ENVIRONMENTAL QUALITY AND LIFE EXPECTANCY IN NIGERIA: EVIDENCE FROM ARDL

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ABSTRACT

The quality of the environment measured through air quality, water quality, waste generation and climate variability directly enhances public health, disease burden and life expectancy. Investigation of the nexus between environmental quality and life expectancy in Nigeria has produced divergent opinions. Thus, this paper examined the effect of environmental quality indicators on life expectancy in Nigeria from 1988 to 2024. Pertinent secondary data were obtained from the World Development Indicator (WDI), the National Environmental Standards Regulations and Enforcement Agency (NESREA), Macro-trend data base, and the Notre Dame Global Adaptation Initiative (ND-GAIN). The data's stationary qualities were established using the Augmented Dickey-Fuller (ADF) unit root test, while the Autoregressive Distributed Lag (ARDL)/Bound co-integration technique was employed to estimate the model. Findings indicated a significant long-term effect of environmental quality indicators on life expectancy in Nigeria. Specifically, municipal solid waste and population growth had a negative and statistically significant effect on life expectancy; water quality index had a positive and statistically significant effect on life expectancy, while poor air quality and climate change index had a negative insignificant effect life expectancy in Nigeria within the sample period. The paper among others, recommended increasing access to safe drinking water for the population by the federal ministry of water resources in collaboration with the states counterpart through a public-private decentralized water supply strategy with focus on community-managed boreholes and small-scale water treatment plants.

Keywords: Environmental Quality, Life Expectancy, Human Capital Development, ARDL.
JEL Classification: Q53, O15, J24, C1.

I. INTRODUCTION

The quality of the environment has become one of the most critical determinants of human health outcomes and survival, particularly in countries experiencing rapid urbanization, industrialization and population growth. A deteriorating environment exposes populations to pollutants, hazardous waste, unsafe water, poor sanitation, greenhouse gas emissions, and climate-related disasters, all of which adversely affect human health outcomes and longevity. Globally, scholars (Polcyn *et al*., (2023); Wei *et al*., (2022); Mutizwa and Makochekanwa, (2015)) have increasingly recognized that improvements in environmental quality are closely correlated with higher life expectancy, reduced mortality rate and better standard of living. Environmental degradation contributes to prevalence of respiratory infections, cardiovascular diseases, waterborne illnesses, and other chronic health conditions that shorten human life span.

According to the World Bank (2020), poor environmental quality was responsible for about 80,000 premature deaths in West Africa. In 2016, air pollution was the second largest risk factor of non-communicable diseases worldwide, with 91 per cent of the world population being exposed to harmful pollution levels in ambient air. Indoor air pollution affected over 40 per cent of the world population, especially in low and middle level income countries. It was estimated that environmental and household air pollution is responsible for 24 per cent of cases of stroke, 25 per cent of ischemic heart disease, 28 per cent of lung cancer and 43 per cent of chronic obstructive respiratory disease while airborne exposure to chemicals caused 882,000 deaths (Badulescu *et al*., 2019).

In Nigeria, declining environmental quality, particularly, air pollution is exacerbated by urbanization and industrialization. Cities such as Lagos, Port Harcourt, and Kano report elevated levels of Particulate Matter ($PM_{2.5}$), often exceeding World Health Organization (WHO) guidelines by threefold, contributing to significant health risks. Lagos experienced $PM_{2.5}$ concentrations of up to 70 $\mu g/m^3$, well above the WHO limit of 25 $\mu g/m^3$, leading to a 20 per cent rise in respiratory illnesses. The Niger Delta faces unique challenges due to gas flaring, emitting over 16 million tons of CO_2 annually alongside other toxic gases, which directly impact air quality. Port Harcourt, for instance, has been heavily impacted by a phenomenon known as "black soot," which is primarily attributed to illegal oil refining activities in the Niger Delta (Kodiya *et al*., 2025). In addition to shortening life expectancy, poor environmental quality creates a burden on government expenditure in terms of healthcare. The World Bank (2020) estimated that poor environmental quality costs Nigeria about 1.5% of the country's GDP. These costs include healthcare expenses, loss of productivity, and damage to natural resources. Also, 11,200 premature deaths were reported as a result of ambient air pollution in Nigeria. Nigeria's response to poor environmental quality is recognized by its subscription to a number of international conventions and treaties on the environment between 1980 and 1990. Specifically, the then Federal Environmental Protection Agency (FEPA) was established in 1988 as part of the emerging coordinated approach to environmental issues by providing environmental guidelines and standards for the abatement and control of all forms of pollution (Odey, 2023). Nigeria's membership of the United Nations Conference on Climate Change (UNFCCC) Conference of Parties (COP) is informed by the government's efforts at improving environmental quality by ameliorating the effects of climate change (Emole, 2024). All these efforts within and outside the country, underscored the importance of improving environmental quality.

Statement of the problem

Empirical literature has increasingly examined how environmental quality affects health outcomes, particularly, life expectancy in both developed and developing countries. For example, Zhao *et al*. (2016) found that 12.5 per cent of annual global deaths are attributable to pollution. In addition, Lelieveld *et al.,* (2020) reported that poor environmental quality related disaster accounted for 2.9 years off global life expectancy; with East and South Asia respectively recording 3.9 and 3.3 years of life loss on the average and 3.1 years of life expectancy loss in Africa. In Nigeria, Kodiya *et al*., (2025) reported that environmental degradation-induced respiratory illnesses and heart diseases shorten the life expectancy of the population in the Niger Delta area of Nigeria. Also, Matthew *et al*., (2018), Afolayan and Aderemi (2019) found that CO_2 emission had adverse impact on life expectancy in Nigeria.

