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Abstract

Background: This study examines how carbon emissions affect life expectancy in Nigeria

Method: The Autoregressive Distributed Lag (ARDL) model was applied in the study to examine how energy consumption impact on life expectancy in Nigeria. Data was sourced from the United States (U.S) Carbon Dioxide Information Analysis Centre, the Central Bank of Nigeria (CBN) Statistical bulletin, International Energy Agency (IEA) and the World Development Indicators (WDI) for the period 1980-2017.

Results: Findings showed that inter alia; carbon emissions are significant and negatively affect life expectancy. This finding implied that, on the average, carbon emissions is capable of reducing life expectancy by 0.35%.

Conclusion: Based finding, the study concluded by recommending that the Nigerian government should embark on the alternative use of energy that emits lesser carbon. Thus, this will help attain the sustainable development goals of good health and well-being alongside with affordable, reliable and sustainable use of energy for all.

Keywords: Fossil Fuel: Electric Power: Carbon Dioxide, SDG

Background:

It has been argued in the literature that economic development in most economies of the world has been an aftermath of the effective use of energy system (Afolayan et al., 2019; Osabohien et al., 2019; Matthew et al., 2018; Lu, 2017; Alege et al., 2016; Alaali et al., 2015). On the other hand, carbon emissions such as burning of fossil fuel, carbon dioxides among others have brought about negative externalities across the globe. This is due to the fact that energy usage, especially fossil fuel alongside manufacturing and construction activities has shown a negative impact on the environment in the form of environmental degradation, poor health outcomes and reduced life expectancy, including aquatic life (Matthew et al., 2019; Matthew et al., 2018; Balan, 2016; Mesagan and Ekundayo, 2015).

Economic growth is one of the macroeconomic goals that cannot be compromised in any developing economy like Nigeria. An attempt to achieve economic growth in a country spurs consumption of energy in the various sectors of the economy. It is instructive to state that between 2000 and 2014, transport alone emitted an average of 47.76% of CO₂ emissions in Nigeria (IEA, 2015). Consumption of fossil fuel has been found to be a critical source of CO₂ emission orchestrating climate change globally and, Nigeria has been identified as one of the highest producers and consumers of fossil fuel (Alege et al., 2017). It is important to state that consumption of fossil fuel deteriorates environmental quality and constitutes serious human health implications in the economy. In the same vein, degradation of the environment increases budgetary allocation in terms of health care financing (Balan, 2016).

Consequently, in achieving a sustainable economic growth, high use of energy cannot be undermined. This is because, it is necessary to derive various activities ranging from manufacturing, agricultural, service and other sectors of the economy. This unfortunately poses a continuous threat to the ecology and human life in terms of environmental degradation and life expectancy reduction. In order to guarantee healthy lives and well-being for all in developing economies like Nigeria, the United Nations sustainable development goal number three (SDG3) emphasises good health and well-being citizens in developing economies by 2030. Meanwhile, in the case of Nigeria, the citizens' welfare has been at stake in the last few decades.

Evidence shows that under-five mortality rate in Nigeria stands at average of 147.4% of 1000 live births (United Nations Inter-Agency Group for Child Mortality Estimation (UN IGME), 2019). This assertion has been affirmed by the World Health Organisation -WHO (2004) which reported that indoor smoke originated from solid fuel kills 100 children every hour in one hand and urban air pollution kills 1800 people on the other hand in developing countries.

In the recent times, studies have shown that life threatening ailments have been associated with the spill-overs of energy consumption in Nigeria (Matthew et al., 2018; Oguntoke and Adeyemi, 2017). Against this backdrop, the answer to the question regarding the outcome of carbon emissions on life expectancy becomes highly imperative Nigeria country. As such this study examined the nexus between carbon emissions and life expectancy in Nigeria. Besides the above introduction, the remaining parts of this study is structured as follows; review of related literature is presented in section two. Section three presents the methodology for the study, analysis and discussion of results and policy recommendations of the study are presented in sections four and five respectively.

Empirical Review

Matthew et al. (2018) employed the autoregressive distribution lag (ARDL) econometric technique to examine the relationship between public health expenditure and health outcomes in Nigeria. The study found that there is a negative relationship between the emissions of greenhouse gas and health outcomes in Nigeria. To be explicit, the emissions of green gas caused a reduction in life of the Nigerian. In another related study, Assadzadeh et al. (2014) investigated the variables that determined per capita health expenditures among the Organisation of Petroleum Exporting Countries (OPEC) from 2000 to 2010 with a view to determining how life expectancy at birth respond to environmental quality. The estimated results showed that emissions of CO₂ have a positive relationship with expenditures on health in one hand and an inverse correlation existed between life expectancy at birth and expenditures on health expenditures on the other hand.

