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ANALYSIS OF THE HEALTH EFFECT OF CARBON EMISSION IN NIGERIA

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Abstract: The quest for industrialization and economic competitiveness has drastically increased global CO_2 emission, including in Nigeria. The rising CO_2 emission apparently has implications for human health. Hence, this study examines the health effect of CO_2 emission in Nigeria using annual data from 1970 to 2022. The Toda-Yamamoto-Dolado-Lutkepohl (TYDL) granger causality test approach was adopted and the result showed no significant relationship between CO_2 emission and health indicators (life expectancy and death rate) in Nigeria. This counterintuitive finding is explained by the nascent stage of Nigeria's industrialization process. Thus, the study recommended that the Nigerian government and policymakers deploy alternative energy sources that generate less CO_2 emission and make them accessible, affordable and reliable to citizens. More so, the government needs to increase the budgetary allocation to the health sector to foster modern service delivery in the sector.

Keywords: CO_2 emission, Life Expectancy, Death Rate, Toda-Yamamoto-Dolado-Lutkepohl causality test, Nigeria

1. INTRODUCTION

The burgeoning global population together with the increasing quest for industrialization, among other economic activities, have led to the surge in carbon dioxide (CO_2) emissions globally (Balan, 2016; Rasoulinezhad *et al.*, 2020). The adverse effects of this growing trend, particularly on human health and environmental quality, have attracted the attention of researchers, policymakers and other stakeholders to assess the health effects of CO_2 emission at the country, regional and global levels (Matthew *et al.*, 2018; Agbanike *et al.*, 2019; Rjoub *et al.*, 2021). Pollutants being emitted in the air as well as in streams and lakes contaminate the drinking water and affect the local ecosystems directly. Changing the dynamics of an ecosystem disrupts the balance of organisms that provide clean air and food. Particularly, emissions from manufacturing plants and other polluting establishments affect humans directly by causing sickness including different types of cancers, inflammations and heart diseases (Pope and Dockery, 2006). In this respect, energy consumption and environmental degradation have gained a large amount of attention worldwide as it is a huge challenge, not only for local areas but for the whole planet on a global scale.

Evidence reveals that emission-related diseases account for about 7 million deaths annually with the diseases ranging from cancer to cardiopathy and stroke (Oyelade *et al.*, 2022). Africa is not exempted from facing the adverse health effects of CO_2 emission as it causes more untimely deaths than childhood deficiency diseases, unsafe sanitation and unsafe water. Specifically, emissions annually account for about 712,000 death compared to 275,000 deaths, 391,000 deaths and 542,000 deaths caused by deficiency diseases, unsafe sanitation and unsafe water respectively (Dhrifi, 2018). The impacts of environment degradation on human health affect the society, both in terms of loss of quality of life and expenditure on health care. Therefore, health care expenditures due to environmental degradation and the studies examining the impact of CO_2 emissions are substantial. Greater carbon dioxide emissions are associated with more air pollution, which leads to health issues involving the lungs, heart and cardiopulmonary system (Davidson 2003). Countries with higher levels of carbon dioxide emissions, like Nigeria, would also likely tolerate higher levels of other harmful chemicals and pollutants, further increasing the risk of health problems among their citizens.

Nigeria, as an oil dependent economy, is not immune from adverse effects of CO_2 emissions. It is well established that all hydrocarbon extraction activities generate CO_2 emissions and one particular by-product of crude oil production is associated gas, the flaring of which generates large amounts of greenhouse gases (Afolabi, 2023). On the net calorific value, Nigeria's economy is fueled by unclean and traditional energy, comprising 80.9 per cent of the total consumption. Cleaner and modern energy like gas and electricity comprised only a paltry amount of 11.1 per cent (Rapu *et al.*, 2015). The sustainability of the energy systems in Nigeria is likely to be vulnerable if the anticipated energy crisis – in particular, the electricity crisis and CO_2 emissions issues – are not addressed appropriately. This is because the country is still highly dependent on fossil fuels such as oil and gas in its productive activities (Ogunjimi, 2020a, 2020b), which also represents other main causes of carbon dioxide (CO_2) emissions.