As a country, Nigeria is inundated with persistent declining environmental quality condition amidst slow gains in life expectancy which manifest in continued premature mortality, productivity loss, and fiscal burden as environmental stressors persist. Thus, the interplay of environmental quality and life expectancy offers a critical area of inquiry, as the interaction of both factors is critical in shaping sustainable development outcomes. The motivation for this study therefore stems from the need to provide a more encompassing understanding of the extent to which environmental quality influence life expectancy in Nigeria.

Theoretically, this study is grounded in the Environmental Kuznet Curve (EKC) (Kuznet, 1955), and the Human Capital theories (Becker, (1964) and Schultz, (1961)), which posit that health is a component of human capital influenced by socioeconomic and environmental factors. Despite their interconnectedness, there is the need in understanding the precise relationship between environmental quality indicators and life expectancy using expanded indicators of environmental quality such as waste generation, water quality and the impact of climate change which were not considered in previous study, in addition to extending the sample period of 1988 to 2024. Life expectancy is generally viewed as a broad indicator of the overall health status and welfare of a population, as it measures the average number of years a newborn is expected to live under prevailing mortality conditions and reflects the combined influence of access to healthcare, nutrition, income, education and environmental conditions; hence, it appropriately captures health outcome.

Thus, this paper seeks to investigate the extent to which key environmental quality indicators namely air quality (proxy by CO_2 emission used widely to gauge air quality), municipal solid waste (used as an indicator of waste generation), water quality (used to measure percentage of the population with access to safe drinking water) as well as the influence of population growth and institutional quality in influencing individual's life expectancy in Nigeria. The study is expected to contribute to existing literature by providing empirical evidence on how environmental quality indicators shape longevity and public health outcomes in Nigeria. It will also provide useful insights for policymakers, environmental agencies as well as public health authorities in designing integrated environmental and health policies aimed at improving living conditions and increasing the life expectancy of Nigerians. Specifically, the paper seeks to:

i. investigate the impact of air quality on life expectancy in Nigeria.
ii. examine the impact of municipal solid waste on life expectancy in Nigeria.
iii. evaluate the impact of water quality on life expectancy in Nigeria.
iv. analyse the impact of climate change on life expectancy in Nigeria.

II. LITERATURE REVIEW

Conceptual Review

The concept of environmental quality is used broadly to refer to the state of the natural environment as well as the notion of ambient quality and such things as the visual and aesthetic quality of the environment (Field & Field, 2017). Environmental quality entails the continuous deterioration in the condition of the environment due majorly to the activities of mankind and other natural phenomenon. It is the extent to which naturally occurring resources (land, air and water) are freed from impurities and degradation caused by human activity (Mutizwa & Makochekanwa, 2015). It measures the degree to which the environment is free from pollution, degradation, and harm, and capable of supporting human health and well-being, and the health and well-being of other living organisms (EPA, 2024). Also, environmental quality is a measure of the extent to which the environment is in a healthy, pristine, or desirable state, free from harm or degradation (Suter, 2016).

Porreca (2020) opined that decline in environmental quality is the consequence of degradation and excessive exploitation of natural resource as a result of the quest for economic growth and development. It involves air pollution concentrations that humans are in constant interaction with. The increasing deterioration in environmental quality across the world is posing serious challenges to healthy living through the increasing threat of global warming. The idea of ambient quality is embedded in the concept of environmental quality. Ambient quality in this context refers to the quantity of pollutants in the environment, for example, the concentration of SO2 in the air over a city or the concentration of a particular chemical in the waters of a lake.

Life expectancy has been widely used to reflect the overall health outcome owing to the fact that it captures the overall health status and well-being of a population. Life expectancy is the average number of years an individual is expected to live, based on the prevailing mortality rates of a given population. A longer life expectancy has been linked to increased productivity thus, yields indirect utility (Berger & Messer, 2002). Improvement in life expectancy can be achieved through medical care, exercises, diet, healthy lifestyles, improved environmental conditions, housing as well as recreation. Life expectancy is one of the most important outcomes that determine the quality of human capital development (Abdullah *et al*., 2016). The United Nations Development Programme (UNDP) through the Sustainable Development Goals (SDGs) to be achieved by the global community indirectly emphasized an improved life expectancy rate particularly under the goal 3 of the SDG which aimed at achieving good health and well-being by 2030. This was encapsulated in various targets of the SDGS such as; reducing the global maternal mortality ratio to less than 70 per 100,000 live births, ending preventable deaths of newborns and children under 5 years, as well as reducing premature mortality from non-communicable diseases by one-third through prevention, treatment and promotion of mental health and well-being (UNDP, 2015). Life expectancy takes into account, factors such as healthcare access, disease prevalence, nutrition, sanitation and overall living condition; and can be used to monitor an economy's progress towards development goals. Thus, life expectancy captures the full spectrum of health outcomes (Afolayan & Aderemi, 2019).

