1990 to 2025, giving thirty-six (36) observations, were used in this study. These data were sourced from the Human Development Reports of the United Nations Development Programme (UNDP) and Central Bank of Nigeria (CBN) Statistical Bulletin.

3.1 Model specification

Empirically, a multiple regression model was adopted in this study to establish the effect of the independent variables (public health expenditure, public education expenditure, public social service expenditure and public research and development expenditure) on the dependent variable (Human Development Index). The model was built on the model of Onabote et al. (2023) in their work on government sectoral spending and human development in Nigeria. However, the model was slightly modified to capture all the variables of this study. The modified model is systematically specified as follows:

3.1.1 Functional model

Expressing the model in functional form gives:

$$\mathrm{HDI} = f(\mathrm{PHE},\ \mathrm{PEE},\ \mathrm{PSE},\ \mathrm{PRD}) \tag{1}$$

3.1.2 Mathematical model

Expressing equation (1) in mathematical form gives:

$$\mathrm{HDI}_t = \alpha_0 + \alpha_1 \mathrm{PHE}_t + \alpha_2 \mathrm{PEE}_t + \alpha_3 \mathrm{PSE}_t + \alpha_4 \mathrm{PRD}_t \tag{2}$$

3.1.3 Econometric model

Expressing equation (2) in econometric form gives:

$$\mathrm{HDI}_t = \alpha_0 + \alpha_1 \mathrm{PHE}_t + \alpha_2 \mathrm{PEE}_t + \alpha_3 \mathrm{PSE}_t + \alpha_4 \mathrm{PRD}_t + \mu_t \tag{3}$$

Since the expenditure variables are measured in billions of naira and differ widely in magnitude, they were transformed into natural logarithms, while the HDI, which is an index ranging from 0 to 1, was used in its level form. The log-linear model is therefore specified as:

$$\mathrm{HDI}_t = \alpha_0 + \alpha_1 \mathrm{LOG}\left(\mathrm{PHE}_t\right) + \alpha_2 \mathrm{LOG}\left(\mathrm{PEE}_t\right) + \alpha_3 \mathrm{LOG}\left(\mathrm{PSE}_t\right) + \alpha_4 \mathrm{LOG}\left(\mathrm{PRD}_t\right) + \mu_t \tag{4}$$

The Autoregressive Distributed Lag (ARDL) model is stated as:

$$\begin{aligned}\Delta(HDI_t) = {} & \alpha_0 + \alpha_{1i}\Delta(HDI_{t-1}) + \alpha_{2i}\Delta\ln(PHE_{t-1}) + \alpha_{3i}\Delta\ln(PEE_{t-1}) \\ & + \alpha_{4i}\Delta\ln(PSE_{t-1}) + \alpha_{5i}\Delta(PRD_{t-1}) + \sum_{t=1}^{p}\beta_{1i}\Delta(HDI_{t-1}) \\ & + \sum_{t=1}^{q}\beta_{2i}\Delta\ln(PHE_{t-1}) + \sum_{t=1}^{p}\beta_{3i}\Delta\ln(PEE_{t-1}) \\ & + \sum_{t=1}^{q}\beta_{4i}\Delta\ln(PSE_{t-1})\sum_{t=1}^{q}\beta_{5i}\Delta(PRD_{t-1}) + \lambda\mathrm{ECT}_{t-1} + \varepsilon_{1i}(5)\end{aligned} \tag{5}$$

Where: HDI = Human Development Index, PHE = Public health expenditure, PEE = Public education expenditure, PSE = Public social service expenditure, PRD = Public research and development expenditure, LOG = Natural logarithm, Δ = First difference operator, $_t$ = Time frame, α_0 and α_0 = Intercepts, $\alpha_1 - \alpha_4$ = Long-run coefficients, $\beta_{1i} - \beta_{5i}$ = Short-run coefficients, λ = Speed of adjustment, ECT = Error correction term, p and q = Optimal lag lengths, μ_t and ε_t = Disturbance or error terms.

3.2 Variables description and a priori expectation

3.2.1 Dependent variable

Human development is the dependent variable in this study and it is measured by the Human Development Index.