The study by Odusanya et al. (2014) assessed the nexus between real per capital health expenditure and per capita CO₂ emissions between 1960 and 2011 in Nigeria. The study posited that both the short-run and the long-run estimates proved that increase in CO₂ emission led to a significant rise in health expenditures. Akin to Matthew et al. (2018); Odusanya et al. (2014), Yazdi et al. (2014) analysed the connection between the quality of environment and health expenditure in Iran from 1967 to 2010 within the framework of ARDL technique. The study finds that variables of interest had a long-run convergence. Also, the correlation between income, the pollutants and health expenditures were positive in both the short-run and the long-run. In another perspective, Afolayan and Aderemi (2019) utilised Dynamic Ordinary Least Square (DOLS) and Granger causality approach to evaluate the impact of environmental quality on health effects in Nigeria from 1980 to 2016. The study argued that emissions of CO₂ had an insignificant negative impact on mortality rate. Whereas electric power consumption and fossil fuel combustion significantly increased rate of mortality in the country.

In the same vein, one-way feedback effect runs from CO₂ emission to electric power consumption. While, fossil fuel consumption had a unidirectional causal relationship with mortality rate. Consequently, while adopting a panel least square to estimate the nexus between health outcome and quality of environment in 25 European countries from 1995 to 2013, Balan (2016) posited that bidirectional feedback effect existed between the life expectancy and CO₂ emissions in the countries under study. Narayan and Narayan (2008) assessed how per capita health expenditures and quality of environment are related in eight OECD economies from 1980 to 1999 with the aid of a panel co-integration technique. It was found that from the study that all the variables of the study have a long-run convergence. The emissions of carbon monoxide and sulphur oxide led to a rise in health expenditures in the countries. Similarly, Declercq et al. (2011) expressed that if pollution from industrial sector, which served as major air pollution in the majority of European cities could reduce, it would lead to a rise in life expectancy at birth by two years.

Furthermore, in investigating the causal link between degradation of environment and the rate of mortality in India from 1971 to 2010, Sinha (2014) reported that two-way feedback effect existed between the rate of infant mortality and CO₂ emission growth in one hand and gross capital formation growth and rate of child mortality on the other hand. In another view, Aye et al. (2017) applied Dynamic Panel Threshold Model to estimate the effect of economic growth on emission of CO₂ developing economies. The authors concluded that the quality of environment was declined owing to a rising agitation for high growth rate in the countries, this might have a negative implication on the health of the population in the short run, but might be sustained in the long run.

In a cross-sectional study of 49 counties in Canada, Jerrett et al. (2003) examined the nexus between quality of environment and spending on health care. It was concluded from the study that the higher the pollution, the higher the per capita health expenditures in counties. Whereas, counties with more environmental budget benchmarked paid a significant lower expenditure on health. In conclusion, the above reviewed studies indicated that increasing in demand on health expenditure has been a result of continuous degradation in quality of environment leading to deterioration in health outcomes. However, studies focusing on carbon emissions and life expectancy in Nigeria are very scanty in the recent times. Hence, the relevance of this study.

Methodology

This study engaged secondary data for the analysis ranging from 1990 to 2018. Therefore, CO₂ emissions were extracted from the database of U.S. Carbon Dioxide Information Analysis Centre. Government health expenditure data was sourced from the CBN Statistical Bulletin. Total electric power and fossil fuel energy consumption data was sourced from the database of International Energy Agency (IEA) and data for life expectancy were sourced from the database of the World Development Indicators (WDI).