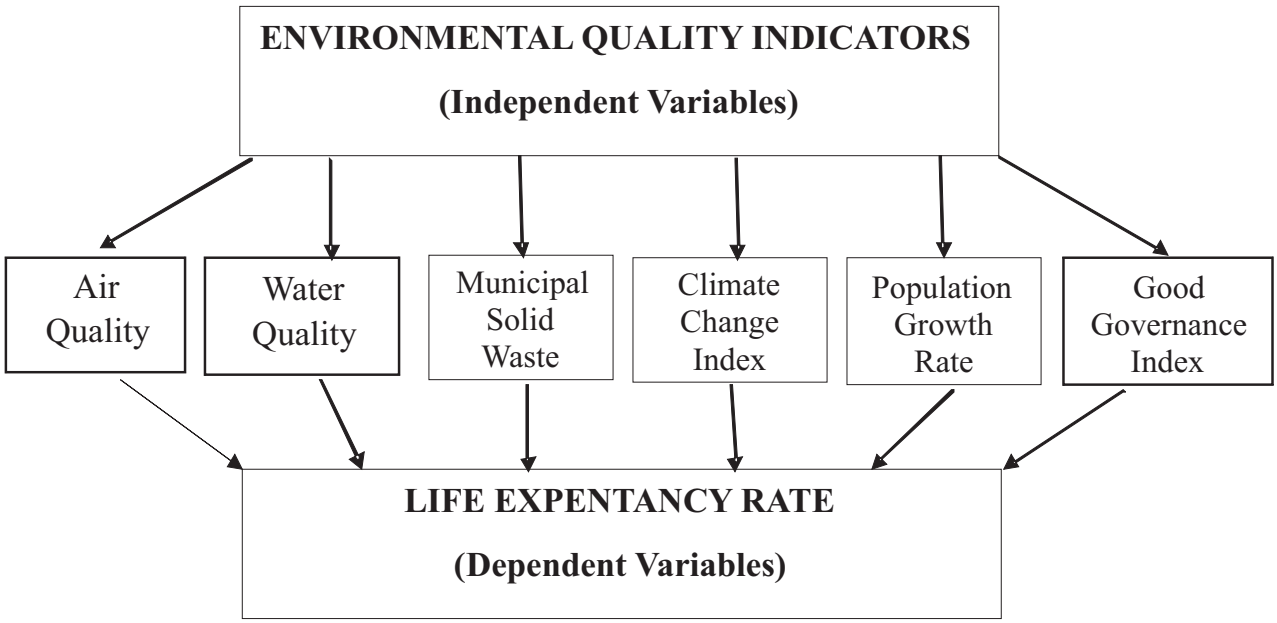


Figure 1: Conceptual framework of Environmental Quality and Life Expectancy

In Figure 1, life expectancy which is the dependent variable is the primary variable of interest in this study. It encompasses the average number of years a population is expected to live giving the prevailing circumstances in a polity. Environmental quality is used in relation to quality of air and water, municipal solid waste and climate index; while population growth rate and good governance index as intervening variables. This establishes a channel of the effect of environmental quality on life expectancy.

Theoretical Underpinning

The theory of Environmental Kuznets Curve (EKC) according to Kuznet (1955) seeks to link environmental quality to human development and economic health by hypothesizing that decline in environmental quality is inevitable at the early stages of a nation's economic growth, but that environmental quality improves after a certain income threshold. The theory is used to illustrate the relationship between per capita income and decline in environmental quality, forming an inverted U-shaped curve. The curve revealed that at the beginning of development, per capita income will increase with decline in environmental quality to a certain point, and afterwards, environmental quality will improve along with the increase of per capita income as societies invest in cleaner technologies and enforce stricter regulations (Citrasmara & Wahyu, 2018). Increased per capita income is related to better standard of living and improved life expectancy. Thus, improvement in environmental quality is invariably, positively correlated with higher life expectancy.

The Human Capital Theory (HCT), as developed by Becker (1964) and Schultz (1961), provides a robust theoretical framework for understanding the relationship between environmental quality indicators and life expectancy. This theory posits that individuals possess knowledge, skills, abilities, and health attributes that constitute assets that generate economic returns both for individuals and society as a whole. Thus, expenditures on education, training, health care, and other capacity-building activities are conceptualized as investments rather than consumption. These investments enhance an individual's productive capacity, leading to higher earnings and improved quality of life which ultimately increase life expectancy.

In the context of environmental quality, a clean and healthy environment represents a fundamental investment in human capital formation as it directly affects an individual's ability to learn, work, and be productive. Environmental quality indicators significantly influences health outcomes through exposure to pollutants, access to clean water and air, and the overall ecosystem services that support human wellbeing. Environmental factors can affect human capital formation, particularly in critical developmental periods, which can have lasting effects on life expectancy. Thus, the HCT views environmental quality improvements as human capital investment.

Empirical Review

Literatures are replete on the impact of environmental qualities in both developed and developing countries with divergent results. For instance, in a study of 46 Asian nations between 1997 and 2019, Polcyn *et al*., (2023) examined the effects of health expenditure, energy consumption, CO_2 emissions, population size, and income on life expectancy. The study employed the inter autoregressive distributive lag (CS-ARDL) model, while the results were checked with a common correlated effects mean group (CCEMG) method and an augmented mean group (AMG) method. Findings revealed that CO_2 emissions, as an indicator of environmental quality were shown to have adverse effect on life expectancy. To improve life expectancy, the study recommended the imperative Asian countries to discourage carbon dioxide production through the implementation of a carbon tax.