Moreover, the Nigerian government and policy makers make efforts to attract foreign direct investment (FDI) in a bid to foster economic growth and advance economic competitiveness. However, the pervasive weak regulatory framework in the country continues to hamper the efforts to control CO_2 emissions, which are often associated with the productive activities of multinationals. Developed economies often setup their industries in developing economies (like Nigeria) with weak environmental, regulatory and institutional frameworks, making the countries become pollution havens

(Odusanya *et al.*, 2014). Unfortunately, Nigeria, like other developing countries, lacks the requisite modern medical facilities needed to address the health challenges associated with CO_2 emission diseases given the meagre budgetary allocation to the health sector (Ogunjimi and Adebayo, 2019). Thus, the limited available resources that could be used for development purposes are expended on foreign medical trip at the expense of the country's development imperatives (Adeniyi *et al.*, 2022; Afolabi, 2022a). In view of this, it is imperative to assess the health effects of CO_2 emission in Nigeria in a bid to ameliorate the current economic situations with regards to the health sector and CO_2 emission intensive activities in the country.

The contribution of this study to the health-CO_2 emission nexus is twofold. First, the study examines the health effects of CO_2 emission in Nigeria using life expectancy and death as health indicators. Most related empirical studies either focused on the impact of CO_2 emission on life expectancy (Matthew *et al.*, 2018; Nkalu and Edeme, 2019; Osabohien *et al.*, 2020; Murthy *et al.*, 2021; Rjoub *et al.*, 2021; Mahalik *et al.*, 2022; Oyelade *et al.*, 2022; Rahman *et al.*, 2022) or provide empirical evidence on its impact on death rate (Rasoulinezhad *et al.*, 2020; Bressler, 2021), but not the two at the same time. A study of this nature is particularly rare for Nigeria. Second, most extant empirical studies on the subject matter ignored the possibility of causality between health outcomes and CO_2 emission as well as its direction (Odusanya *et al.*, 2014; Matthew *et al.*, 2018; Rasoulinezhad *et al.*, 2020). This study tests for causality between health outcomes (life expectancy and death rate) and CO_2 emission in Nigeria using the Toda-Yamamoto-Dolado-Lutkepohl causality test similar to what Rjoub *et al.* (2021) did for Turkey. The test for causality using this technique is important because of its robustness as it calculates an augmented vector autoregression (VAR) that ascertains the asymptotic distribution of the Wald statistics (Toda and Yamamoto, 1995).

The rest of this study is structured as follows: Section 2 reviews related studies on the relationships among life expectancy, mortality rate and CO_2 emission while Section 3 presents the methodological approach adopted in this study. Section 4 presents the analysis of the empirical findings while Section 5 concludes the study.

2. REVIEW OF RELATED STUDIES

In the literature, studies have also been extended to cover relationship between carbon emission and health indicators (Matthew *et al.*, 2018; Nkalu and Edeme, 2019; Osabohien *et al.*, 2020; Rasoulinezhad *et al.*, 2020; Bressler, 2021; Murthy *et al.*, 2021; Rjoub *et al.*, 2021; Mahalik *et al.*, 2022; Oyelade *et al.*, 2022; Rahman *et al.*, 2022). These set of studies underscore the possible impact of environmental pollution on health variables in single country and panel studies. In terms of empirical findings, Mahalik *et al.* (2022) examined the effect of CO_2 emissions on life expectancy in 68 countries between 1990 and 2017.