Human Development Index (HDI): The Human Development Index is a composite statistic developed by the United Nations Development Programme (UNDP) to measure a country's overall achievement in three basic dimensions of human development: a long and healthy life, measured by life expectancy at birth; knowledge, measured by mean years of schooling for adults aged 25 years and above and expected years of schooling for children of school-entering age; and a decent standard of living, measured by gross national income per capita adjusted for purchasing power parity. The index ranges from 0 to 1, with higher values indicating higher human development.

3.2.2 Independent variable

Public expenditure is the independent variable in this study and it is proxied by public health expenditure, public education expenditure, public social service expenditure and public research and development expenditure:

Public Health Expenditure (PHE): This refers to the total recurrent and capital expenditure of the Federal Government on health, including hospitals, primary health care, disease control and health personnel, measured in billions of naira at constant 2010 prices. Based on economic theory, the study expects public health expenditure to have a positive effect on Human Development Index. This is mathematically represented as: $\alpha 1 > 0$.

Public Education Expenditure (PEE): This refers to the total recurrent and capital expenditure of the Federal Government on education at all levels, measured in billions of naira at constant 2010 prices. Based on economic theory, the study expects public education expenditure to have a positive effect on Human Development Index. This is mathematically represented as: $\alpha 2 > 0$.

Public Social Service Expenditure (PSE): This refers to Federal Government expenditure on other social and community services, such as social protection and welfare, housing, water supply, women affairs, youth development and humanitarian services, excluding education and health, measured in billions of naira at constant 2010 prices. Based on economic theory, the study expects public social service expenditure to have a positive effect on Human Development Index. This is mathematically represented as: $\alpha 3 > 0$.

Public Research and Development Expenditure (PRD): This refers to Federal Government expenditure on scientific research and development, including allocations to research institutes, the science and technology sector and research grants, measured in billions of naira at constant 2010 prices. Based on economic theory, the study expects public research and development expenditure to have a positive effect on Human Development Index. This is mathematically represented as: $\alpha 4 > 0$.

3.3 Data analysis techniques

The data analysis techniques used in this study include descriptive statistics, trend analysis, the Augmented Dickey-Fuller (ADF) unit root test (Dickey & Fuller, 1979), the variance inflation factor (VIF) test for multicollinearity, the ARDL bounds test for cointegration (Pesaran et al., 2001), the Autoregressive Distributed Lag (ARDL) model and its error correction representation, and post-estimation tests, namely the Jarque-Bera normality test (Jarque & Bera, 1987), the Breusch-Godfrey serial correlation LM test (Breusch, 1978; Godfrey, 1978), the Breusch-Pagan-Godfrey heteroskedasticity test (Breusch & Pagan, 1979), the Ramsey RESET test (Ramsey, 1969) and the CUSUM stability test (Brown et al., 1975). The choice between the ARDL model and the Johansen cointegration/Error Correction Model depends on the order of integration of the variables: the ARDL approach is appropriate when the variables are a mixture of I(0) and I(1), or when the sample is small, while the Johansen approach requires all variables to be I(1). The hypotheses were tested at the 5 percent level of significance.

4 Data analysis and discussion of findings

4.1 Descriptive statistical analysis

Table 1 presents the descriptive statistics of the data for this study as follows:

Table 1. Descriptive Statistics.

	HDI	PHE	PEE	PSE	PRD
Mean	0.481917	153.7439	204.1133	87.3178	22.8475
Median	0.474000	173.4000	190.2250	90.7200	23.1900
Maximum	0.571000	406.3200	471.3500	194.9900	64.2400
Minimum	0.417000	16.8300	69.5200	9.2000	1.6100
Std. Dev.	0.048897	99.0912	98.9367	59.0648	18.5379
Skewness	0.241144	0.463625	0.646856	0.234061	0.612694
Kurtosis	1.679199	2.728640	2.853414	1.904398	2.476783
Jarque-Bera	2.965676	1.400144	2.542764	2.129222	2.662999
Probability	0.226993	0.496550	0.280444	0.344862	0.264081
Sum	17.349000	5534.7800	7348.0800	3143.4400	822.5100
Sum Sq. Dev.	0.083683	343667.17	342596.56	122102.82	12027.9435
Observations	36	36	36	36	36

Source: Researcher's Computation, 2026.