The nexus of various economic, non-economic, governance, and environmental indicators on life expectancy for seven emerging economies from 2000 to 2018 was investigated by Wei *et al*., (2022). The panel quantile regression technique was utilized for the analysis; and findings asserted that economic growth, government health expenditure, and human capital significantly reduce human health disasters like malaria incidences and cases, thus enhancing life expectancy, while greenhouse gas emissions and regulatory quality are significantly and positively correlated to life expectancy in emerging economies.

The interplay of environmental quality, health, and human capital development in South Africa using a Structural Equation Modeling (SEM) approach in evaluating the direct and indirect impact of environmental quality on human capital, mediated by life expectancy was studied by Manda and Zulu (2021). Their findings indicated that deteriorating environmental conditions led to health problems that adversely affected life expectancy. The integration of health and environmental policies to create a conducive environment, particularly in marginalized communities in South Africa was advocated.

Afolayan and Aderemi (2019) studied the relationship between environmental quality (proxied by carbon dioxide, CO_2) and life expectancy; and its implications for achieving sustainable economic development in Nigeria from 1980 to 2016 using Dynamic Ordinary Least Square (DOLS) and Granger causality techniques. Findings revealed that CO_2 emissions and life expectancy are negatively but insignificantly related, while total electric power consumption and life expectancy have a positive relationship which is significant at 5% level. The study implied fossil fuel combustion and life expectancy were found to have a significant positive relationship, implying that combustion of fossil fuel is hazardous to human welfare. The study recommended that government formulates appropriate policies that will increase life expectancy through a reduction in fossil fuel combustion and CO_2 emissions.

Matthew *et al*., (2018) examined the long-run effect of emissions of greenhouse gas (GHG) on life expectancy in Nigeria using time series data from 1985 to 2016. The auto-regressive distribution lag (ARDL) econometric approach to cointegration technique was applied. Findings revealed that human activities increase GHG to the atmosphere, through combustion of fossil fuels and CO_2. Thus, when the quantity of carbon dioxide increases in the air, more heat is stored in the atmosphere; and this comes upon human beings thereby causing a great harmful effect to human health, thus reducing life expectancy. Specifically it was revealed that 1% increase in GHG reduces life expectancy by 0.0422%, invariably leading to mortality rate of 146.6%. The paper recommended increase in public health expenditure and control of gaseous emissions in order to increase life expectancy.

Mutizwa and Makochekanwa (2015) examined the impact of environmental quality on life expectancy in 12 Southern African Development Community (SADC) countries between 2000 and 2008. Carbon emissions, access to improved water sources and improved sanitary facilities were used as proxies for environmental quality, while infant mortality was used to measure life expectancy. The study developed two panel data models which were estimated by the random effects and fixed effects approach techniques and found that environmental factors accounted for about 38 percent decline in life expectancy in the region. Specifically, it was revealed that carbon emissions have no impact on life expectancy of SADC countries, and that access to improved water sources and sanitary facilities had a greater impact on life expectancy than socioeconomic variables. In addition, it was revealed that there is significant difference in life expectancy rates between countries with environmental laws and where there are none. The study recommended the imperative for SADC countries to strengthen environmental regulations targeted at improving people's access to quality water and sanitary facilities.

I. METHODOLOGY

The causal research design was adopted to analyzed how environmental quality indicators impact on life expectancy for a sample period of 37 years spanning from 1988 to 2024 (Creswell & Creswell, 2023). Secondary data sourced from well recognized data base. Secondary data stands out in the source of data as much of the background work such as testing for validity and reliability have already being carried out, thus possessing a pre-established degree of validity and reliability which need not be re-examined (Creswell & Creswell, 2023). Data on CO_2 emission and governance quality were sourced from the World Development Indicator (WDI); data on water quality and population growth were source from Macro-trend; data on municipal solid waste were sourced from NESREA; while data on climate change vulnerability were sourced from ND-GAIN. Data for the sample period were largely available from the mentioned source; however, a few unavailable data were sorted through extrapolation.

Model Specification

Following the theoretical underpinning of the Human Capital theory; and adapting the empirical work of of Polcyn *et al*., (2023) who examined the effects of health expenditure, energy consumption, CO2 emissions, population size, and income on health outcomes in 46 Asian nations between 1997 and 2019.; variables namely; Life expectancy (LIF) as dependent variable; Air quality index (AQI) proxy by carbon dioxide emission, municipal solid waste (MSW), water quality index (WQI) proxy by access to drinking water, climate change index (CCI), population growth (POP) and governance quality (GOV) as independent variables were employed. The model is functionally specified as:

$LIF = f(AQI, MSW, WQI, CCI, POP, GOV)$ - - - - - (1)

Econometrically, the model is stated as:

$InLIFt = \beta_0 + \beta_1 AQI + \beta_2 InMSW + \beta_3 WQI + \beta_4 InCCI + \beta_5 POP + \beta_6 GOV + \mu t$ - - - (2)

Where β_0 is the intercept coefficient for life expectancy, and β_1 - β_6 are coefficients of the independent variables, μt is the error term and *In* is the natural logarithm notation.

On a priori expectation, the coefficients are symbolized as: β_1, β_2 and $\beta_4 < 0$; β_3, β_5 and $\beta_6 > 0$.

In order to examine the impact of environmental quality on life expectancy in Nigeria, the research employed a comprehensive methodological approach. First, an informative summary of the data was done through descriptive statistics. This was followed by pre-estimation test, specifically, the ADF unit root test was employed to establish the stationarity property of our data. This was done to avoid spurious outcome of the regression results and to uphold the validity and policy relevance of the parameter estimates.