Findings revealed that CO_2 emissions attenuates life expectancy with the impact attributable more to consumption than production. Moreover, Oyelade *et al.* (2022) investigated how CO_2 emission affects the quality of life in Anglophone West African countries between 1990 and 2018. The panel quantile regression result showed that CO_2 emission from solid, gaseous and liquid fuels lowers the quality of life, measured as life expectancy. Murthy *et al.* (2021) also assessed the impact of CO_2 emissions on life expectancy in the D-8 countries between 1992 and 2017. The pool mean group result showed that CO2 emissions has a significant negative influence on life expectancy. Matthew *et al.* (2018) assessed the impact of greenhouse gases on health outcomes in Nigeria between 1985 and 2016. The result of the autoregressive distribution lag (ARDL) model showed that greenhouse gases have harmful effects on human health as its increase, through increased human activities, reduces life expectancy.

Similarly, Osabohien *et al.* (2020) examined the effect of CO_2 emission on life expectancy in Nigeria between 1980 and 2017. The ARDL result showed that CO_2 emission lowers life expectancy. Another study by Narayan and Narayan (2008) found that carbon monoxide emissions and sulphur oxide emissions have positive effect on health expenditure, while Declercq *et al.* (2011) advised that life expectancy would increase up to 22 months if the major European cities can reduce air pollutions. Assadzadeh *et al.* (2014) found that increases in carbon dioxide emissions increases health expenditures, while a rise in life expectancy at birth decreases health expenditures in the short-run. Yazdi *et al.* (2014) examined the role of environmental quality and income in determining health expenditures (1967 to 2010) in Iran. Their study showed evidence that income, health expenditures and pollutants such as sulphur oxide and carbon monoxide emissions are co-integrated in the long-run. Moreover, their empirical findings showed that income and the pollutants are correlated with health expenditures in both the short run and long-run.

Also, Odusanya *et al.* (2014) studied the effect of per capita carbon dioxide emission on real per capita health expenditures in Nigeria from 1960 to 2011. They concluded that carbon dioxide emission increases health expenditures significantly in both the long-run and short-run. Similarly, Jaba *et al.* (2014) analyzed the relationship between the dynamics of the inputs and outputs of healthcare systems. Applying panel data analysis for 175 countries from 1995 to 2010, the authors found that health expenditure, as an input to the healthcare system, has a significant positive impact on life expectancy at birth. With regards to causality, Rahman *et al.* (2022) investigated the determinants of life expectancy in 31 world's most polluted countries and found one-way causality running from CO_2 emissions to life expectancy. In the same vein, Rjoub *et al.* (2021) investigated the causality among CO_2 emissions, economic growth, and life expectancy in Turkey between 1960 and 2018 using time and frequency domain causality techniques.

The result showed bidirectional causality between CO_2 emission and life expectancy while also showing a positive relationship between the variables contrary to a priori expectation.

On the nexus between mortality rate and CO_2 emissions, Rasoulinezhad *et al.* (2020) evaluated how mortality is affected by CO_2 emissions, fossil fuel consumption and economic factors in the Commonwealth of Independent States (CIS) region between 1993 and 2018. The result of the generalized method of moments (GMM) estimation showed that CO_2 emissions exert the greatest negative influence on mortality rate in the CIS region. Similarly, Bressler (2021) evaluated the mortality cost of CO_2 emission and found that CO_2 emission has a positive relationship with mortality rate such that mortality rate increases with increasing emission of carbon dioxide.

3. METHODOLOGY

3.1. Model Specification and Estimation Method

Taking cognizance of the ambiguity regarding the direction of relationship between the health indicators (life expectancy and death rate) and CO_2 emission, this study explores the relationship using a multivariate-based estimation technique, the Vector Autoregression (VAR) precisely. The VAR model allows for all variables to be treated as endogenous and therefore, there is no a priori distinction between endogenous and exogenous variables. Essentially, we favour a VAR model with the Toda-Yamamoto-Dolado-Lutkepohl (TYDL) causality testing approach, developed by Toda and Yamamoto (1995) and Dolado and Lutkepohl (1996), to determine the direction of relationship between CO_2 emission and the health indicators - life expectancy (LE) and death rate (DR).