Model Specification

In addressing the objective of this study, the implicit form of the model is specified as;

$$LE = f(CO_2, FFC, TEPC, EH) \quad [1]$$

Equation [1] is the implicit form of the mode, which is linearised in equation [2] using a semi-double-log

$$\ln LE_t = \beta_0 + \beta_1 \ln CO_{2t} + \beta_2 FFC_t + \beta_3 \ln TEPC_t + \beta_4 EH_t + U_t \quad (2)$$

This method of estimation was informed by the results of diagnostic tests such as unit root test and Bounds Test performed on the data for the analysis in this study.

$$\Delta \ln LE_t = \beta_0 + \sum_{i=1}^p \beta_1 \Delta \ln CO_{2t-i} + \sum_{i=0}^p \beta_2 \Delta FFC + \sum_{i=0}^p \beta_3 \Delta \ln TEPC_{t-1} + \sum_{i=0}^p \beta_4 \Delta EH_{t-1} + U_t \quad [3]$$

Where; LE is life expectancy, which measures average age of all individuals who die in a certain year. CO₂ is emissions of Carbon dioxide (in kiloton) from consumption of solid, liquid and gas fuel or burning of bush, construction and manufacturing activities etc. Meanwhile, FFC is consumption of energy from fossil fuel measured as percentage of total energy consumption. TEPC represents total electric power consumption which is calculated as total net consumption of the generating units, and measured as in kilo-watt (kWh) per capita. EH is used to capture government health expenditure which is measured as proportion of total government expenditure spent on health. It is expressed in percentage. t ranges from 1980 to 2016 while U_t is error term.

The ‘a priori’ expectation is that: $\beta_1, \beta_2 < 0$ and $\beta_3, \beta_4 > 0$. This implies that the coefficient of carbon emissions, burning of fossil fuel (energy from fossil fuel) negatively affect life expectancy, meaning that their estimated coefficient should be less than one, but greater than zero. This literally means that, fossil fuel and carbon emissions, when inhaled has a negative effect of human health which invariably reduces life expectancy (Matthew et

al., 2018). $\beta_3, \beta_4 > 0$ means that the expected coefficient of electricity usage and government funding on health sector should positively impact on health outcomes. Their coefficient should be positive; greater than zero but, not equal to one.

Results

Table 1: Descriptive Statistics of Variables

Descriptive Statistics	LnLE	LnCO ₂	FFC	LnTEPC	EH
Mean	3.863332	11.09797	19.63000	4.570880	2.990571
Median	3.835574	11.15472	19.71000	4.508990	2.400000
Maximum	3.963096	11.57184	22.84000	5.054525	7.300000
Minimum	3.818811	10.46880	15.89000	3.929273	1.100000
Std. Deviation	0.045911	0.373742	1.636799	0.267958	1.714216
Skewness	1.087375	-0.356473	0.088005	0.011091	0.835393
Kurtosis	2.630499	1.644621	2.437245	2.549871	2.628861
Jarque-Bera Probability	7.096354	3.420295	0.507022	0.296199	4.271848
Sum	0.028777	0.180839	0.776071	0.862345	0.118135
Sum Sq. Deviation	135.2166	388.4290	687.0500	159.9808	104.6700
Observation	0.071667	4.749216	91.08980	2.441255	99.91019
	36	36	36	36	36

Source: Authors'

In Table 1, it could be deduced from the estimated descriptive statistics that log of life expectancy in 36 years has 3.8 years and 3.9 years as its minimum and maximum values respectively. Meanwhile, its mean value and standard deviation are 3.86 years and 0.071 year. The mean value is greater than standard deviation, therefore it could be stated that these data were not widely dispersed during the periods under investigation. In the same vein, all other variables of interest in this study followed the same pattern like life expectancy data.

Furthermore, in checking the symmetrical distribution of the data series, the skewness and kurtosis of the data were examined. It is evident in the above table that all the variables of interest, except LnCO₂ are positively skewed with Kurtosis values very close to 3. This attests to the fact that the distribution of these series is fairly symmetrical which in agreement with basic assumption of econometric analysis.

Table 2: Unit Root Test

Variables	ADF Test						
	Level	1 st Diff	Remark				
LnLE	-2.957110	-2.957110	I(1)	LnLE	-2.945842	-2.948404	I(1)
LnCO ₂	-2.945842	-2.948404	I(1)	LnCO ₂	-2.945842	-2.948404	I(1)
FFC	-2.951125	-	I(0)	FFC	-2.948404	-	I(0)
LnTEPC	-2.948404	-2.951125	I(1)	LnTEPC	-2.948404	-2.951125	I(1)
EH	-2.945842	-2.951125	I(1)	EH	-2.945842	-2.948404	I(1)

Source: Authors'

Test for the stationary property of time series data in empirical analysis has become more pronounced in the literature in the recent times. This is due to the fact time series data are usually linked with stationarity problems which usually motivate spurious results in the analysis and consequently spells doom for policy formulated based on the spurious results. In order to avert the problem of spurious findings in this study, an attempt was made to verify the behaviour of the series via the standard Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. The estimated results presented in the above table indicated that it is only one variable, namely FFC is stationary in its native form. Whereas, the other variables are otherwise. This implies that the study made use of the combination of data with various order on integration i.e. I(1) and (0) and as such Autoregressive Distributed Lagged (ARDL) Model was subsequently estimated (Pesaran, Shin and Smith, 2001, Pesaran and Pesaran, 1997).