The Augmented Dickey Fuller (ADF) test is of the form:

$$\Delta Y_t = \delta y_{t-1} + \sum_{i=1}^{n} \beta_i + \varepsilon_t$$

Where:

Δ = First difference operator which determines stationary of the series under a null hypothesis,

H0: δ = 0 (there is unit root)

H1: δ < 0 (There is no unit root)

Y_t= Time series variable at time t

Y_{t-1}= Time series variable at lag period

n = optimum number of lag length in the dependent variable (Y_t) and it is solely determined by the parameter; and

β = Parameter.

ε_t= Stochastic error term

The confirmation of a long-run equilibrium relationship in the data set was further established using the ARDL Bounds test approach which considers lags of dependent variable, Y_t and explanatory variable X_t. This is specified as:

$$\Delta Y_t = \beta_0 + \sum_{i=1}^{n}\beta_i \Delta Y_{t-i} + \sum_{i=1}^{n}\delta_i \Delta X_{t-i} + \varphi 1 Y_{t-i} + \varphi 1 X_{t-i} + \varepsilon_t \quad \text{..... (4)}$$

This test determines whether each of the parameters in the model has a long-term relationship (Ezie & Ezie, 2021). The hypothesis of F-bound cointegration test is stated as

H_0: $\varphi_1 = \varphi_2 = 0$ (No cointegration exists between the variables).

H_1: $\varphi_1 = \varphi_2 \neq 0$ (Cointegration exists between the variables).

Decision Rule:

Reject H_0 if the calculated F-statistic is greater than the critical upper bounds I (1)

Accept H_0 if the F-statistic falls below the critical lower bounds I (0)

The test is inconclusive if the F-statistic falls between the critical upper and lower bounds.

Equation (3) is built into an ARDL model in order to estimate the long-run relationship between environmental quality and life expectancy in Nigeria.

Adopting the work of Abdullah *et al.*, (2016) who investigated the impact of environmental quality on public health expenditure in Malaysia, the ARDL model was specified as:

$$lnHE_t = \beta_0 + \beta_1 ln\,HE_{t-1} + \beta_2 ln\,GDP_{t-1} + \beta_3 \ln CO2_{t-1} + \beta_4 \ln SO2_{t-1} + \beta_5 \ln NO2_{t-1} + \beta_6 \ln MR_{t-1} + \beta_7 \ln FR_{t-1} + \beta_1 \sum \Delta ln\,HE_{t-1} + \beta_2 \sum \Delta ln\,GDP_{t-1} + \beta_3 \sum \Delta \ln CO2_{t-1} + \beta_4 \sum \Delta \ln SO2_{t-1} + \beta_5 \sum \Delta \ln NO2_{t-1} + \beta_6 \sum \Delta \ln MR_{t-1} + \beta_7 \sum \Delta \ln FR_{t-1} + \varepsilon_t \quad \text{- - - - - - - (5)}$$

Adapting equation (5) to this present study and using equation (2), the ARDL model is expressed as:

$$\Delta lnLIF_t = \beta_o + \sum_{t=i}^{n}\beta_1 \Delta lnLIF_{t-i} + \sum_{t=i}^{n}\beta_2 \Delta AQI_{t-i} + \sum_{t=i}^{n}\beta_3 \Delta lnMSW_{t-i} + \sum_{t=i}^{n}\beta_4 \Delta WQI_{t-i} + \sum_{t=i}^{n}\beta_5 \Delta lnCCI_{t-i} + \sum_{t=i}^{n}\beta_6 \Delta lnPOP_{t-i} + \sum_{t=i}^{n}\beta_7 \Delta GOV_{t-i} + \varphi_1 lnLIF_{t-1} + \varphi_2 AQI_{t-1} + \varphi_3 lnMSW_{t-1} + \varphi_4 WQI_{t-1} + \varphi_5 lnCCI_{t-1} + \varphi_6 lnPOP_{t-1} + \varphi_7 GOV_{t-1} + \varepsilon_t \quad \text{- - - (6)}$$

Where:

β_0 is the intercept parameter

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7$ are the long –run parameters

$\varphi_1, \varphi_2, \varphi_3, \varphi_4, \varphi_5, \varphi_6, \varphi_7$ are the short-run parameter

Δ is the first difference operator.

t is the current value of the variable

$_{t-1}$ is the lagged values of the variables in both long-run and short-run

ε_t is the error term

Equation (6) indicates that both the long-run and short-run impact of the model can be estimated based on the assumption of the ARDL technique. The Error Correction Model (ECM) has been incorporated in the model because whenever a bounds cointegration test show evidence of long-run relationship between the variables, the adjustment path needs to be estimated to ascertain the extent to which the model adjust itself back to short-run equilibrium after the shock (Ezie & Ezie, 2021).

IV. RESULTS AND DISCUSSION

Descriptive Statistics

To get a precise idea of the data employed in the study, a descriptive statistics was used to provide an informative summary of the data in terms of the mean, standard deviation as well as the minimum and maximum values. This is presented in Table 1.