Greater carbon dioxide emissions are associated with more air pollution, which leads to health issues involving the lungs, heart and cardiopulmonary system (Davidson 2003). Countries with higher levels of carbon dioxide emissions would also likely tolerate higher levels of other harmful chemicals and pollutants, further increasing the risk of health problems among its citizens (Balan, 2016). Thus, we would expect that as carbon dioxide emissions increases, life expectancy will decrease and there is potential of death rate increasing. There is also, the likelihood of healthy population constituting robust economic activity and consequently increasing carbon dioxide. It is this ambiguity of a priori regarding the direction of relationship between CO_2 emission and health issue that motivated our preference for causality testing technique.

Although there are others approaches to implement causality testing in the literature including a VAR model in the level data, a VAR model in the first difference data (VARD), and a vector error correction model (VECM), the simulation results by Yamada and Toda (1998) suggests the TYDL model is relatively the more stable when compared to these listed alternative causality procedures. The main rationale behind TYDL is to artificially augment the correct VAR order, say *k*, with d_{max} extra lags, where d_{max} is the maximum likely order of integration of the series contained in the system. In the case of this present study however, we follow the TYDL framework and the given lag augmented VAR ($k + d_{max}$) for CO_2 emission-economic growth nexus as below:

$$
\begin{aligned}
CO_{2t} &= \alpha_0 + \sum_{i=1}^{k}\alpha_{1i}CO_{2t-i} + \sum_{j=k+1}^{k+d_{max}}\alpha_{2j}CO_{2t-j} + \sum_{i=1}^{k}\beta_{1i}LE_{t-i} + \sum_{j=k+1}^{k+d_{max}}\beta_{2j}LE_{t-j} + \sum_{i=1}^{k}\lambda_{1i}DR_{t-i} + \sum_{j=k+1}^{k+d_{max}}\lambda_{2j}DR_{t-j} + \varepsilon_{1t} \\
LE_t &= \beta_0 + \sum_{i=1}^{k}\beta_{1i}LE_{t-i} + \sum_{j=k+1}^{k+d_{max}}\beta_{2j}LE_{2t-j} + \sum_{i=1}^{k}\alpha_{1i}CO_{2t-i} + \sum_{j=k+1}^{k+d_{max}}\alpha_{2j}CO_{2t-j} + \sum_{i=1}^{k}\lambda_{1i}DR_{t-i} + \sum_{j=k+1}^{k+d_{max}}\lambda_{2j}DR_{t-j} + \varepsilon_{2t} \\
DR_t &= \lambda_0 + \sum_{i=1}^{k}\lambda_{1i}LE_{t-i} + \sum_{j=k+1}^{k+d_{max}}\lambda_{2j}LE_{2t-j} + \sum_{i=1}^{k}\alpha_{1i}CO_{2t-i} + \sum_{j=k+1}^{k+d_{max}}\alpha_{2j}CO_{2t-j} + \sum_{i=1}^{k}\beta_{1i}DR_{t-i} + \sum_{j=k+1}^{k+d_{max}}\beta_{2j}DR_{t-j} + \varepsilon_{3t}
\end{aligned} \quad (1)
$$

The multivariate VAR model in equation (1) would be considered where the two series are different orders of integration say I(0) and I(1), which is the case in the context of this study. The VAR specification can be further re-represented in matrix form as follows:

$$
\begin{bmatrix} CO_{2t} \\ LE_t \\ DR_t \end{bmatrix} = \begin{bmatrix} \delta_{10} \\ \delta_{20} \\ \delta_{30} \end{bmatrix} + \sum_{i=1}^{k} \begin{bmatrix} \delta_{11,i} & \delta_{12,i} & \delta_{13,i} \\ \delta_{21,i} & \delta_{22,i} & \delta_{23,i} \\ \delta_{31,i} & \delta_{32,i} & \delta_{33,i} \end{bmatrix} \begin{bmatrix} CO_{2t-i} \\ LE_{t-i} \\ DR_{t-i} \end{bmatrix} + \sum_{j=1}^{d_{max}} \begin{bmatrix} \delta_{11,k+j} & \delta_{12,k+j} & \delta_{13,k+j} \\ \delta_{21,k+j} & \delta_{22,k+j} & \delta_{23,k+j} \\ \delta_{31,k+j} & \delta_{32,k+j} & \delta_{33,k+j} \end{bmatrix} \begin{bmatrix} CO_{2t-k-j} \\ LE_{t-k-j} \\ DR_{t-k-j} \end{bmatrix} + \begin{bmatrix} \varepsilon_{CO_2} \\ \varepsilon_{LE} \\ \varepsilon_{DR} \end{bmatrix} \quad (2)
$$