In testing for the existence or otherwise of the long run convergence among the variables of interest, this study employed the technique of Bound Test. It was discovered from the estimated results that the Null hypothesis of no long-run relationships exist was accepted as a result of the F-Statistic value (1.81) that is less than the upper and lower Critical (3.52) Value Bounds at 5% level of significance. Hence, it could be submitted that no long run relationship between energy consumption and life expectancy in Nigeria. The short run relations will be estimated within ARDL framework.

Table 3: Short-run Relationship between Carbon Emissions and Life Expectancy

Short Run	coefficient	T-statistics	Prob. Value
D(LnLE(-1)	-1.046676***	10.92787	0.0000
D(LnCO ₂)	-0.002411**	2.018188	0.0579
D(FFC)	-0.000139	0.796333	0.4357
D(TEPC)	0.004022*	1.975020	0.0630
D(EH)	-4.63E-05	0.202719	0.8415
R-Squared	0.999753		

Source: Authors'

Table 3 shows the estimates of the relationship between carbon emissions and life expectancy in Nigeria. From the estimated results as presented in Table 3, all parameters have the expected signs except expenditure on health. The lagged value of life expectancy is negative. This shows that life in expectancy in the previous year cause reduction in the life expectancy in the current year. However, emissions of carbon dioxide and life expectancy have an inverse relationship. This relationship is significant at 5% level of significance. A unit change in emissions of carbon dioxide leads to 0.002% reduction in life expectancy in Nigeria. This finding is tandem with the submission of Afolayan and Aderemi (2019) and Declercq et al. (2011) in similar studies in Nigeria and European cities in spite of the fact that different methodology was adopted.

In the same vein, consumption of fossil fuel energy has a negative relationship with life expectancy. Though, the relationship is not significant at ten percent level of significance. A unit change in consumption of fossil fuel energy brings about 0.13% reduction in life expectancy in Nigeria. However, total electric power consumption has a positive impact on life expectancy in Nigeria. The impact is significant is at 10% level of significance. A unit change in total electric power consumption increases life expectancy by 0.4% in the country. This finding contradicts the submission of Afolayan and Aderemi (2019) in a related study. Moreover, the relationship between health expenditure and life expectancy is negative, though not significant at 10% level of significance. The reason for this relationship might be

connected with lack of sufficient funding in health sector and gross misappropriation of public funds in the public sectors in the country.

Summary and Conclusion

In this study, an attempt has been made to examine the impact of carbon emission on life expectancy in Nigeria using the ARDL for the period 1980 to 2016. The findings show that; the lagged value of life expectancy is negative. Emissions of carbon dioxide and life expectancy have an inverse relationship. This relationship is significant at five percent level of significance. A unit change in emissions of carbon dioxide leads to 0.002% reduction in life expectancy in Nigeria. Consumption of fossil fuel energy has a negative relationship with life expectancy.

Though, the relationship is not significant at 10% level, however, the total electric power consumption has a positive impact on life expectancy in Nigeria. The impact is significant at 10% level. Moreover, the relationship between health expenditure and life expectancy is negative, though not significant at 10% level. Therefore, it could be concluded that carbon emissions reduce life expectancy in Nigeria. This implies that there is a trade-off between carbon emissions and life expectancy in Nigeria. Based on this finding, this study recommends that if the goal of the policy makers in Nigeria is to achieve the sustainable development goals of good health and well-being alongside with affordable, reliable and sustainable use of energy for all, the Nigerian government should embark on the alternative use of energy that generate less emission of carbon dioxide. Also, government expenditure on health should be increased substantially in order provide amenities that guarantee an increment in life expectancy in Nigeria.

Ethical Approval and Consent to participate

Not applicable

Consent for publication

Not applicable

Availability of supporting data

Not applicable

Competing interests

The authors strive for neutral and open-ended research. The methods developed here can be used as a tool in policy consulting

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Authors' contributions

Romanus Osabohien conceive the ide and wrote the paper

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