Table 1: Descriptive Statistics

Variables	Mean	Maximum	Minimum	Std. Dev.
LIF	3.901065	4.026244	3.825811	0.072785
AQI	11.47803	11.71820	11.19504	0.147797
MSW	15.49483	16.78593	14.40330	0.710515
WQI	18.19703	30.10000	8.160000	7.297978
CCI	4.909735	5.093750	4.532599	0.188026
POP	18.78843	19.24990	18.31922	0.283580
GOV	-0.019030	1.215450	-1.998330	0.994137

Source: Authors Computation using E-views 12 (2025)

The descriptive statistics in Table 1 indicated that Life Expectancy (LIF) from 1988–2024 had maximum and minimum values of 4.03% and 3.83% respectively. With a standard deviation of 0.07% and an average rate of 3.90% for the period, the data indicated a 3.83% divergence from both sides of the mean which implies consistency and absence of outliers in the data set. This suggests that the life expectancy rate in Nigeria was fairly evenly distributed during the study period, resulting in a marginal variation in LIF rate. Air Quality Index (AQI) had minimum and maximum values of 11.20% and 11.72% respectively, for the period which indicates the continuous decline in air quality over the years. The AQI average was 11.48%, with a standard deviation of 0.15% meaning that there was a 11.33% departure from both sides of the mean. Given that the standard deviation was found to be lower than the mean value, this implies a minimal fluctuation in the data set over the sample period which further confirms initiatives towards improvement in air quality through reduction in CO_2 emission.

With a magnitude of 14.78%, Municipal Solid Waste (MSW) is widely spread from the mean, as indicated by its mean value and standard deviation of 15.49% and 0.71% respectively, with a minimum and maximum values of 14.40% and 16.79% in that order, indicating a measure of consistency in the data set. Also, Water Quality Index **(WQI)** had maximum and minimum values of 30.10% and 8.16% respectively. With a standard deviation of 7.30% and an average value of 18.20% for the period, the data indicated a relative 10.90% divergence from both sides of the mean which implies that WQI is normally spread over the years. Climate Change Index (CCI) is relatively spread from the mean, as indicated by its maximum and minimum values of 5.09% and 4.53% respectively, and its mean value and standard deviation of 4.91% and 0.19% respectively. Population growth rate (POP) ranged from 18.32% at the minimum to 19.25% at the maximum. Throughout the period, the average POP was 18.79%, with a standard deviation of 0.28%, meaning that the data varied by 18.50% from the mean value. The fact that the standard deviation was far less than the mean value suggests consistency in POP during the study period. In addition, Good Governance Index (GOV) had maximum and minimum values of 1.22% and -1.99% respectively. With a standard deviation of 0.99 and an average rate of -0.02 for the period, the data indicated a 1.01 divergence from both sides of the mean which implies consistency and absence of outliers in the data set.

Unit Root Test Results

The Augmented Dickey-Fuller (ADF) test was employed to check the unit root and stationarity hypotheses of the data set. The test was conducted at the 5% level of significance and the result is presented in Table 2.

Table 2: Augmented Dickey-Fuller (ADF)Test Results

Variables	At Levels	At 1st Difference	5% Critical Value	Probability Value	Order of Integration	Remark
LIF	-4.045713	-1.353884	-3.540328	0.0158	I(0)	Stationary
AQI	-2.951841	-6.461229	-3.544284	0.0000	I(1)	Stationary
MSW	-1.722476	-6.124731	-3.544284	0.0001	I(1)	Stationary
WQI	-1.191762	-4.369014	-3.644963	0.0122	I(1)	Stationary
CCI	-1.654052	-5.715108	-3.544284	0.0002	I(1)	Stationary
POP	-3.752539	-1.329849	-3.587527	0.0357	I(0)	Stationary
GOV	-3.745404	-4.359390	-3.552973	0.0330	I(0)	Stationary

Source: Authors Computation using E-views 12 (2025)

The ADF test results in Table 2 indicated that when the variables were tested at levels, LIF, POP, and GOV were stationary (I(0)). After first differencing, AQI, MSW, WQI and CCI were found to be stationary (I(1)). Hence the null hypothesis of no unit root (stationarity) was accepted at the 5% level of significance. Thus, the adoption of the Autoregresssive Distributed Lag (ARDL)/ Bounds test is justified since there are mixed order of integration to ascertain the existence of a long run relationship among the variables. The result of the ARDL/Bound test is presented in Table 3.

Table 3: ARDL Bound Test Result

Test Statistics	Value	K
F-statistic	17.99829	6
Critical Value Bounds		
Significance	I(0) Bound	I(1) Bound
10%	1.99	2.94
5%	2.27	3.28
2.5%	2.55	3.61
1%	2.88	3.99

Source: Author's computation using E-views 12 (2025).

Table 3 revealed that the calculated F-statistic (17.99) is greater than the critical upper bound I(1) value (3.28) at the 5% level of significance, hence the conclusion that there is co-integration. Thus, the null hypothesis of no long-run relationship is rejected at the 5% level of significance. This implies that, there is long-run effect of **environmental policy onlife expectancy** in Nigeria within the study period. To further estimate the effect of environmental quality variables in Nigeria, the results of the estimation of the independent variables on the dependent variables of both the short and long run dynamics are presented in Table 4.