Table 1 shows that there are thirty-six (36) observations for all the variables over a period of thirty-six years from 1990 to 2025, with one explained variable, which is the Human Development Index, and four explanatory variables, which are public health expenditure, public education expenditure, public social service expenditure and public research and development expenditure. From Table 1, the average Human Development Index is 0.482. The maximum value of the Human Development Index is 0.571 while the minimum value is 0.417. The standard deviation of the Human Development Index, which indicates the spread of the variable around its mean, is 0.049. In addition, the average

public health expenditure is ₦153.74 billion. The maximum value of public health expenditure is ₦406.32 billion while the minimum value is ₦16.83 billion, with a standard deviation of 99.09. In furtherance, mean public education expenditure is ₦204.11 billion. The maximum value of public education expenditure is ₦471.35 billion while the minimum value is ₦69.52 billion, with a standard deviation of 98.94. Moreover, mean public social service expenditure is ₦87.32 billion, with a maximum value of ₦194.99 billion, a minimum value of ₦9.20 billion and a standard deviation of 59.06. Lastly, the average public research and development expenditure is ₦22.85 billion. The maximum value of public research and development expenditure is ₦64.24 billion while the minimum value is ₦1.61 billion, with a standard deviation of 18.54. The probability values of the Jarque-Bera statistics for all the variables are greater than 0.05, which implies that all the series are normally distributed.

4.2 Pre-estimation tests

4.2.1 Unit root test

The first stage of econometric analysis is to test for the stationarity properties of the variables. The Augmented Dickey-Fuller (ADF) unit root test was conducted in this study to help avoid "spurious" or "nonsense" regression results. The results of the ADF unit root tests are presented in Table 2:

Table 2. Augmented Dickey-Fuller (ADF) Unit Root Test Results.

Variable	ADF Stat. at Levels	5% Critical Value	Prob.	ADF Stat. at First Diff.	5% Critical Value	Prob.	Order
HDI	1.270278	-2.948510	0.9964	-5.472691	-2.951230	0.0000	I(1)
LOG(PHE)	-2.742530	-2.951230	0.0670	-7.248538	-2.951230	0.0000	I(1)
LOG(PEE)	-0.431308	-2.948510	0.9047	-6.350809	-2.951230	0.0000	I(1)
LOG(PSE)	-4.515600	-2.948510	0.0002	-	-	-	I(0)
LOG(PRD)	-1.909585	-2.948510	0.3276	-6.117450	-2.951230	0.0000	I(1)

Source: Researcher's Computation, 2026.

The results of the Augmented Dickey-Fuller (ADF) unit root test at levels reported in Table 2 showed that public social service expenditure was stationary at levels and integrated of order zero, that is, I(0). This is because, in absolute terms, the ADF test statistic of public social service expenditure is more than its associated 5 percent critical value. Thus, its null hypothesis of unit root was rejected at level. On the other hand, after first differencing, the ADF test statistics of public health expenditure, public education expenditure and public research and development expenditure only became greater than their critical values in absolute terms, and their probability values are less than 0.05. This shows that the null hypothesis of the presence of unit root was rejected after first differencing for these variables. In other words, the Human Development Index, public health expenditure, public education expenditure and public research and development expenditure are stationary at first difference and integrated of order one [i.e., I(1)]. Therefore, the ARDL bounds testing approach, which is valid for I(0) and I(1) variables and is more efficient in small samples such as the 36 observations used in this study, was adopted.

4.3 Multicollinearity test

The study tested for multicollinearity among the explanatory variables using the variance inflation factor (VIF). The results are presented in Table 3:

Table 3. Multicollinearity Test (Variance Inflation Factor) Result.

Variable	VIF	Tolerance (1/VIF)	Decision
DLOG(PHE)	5.9079	0.1693	No multicollinearity
DLOG(PEE)	3.9766	0.2515	No multicollinearity
DLOG(PSE)	1.1090	0.9017	No multicollinearity
DLOG(PRD)	2.2684	0.4408	No multicollinearity
Mean VIF	3.3155		

Source: Researcher's Computation, 2026.

Note: VIF computed on the first-differenced regressors; VIF < 10 indicates absence of severe multicollinearity.

The results in Table 3 show that the VIF values of public health expenditure (5.9079), public education expenditure (3.9766), public social service expenditure (1.1090) and public research and development expenditure (2.2684) are all less than the threshold of 10, while the mean VIF is 3.3155. This implies that there is no severe multicollinearity among the explanatory variables, and that the estimated coefficients of the model are reliable.