The above three variables TYDL VAR approach modified the original bivariate form of Toda and Yamamoto (1995) to accommodate our variables of interest, where *k* represents optimal lag length determined using SIC while d_{max} is the maximum order of integration. The direction of causality running from CO_2 to life expectancy (LE), from CO_2 to death rate (DR) and so on can be established through rejecting the null hypothesis which requires finding the significance of the Modified Wald (MWald) statistics for the group of the lagged independent variables identified above.

$H_{01}: \delta_{12,1} = \delta_{12,2} = ... = \delta_{12,k} = 0,$ implies that LE does not granger cause CO_2 emission.

$H_{02}: \delta_{21,1} = \delta_{21,2} = ... = \delta_{21,k} = 0,$ implies that CO_2 emission does not granger cause LE.

$H_{03}: \delta_{13,1} = \delta_{13,2} = ... = \delta_{13,k} = 0,$ implies that DR does not granger cause CO_2 emission.

$H_{04}: \delta_{31,1} = \delta_{31,2} = ... = \delta_{31,k} = 0,$ implies that CO_2 emission does not granger cause DR.

3.2. Data

Based on the empirical specification, annual time series was collected for Nigeria between 1970 and 2022. Health outcomes (HE_t) are measured as life expectancy at birth (years) and death rate (%) while CO_2 emission is measured as CO_2 emissions (metric tons per capita). The data are sourced from World Development Indicator of the World Bank.

4. EMPIRICAL RESULTS

4.1. Descriptive Statistics

The descriptive statistics, reported in Table 1, includes mean, maximum, minimum and the corresponding standard deviation statistics of the variables. The distributional properties of the variables are also examined via skewness and kurtosis statistics, while the Jarque-Bera test statistic is used to test for normality in the distribution. The variables are expressed in their level form with CO_2 emission averaging 0.64 metric tons per capita even though it ranged from 0.67 to 1.01 metric ton per capita for the review period. For health outcome variables, life expectancy and death rate averaged 46.4 years and 18.2 percent respectively. Confirming the slight difference in the maximum and minimum statistics is the corresponding low values of standard deviation statistics. With regards to the skewness and kurtosis, CO_2 emission and death rate are negatively skewed and platykurtic respectively while life expectancy is positively skewed and leptokurtic. The probability values of the Jarque-Bera statistics show that all the variables are normally distributed.

Table 1: Descriptive/Summary Statistics

Statistics	*CO_2*	*LE*	*DR*
Mean	0.64	46.39	18.16
Maximum	1.01	52.54	22.81
Minimum	0.67	40.97	13.07
Std. Dev.	0.33	2.74	2.42
Skewness	-0.11	0.40	-0.29
Kurtosis	1.99	3.04	2.74
Jarque Bera (P-Value)	1.99 (0.37)	1.18 (0.56)	0.74 (0.69)

Source: Author's Computation

4.2. Unit Root Tests

Table 2 shows the results of the ADF and DF-GLS unit root tests. The results are presented in two forms: model with constant and model with constant and trend. The