Table 4: Long-run and Short-run Estimates of the ARDL Model

Cointegrating Form				
Variable	Coefficient	Standard Error	t-Statistics	Probability
D(INLEX(-1))	0.554853	0.057874	9.587285	0.0000

D(GOV)	-0.001300	0.000242	-5.366096	0.0007
D(GOV(-1))	-0.001006	0.000349	-2.879922	0.0205
D(GOV(-2))	0.000788	0.000318	2.478353	0.0382
D(INAQI)	3.73E-05	0.001729	0.021594	0.9833
D(INAQI(-1))	-0.003643	0.001616	-2.253742	0.0542
D(INAQI(-2))	-0.003743	0.001550	-2.414505	0.0422
D(INCCI)	-0.004111	0.001201	-3.422302	0.0091
D(INCCI(-1))	0.003360	0.000944	3.559552	0.0074
D(INMSW)	-0.004835	0.001654	-2.922352	0.0192
D(INMSW(-1))	0.016066	0.002147	7.484367	0.0001
D(INMSW(-2))	0.013580	0.002004	6.776740	0.0001
D(INPOP)	-2.506102	0.483453	-5.183752	0.0008
D(INPOP(-1))	-0.967138	0.600370	-1.610904	0.1459
D(INPOP(-2))	-2.536744	0.468596	-5.413503	0.0006
D(WQI)	0.008079	0.001607	5.028510	0.0010
D(WQI(-1))	-0.010130	0.002528	-4.006802	0.0039
D(WQI(-2))	0.011123	0.001806	6.159581	0.0003
?????$_{?-1}$	-0.494491	0.030095	-16.43090	0.0000

EC = INLEX - (0.0009*GOV -0.0013*INAQI -0.0069*INCCI -0.0609*INMSW -0.0927*INPOP + 0.0185*WQI + 6.6034)

Variable	Coefficient	Std. Error	t-Statistics	Probability

GOV	0.000944	0.002369	0.398665	0.7006
*IN*AQI	-0.001265	0.033733	-0.037510	0.9710
*IN*CCI	-0.006940	0.007695	-0.901879	0.3935
*IN*MSW	-0.060885	0.008535	-7.133710	0.0001
*IN*POP	-0.092698	0.042124	-2.200604	0.0589
WQI	0.018489	0.000930	19.87877	0.0000
C	6.603420	0.512407	12.88707	0.0000

Source: Author's Computation, extracted from E-views 12 (2025)

The ARDL model is estimated using automatic selection of maximum lag of 3 and Akaike information criteria in selecting the optimum lag order of (2, 3, 3, 2, 3, 3, 3). Table 4 presents the statistics. The short-run analysis revealed that, air quality had a significant negative {(-0.003743) (0.0422)} effect on life expectancy in the lagged period as shown by the coefficient and probability values. MSW negatively affected life expectancy by 0.48% in the present period, while the effect was positively significant in the lagged periods. CCI had a significant negative {(-0.004111) (0.0091)} effect on life expectancy in the present periods whereas the effect was positive in the lagged periods. Also, WQI had a significant positive effect on life expectancy both in the lagged and present periods respectively {(0.011123) (0.0003), (0.008079) (0.0010)}.

Furthermore, coefficient of error correction term

Table 5: Diagnostic Test Result

Test	F-statistic	Prob. Value	Obs*R-squared	Prob. Value
Breusch-Godfrey Serial Correlation LM Test:	3.062506	0.0681	7.903237	0.0192
Breusch-Pagan-Godfrey Heteroskedasticity Test:	1.165617	0.4099	23.79357	0.3581
CUSUM	Within 5% bounds		Model is stable	

Source: Author's Computation, extracted from E-views 12 (2025)

From Table 5, using the F-statistic, the probability values for the Breusch-Godfrey Serial Correlation LM test and the Breusch- Pagan-Godfrey Heteroskedasticity test (0.0681) and (0.4099) are respectively greater than 0.05, hence the null hypotheses of no serial correlation and heteroskedasticity are accepted. In addition, the result of the CUSUM plots been within the 5% confidence bands showed that the model parameters are stable and robust overtime.

Discussion of Findings

Based on the result in Table 4, decline in air quality impacted life expectancy negatively by 0.13%. The implication of this finding is that air quality is a critical factor in efforts towards achieving higher life expectancy. This finding is consistent with the a priori expectation and corroborates the works of Matthew *et al*., (2018), Manda and Zulu (2021), and Polcyn *et al*., (2023). Climate change was found to have a negative impact on life expectancy such that a 1% increase in climate change vulnerability reduces life expectancy by 0.69%. This is consistent with a priori expectation and corroborates the findings of Manda and Zulu (2021) and Afolayan and Aderemi (2019).

The long run coefficient of MSW had a negative effect on life expectancy. Hence, a percentage increase in MSW shortens life expectancy by 6.09%. This finding is highly significant and consistent with a priori expectation; implying that increasing rate of municipal solid waste in harmful to health of the population over the years. This finding is consistent with a priori expectation.

Also, water quality (WQI) was found to have a positive and statistically significant effect on life expectancy. This finding is in line with a priori expectation. Specifically, a unit increase in water quality will increase life expectancy by 1.85%. Increase in access to good water quality will manifest in improved health outcome, hence life expectancy will increase. In addition, much of the water borne diseases that shortens life expectancy can be prevented through increased access to high water quality. The work of Mutizwa and Makochekanwa (2015) who found that access to improved water sources had a greater impact on life expectancy is consistent with this finding.