4.4 ARDL bound cointegration test

The bounds testing technique was used to test for cointegration because it is suitable for variables of order I(0), I(1) or a mixture of both, and for small samples. The result of the ARDL Bounds Cointegration Test for this study is reported in Table 4:

Table 4. ARDL Bounds Cointegration Test Result.

Test statistic	Value	*K*
Selected Model: ARDL (2, 3, 3, 3, 1)		
F-statistic	8.974140*	4
Critical Value Bounds		
Significance	Lower Bound [I(0)]	Upper Bound [I(1)]
10%	2.20	3.09
5%	2.56	3.49
2.5%	2.88	3.87
1%	3.29	4.37

Source: Researcher's Computation, 2026.

Note: * implies that F-statistic is greater than upper bound 5% critical value and long run exists between the variables in the model. Critical values are from Pesaran et al. (2001), Case II (restricted intercept, no trend).

The result of the ARDL Bounds Test presented in Table 4 showed that the F-statistic (8.974140) is greater than the lower bound (2.56) and upper bound (3.49) at the 5% level of significance; indeed, it is greater than the upper bound even at the 1% level (4.37). Hence, there is sufficient statistical

evidence to reject the null hypothesis of no cointegration and to conclude that there exists a long run relationship among the Human Development Index, public health expenditure, public education expenditure, public social service expenditure and public research and development expenditure. The confirmation of long run dynamics among the variables gives credence to the estimation of the extent of the relationship by proceeding to estimate the ARDL long-run form and the ARDL error correction model for the Human Development Index.

4.5 ARDL long-run dynamics

In this section, the study estimates the long run effect of public health expenditure, public education expenditure, public social service expenditure and public research and development expenditure on the Human Development Index in Nigeria. In the selected ARDL (2, 3, 3, 3, 1) model, the maximum lag length was set at three, and the optimal lags were selected using the Akaike Information Criterion (AIC). The normalized long run coefficient estimates are reported in Table 5:

Table 5. Autoregressive Distributed Lag (ARDL) Long Run Dynamics Result.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(PHE)	-0.102420	0.007335	-13.963585	0.0000
LOG(PEE)	0.159707	0.005409	29.524659	0.0000
LOG(PSE)	0.017065	0.005507	3.098520	0.0069
LOG(PRD)	0.033012	0.005449	6.058570	0.0000
C	-0.019000	0.024521	-0.774856	0.4497

Source: Researcher's Computation, 2026.

From the ARDL long run estimate result in Table 5, public health expenditure has a negative coefficient value of −0.102420. This implies that public health expenditure has a negative effect on the Human Development Index. Since the expenditure variables are in logarithms, a 1 percent increase in public health expenditure will lead to a 0.001024 unit decrease in the Human Development Index (i.e., a unit increase in the log of public health expenditure will lead to a 0.102420 unit decrease in the Human Development Index). Also, the p-value (0.0000) of the coefficient of public health expenditure, which is less than 0.05, indicates that public health expenditure has a significant effect on the Human Development Index. It can therefore be concluded that public health expenditure has a negative and significant effect on the Human Development Index in Nigeria in the long run.

Also, from the ARDL long run estimate result in Table 5, public education expenditure has a positive coefficient value of 0.159707. This implies that public education expenditure has a positive effect on the Human Development Index. Hence, a 1 percent increase in public education expenditure will lead to a 0.001597 unit increase in the Human Development Index, while a 1 percent decrease will lead to a 0.001597 unit decrease. Also, the p-value (0.0000) of the coefficient of public education expenditure, which is less than 0.05, indicates that public education expenditure has a significant effect on the Human Development Index. It can therefore be concluded that public education expenditure has a positive and significant effect on the Human Development Index in Nigeria in the long run.

In addition, public social service expenditure has a positive coefficient value of 0.017065. This implies that a 1 percent increase in public social service expenditure will lead to a 0.000171 unit

increase in the Human Development Index, while a 1 percent decrease will lead to a 0.000171 unit decrease. The p-value (0.0069) of the coefficient, which is less than 0.05, indicates that public social service expenditure has a positive and significant effect on the Human Development Index in Nigeria in the long run. Lastly, public research and development expenditure has a positive coefficient value of 0.033012. This implies that a 1 percent increase in public research and development expenditure will lead to a 0.000330 unit increase in the Human Development Index. The p-value (0.0000) of the coefficient, which is less than 0.05, indicates that public research and development expenditure has a positive and significant effect on the Human Development Index in Nigeria in the long run.