Furthermore, the coefficient of good governance (GOV) was found to be positive (0.000944) and statistically insignificant (0.7006 p-value) effect on life expectancy. Specifically, a 1% improvement in good governance index will increase life expectancy by 0.09% within the period under investigation; while 1% deterioration in governance effectiveness will reduce life expectancy by same percentage. For instance, poor environmental laws and weak enforcement which invariably implies reduction in environmental quality will in the long run have adverse effect on health and life expectancy. This can enhance life expectancy by reducing environmental degradation and morbidity rate.

In addition, the result of the population growth rate (POP) revealed a negative relationship with life expectancy such that a 1% increase in POP will reduce life expectancy by 9.3%. This finding is statistically fairly significant given the p-value 0.0589. This finding is consistent with Malthusian postulation that increased population will spell doom for mankind in terms of survival.

V. CONCLUSION AND RECOMMENDATION

This study has established that environmental quality indicators have a long run effect on life expectancy in Nigeria. Based on the finding, it concluded that environmental quality indicators under the period of investigation have differing impact life expectancy in Nigeria. Indicators such as air quality proxy, climate change reported negative but insignificant impact on life expectancy; governance quality had a positive but insignificant impact; population growth had a negative borderline impact; municipal solid waste had a negative and significant impact; while access to quality drinking water had a positive and significant impact on life expectancy rate in Nigeria. This suggestively implies that environmentalists and agencies in the ministry of environment such as NESREA are duty bound to raise more awareness about environmental quality. Thus, this paper recommended that:

(i) The federal ministry of environment in partnership with NESREA should deliberately embark on air pollution control so as to improve the quality of air in the country. Initiatives to ameliorate climate change vulnerability with respect to poor air quality should be equally put in place.
(ii) Increasing access to safe drinking water for the population by the federal ministry of water resources in collaboration with the states counterpart through a public-private decentralized water supply strategy with focus on community-managed boreholes and small-scale water treatment plants.
(iii) Also, NESREA should intensify efforts towards reducing solid wastes particularly in municipal areas with incentives provided to industries involved in wastes recycling initiatives. Interventions such as waste-to-cash or wastes monetization initiatives should be encouraged in Nigeria. Similarly, there should be designated controlled dumpsites for waste collection with enforcement mechanisms with appropriate environmental laws and regulation. Penalties should be made enforceable such that violators of environmental laws should be punished by the government.

(iv)With regards to population growth, the National Population Commission should integrate health infrastructure scaling and urban planning. This will mitigate the adverse effect of population growth on life expectancy.

REFERENCES

Abdullah, H., Azam, M., Zakariya, S. K. (2016). The impact of environmental quality on public health expenditure in Malaysia. *Asia Pacific Journal of Advanced Business and Social Studies, 2*(2), 365-379.

Afolayan, O. T. & Aderemi, T. A. (2019). Environmental Quality and Health Effects in Nigeria: Implications for Sustainable Economic Development. *SSRG International Journal of Economics and Management Studies (SSRG-IJEMS),*6(11), 44 – 55.

Badulescu, D., Simut, D., Badulescu, A. & Badulescu, A. V. (2019). The Relative Effects of Economic Growth, Environmental Pollution and Non-Communicable Diseases on Health Expenditures in European Union Countries. *International Journal of Environmental Research and Public Health, 16, 5115*, doi:10.3390/ijerph16245115.

Becker, G. (1964). *Human Capital*. Chicago: University of Chicago Press

Berger, M. C., & Messer, J. (2002). Public financing of health expenditures, insurance and health outcomes. *Applied Economics, Taylor & Francis Journals, 34*(17), 2105 – 2113.

Citrasmara, G. N. & Wahyu, W. (2018). Environmental Kuznets Curve Hypothesis: A perspective of Sustainable Development in Indonesia. *E3S Web of Conference 31, 09021.*

*https://doi.org/10.1051/e3sconf/20183109021*Emole, 2022

Creswell, J. W., & Creswell, J. D. (2023). *Research design:qualitative, quantitative and mixed methods approaches (Sixth Edition).* California: Sage Publications, Inc.

Emole, U. (2024). Overview of COP 27 outcomes and the ESG implications for Nigeria's climate change action ambitions. Available at https://www.templars-law.com Accessed 26/11/2024.

Environmental Protection Agency (EPA). (2024). Environmental Quality Index. Available Online.https://www.epa.gov/healthresearch/environmental-quality-index-eqi.Retrieved 08/10/2024.

Ezie, O. & Ezie, P. K. (2021). *Applied Econometrics: Theory and Empirical Illustration. First Edition.* Kabod Limited, Kaduna. ISBN: 978-978-996-729-2

Field, B. C. & Field, M. K. (2017). *Environmental economics: An introduction (7th edition).* New York: McGraw-Hill Education.

Kodiya, M. A.; Modu, M. A.; Ishaq, K.; Yusuf, Z.; Wakili, A. Z.; Dayyabu, N.; Jibrin, M.A.; & Babangida, M. U. (2025). Environmental Pollution in Nigeria: Unlocking Integrated Strategies for Environmental Sustainability. *African Journal of Environmental Sciences & Renewable Energy*. 18(1), 30 – 50.

Kuznet, S. (1955). Economic growth and income inequality. American Economic Review, 14.

Lelieveld, J., Pozzer, A., Poschl, U., Fnais, M., Haines, A., & Munzel, T. (2020). Loss of life expectancy from air pollution compared to other risk factors: A worldwide perspective. *Cardiovascular Research, 116*(11), 1910-1917. https://doi.org/10.1093/cvr/cvaa025 Accessed 20/09/2025