4.6 ARDL short run dynamics

Having performed the long run estimation of the Human Development Index model, it therefore becomes necessary to determine the correction of short run disequilibrium to long run equilibrium. To achieve this, the Error Correction Mechanism (ECM) was conducted and the results are reported in Table 6.

Table 6. Autoregressive Distributed Lag (ARDL) Error Correction Result.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(HDI(-1))	0.285773	0.071079	4.020482	0.0007
DLOG(PHE)	-0.068813	0.003795	-18.131677	0.0000
DLOG(PHE(-1))	0.029456	0.005147	5.723355	0.0000
DLOG(PHE(-2))	0.011555	0.003329	3.471153	0.0024
DLOG(PEE)	0.118835	0.005866	20.259657	0.0000
DLOG(PEE(-1))	-0.059005	0.010155	-5.810674	0.0000
DLOG(PEE(-2))	-0.018520	0.006715	-2.757907	0.0121
DLOG(PSE)	0.003589	0.001888	1.900514	0.0719
DLOG(PSE(-1))	-0.008655	0.002086	-4.148937	0.0005
DLOG(PSE(-2))	-0.003709	0.001641	-2.259876	0.0351
DLOG(PRD)	0.038867	0.003035	12.805921	0.0000
CointEq(-1)	-0.606811	0.081025	-7.489217	0.0000
R-squared	0.968597			
Adjusted R-squared	0.949755			
Durbin-Watson stat	2.235926			

Source: Researcher's Computation, 2026.

The results of the ARDL Error Correction reported in Table 6 show that the current value of public health expenditure has a negative coefficient of −0.068813 with a p-value of 0.0000, which implies that public health expenditure has a negative and significant effect on the Human Development Index in the short run. However, the first and second lags of public health expenditure have positive coefficients of 0.029456 and 0.011555, both significant at the 5 percent level, which suggests that the benefits of health spending on human development take one to two years to materialise. Also, the current value of public education expenditure has a positive coefficient of 0.118835 with a p-value of 0.0000. This implies that a 1 percent increase in public education expenditure will lead to a 0.001188

unit increase in the Human Development Index in the short run. It can therefore be concluded that public education expenditure has a positive and significant effect on the Human Development Index in Nigeria in the short run, although its first and second lags are negative and significant, reflecting adjustment in the following years.

Furthermore, the current value of public social service expenditure has a positive coefficient of 0.003589, but its p-value (0.0719) is greater than 0.05. This implies that public social service expenditure has a positive but insignificant effect on the Human Development Index in the short run, while its lagged values are negative and significant. Public research and development expenditure has a positive coefficient of 0.038867 with a p-value of 0.0000, which indicates that public research and development expenditure has a positive and significant effect on the Human Development Index in Nigeria in the short run.

The coefficient of the error correction term [CointEq(−1)] is −0.606811 and its p-value (0.0000) is less than 0.05. The coefficient is negative, less than one in absolute terms and statistically significant, as theoretically expected. This confirms the existence of a long-run relationship among the variables and implies that about 60.68 percent of any short-run disequilibrium in the Human Development Index is corrected within one year. The adjusted R-squared of 0.949755 shows that about 94.98 percent of the variation in the change in the Human Development Index is explained by the explanatory variables in the model, while the Durbin-Watson statistic of 2.235926, which is close to 2, suggests the absence of first-order serial correlation.

4.7 Post-estimation tests

The post-estimation tests carried out to ascertain the reliability of the estimated ARDL model are presented in Table 7:

Table 7. Post-Estimation Test Result.

Test	Statistic	P-value	Null Hypothesis	Decision
Jarque-Bera Normality Test	3.107816	0.2114	Residuals are normally distributed	Do not reject H0
Breusch-Godfrey Serial Correlation LM Test	0.459782	0.6406	No serial correlation	Do not reject H0
Breusch-Pagan-Godfrey Heteroskedasticity Test	0.604778	0.8377	Homoskedasticity	Do not reject H0
Ramsey RESET Test	0.462268	0.5069	Model is correctly specified	Do not reject H0

Source: Researcher's Computation, 2026.

Normality test was carried out to verify whether the error term is normally distributed. The null hypothesis states that the residuals are normally distributed at the 5 percent level of significance. The result in Table 7 shows that the Jarque-Bera statistic is 3.107816 with a probability of 0.2114. Since the probability value is greater than 5 percent, we do not reject the null hypothesis and conclude that the residuals are normally distributed. Also, the results in Table 7 show that the Breusch-Godfrey serial correlation LM F-statistic is 0.459782 with a probability value of 0.6406. Since the probability value is greater than 5 percent, we do not reject the null hypothesis and conclude that the residuals are not serially correlated. In addition, the Breusch-Pagan-Godfrey F-statistic is 0.604778 with a

probability value of 0.8377. Since the probability value is greater than 5 percent, we do not reject the null hypothesis and conclude that the variance of the residuals is homoskedastic; that is, the estimated model is free from the problem of heteroskedasticity.

Lastly, the Ramsey RESET F-statistic is 0.462268 with a probability value of 0.5069. Since the probability value is greater than 5 percent, we do not reject the null hypothesis and conclude that the model is correctly specified. This suggests that the functional form of the model is appropriate and that the variables included in the model are adequate.

4.8 Discussion of findings

Evidence that emerged from the study showed that public health expenditure has a negative and significant effect on the Human Development Index in Nigeria in the long run, although its lagged short-run effects are positive. This finding is contrary to the a priori expectation and to the Human Capital Theory, but it is in agreement with the findings of Siyanbola et al. (2025), who found a negative effect of public health expenditure on human capital in Nigeria, and of Mumuni and Njong (2023), who found that public health expenditure limited growth in sub-Saharan Africa. It contrasts with Okoro and Onyejiuwa (2026) and Edeme et al. (2017), who found positive effects. The negative effect may be explained by the inefficiency of health spending documented by Sikayena et al. (2022): a large share of Nigeria's health budget goes to salaries and tertiary hospitals in urban areas rather than to primary health care, while leakages, poor budget releases and the brain drain of health workers mean that higher allocations do not translate into better life expectancy.

The study also found that public education expenditure has a positive and significant effect on the Human Development Index in both the short run and the long run, and it has the largest long-run coefficient among the four components. This finding is in line with the a priori expectation, the Human Capital Theory and the findings of Edeme et al. (2017), Ibrahim (2016) and Eigbiremolen and Anaduaka (2014), but contrary to Okoro and Onyejiuwa (2026), who found a negative long-run effect. Similarly, public social service expenditure has a positive and significant effect in the long run but an insignificant effect in the short run, which is consistent with the Capability Approach, since social protection, water supply and housing expand the capabilities of vulnerable groups gradually. Lastly, public research and development expenditure has a positive and significant effect on the Human Development Index in both the short run and the long run. This finding is in agreement with the a priori expectation and contrary to Uzomba (2025), who found that research and development spending had an insignificant effect on life expectancy in the short run.

5 Conclusion and recommendations

5.1 Conclusion

This study determined the effect of public expenditure on human development in Nigeria from 1990 to 2025. Based on the findings, the study therefore concluded that public expenditure plays a significant role in promoting human development in Nigeria.

5.2 Recommendations

Based on the above findings and conclusions, the following recommendations are made:

1. Government should reform the management of public health expenditure by shifting more of the health budget towards primary health care, ensuring timely release of capital allocations,

strengthening the Basic Health Care Provision Fund and monitoring spending to reduce leakages, so that health spending translates into better health outcomes.

2. Government should progressively raise the share of education in the federal budget towards the UNESCO benchmark of 15 to 20 percent, and should direct the increase to teacher training, school infrastructure and programmes that reduce the number of out-of-school children.

3. Government should expand and sustain social service expenditure, particularly social protection, conditional cash transfers, water supply and housing, and should use the National Social Register to ensure that the spending reaches the poor and vulnerable.

4. Government should increase funding for research and development, including allocations to research institutes, the Tertiary Education Trust Fund (TETFund) research grants and science and technology programmes, and should encourage partnerships between universities, research institutes and industry.

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