ADF unit root results show the existence of unit root in CO_2 emission for the model with constant but showed the existence of unit root in all the variables in the model with constant and trend. This implies that the variables have mixed order of integration in the model with constant but the same order of integration in the model with constant and trend. Thus, while the null hypothesis of, "there is no unit root" is rejected for life expectancy and death rate in the model with constant, the hypothesis is not rejected for all the variables in the model with constant and trend. Despite the importance of the ADF as the workhorse of unit root test in the literature, the low power associated with the ADF null against the stationary alternative, particularly when trend is included in the specification has been the major shortcoming of the ADF test. Thus, Eliott, Rothenberg and Stock (1996) proposed an extension to the conventional ADF and the outcome of the augmented ADF test which has come to be known as Dickey Fuller GLS (DF-GLS) show a significant greater power than the traditional ADF. In addition to the ADF test, the DF-GLS unit root test was considered to complement or provide robustness to the ADF result. The results show that life expectancy and death rate have unit root in the model with constant, thus, the null hypothesis is rejected. However, for the model with constant and trend, only life expectancy contains unit root. Thus, the stationarity of the variables hovered around I(0) and I(1).

Table 2: ADF Unit Root Test Results

Variable	*Model with Constant*					
	ADF			*DF-GLS*		
	Level	*1st Diff.*	*I(d)*	*Level*	*1st Diff.*	*I(d)*
CO_2	-2.21	-6.86***	I(1)	0.22***	-	I(0)
LE	-2.28**	-	I(0)	-1.60	-3.99**	I(1)
DR	-5.26***	-	I(0)	0.95	-2.21**	I(1)
	Model with Constant & Trend					
	ADF			*DF-GLS*		
	Level	*1st Diff.*	*I(d)*	*Level*	*1st Diff.*	*I(d)*
CO_2	-2.70	-6.79***	I(1)	0.10***	-	I(0)
LE	-0.55	-2.51**	I(1)	-1.03	-3.82**	I(1)
DR	1.17	-7.83***	I(1)	-5.91***	-	I(0)

Source: Authors' Computation

Note: The exogenous lags are selected based on Schwarz info criteria, while ***, **, * imply that the series is stationary at 1%, 5% and 10% respectively. ADF and DF-GLS represent Augmented Dickey-Fuller and Dickey-Fuller GLS (DF-GLS) Unit Root tests respectively. The null hypothesis for ADF and DF-GLS is that an observable time series is not stationary (i.e. has unit root).

4.3. Optimal Lag Selection

Given the sensitivity of Toda and Yamamoto Vector Autoregressive (TY-VAR) causality testing approach to the choice of lag length, we started our empirical analysis on the causal relation between CO_2 emission and health with a series of nested likelihood ratio tests on level VARs to determine the optimal lag length (p) prior to performing causality test based on TY-VAR estimates. Employing the Schwarz information criterion (SIC) to determine the optimal lag length, the preferred multivariate model for the analysis is presented in Table 3 as VAR (4).

Table 3: VAR Lag Order Selection Criteria

Endogenous Variables: Ln(CO_2) Ln(LE) Ln(DR)
Exogenous Variable: C
Included Observation: 31

	LR	*FPE*	*AIC*	*SIC*	*HQ*
0	NA	0.000149	-0.29508	-0.16711	-0.24917
1	287.1038	6.51E-08	-8.03651	-7.52464	-7.85285
2	158.7706	7.30E-10	-12.5366	-11.6408	-12.2152
3	71.33839	1.01E-10	-14.535	-13.2553	-14.0758
4	42.63862	3.26E-11	-15.7134	-14.04980*	-15.1165
5	16.43553	2.72E-11	-15.9664	-13.919	-15.2318
6	17.67517*	2.01E-11	-16.3886	-13.9573	-15.5163
7	11.13259	1.98E-11	-16.582	-13.7667	-15.5719
8	10.8924	1.88e-11*	-16.89844*	-13.6993	-15.75061*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

4.4. Health Effects of CO_2 Emission in Nigeria

To estimate the chosen multivariate VAR(4) model via TYDL causality testing approach, we select the lag length 5 as our maximum order of integration (d_{max}) and this is due to the outcomes of our unit root testing result, where the series order of integration are revealed as mixture of I(0) and I(1). Table 4 presents the causality testing results on CO_2 emission–health relationship. For the period under consideration, the result shows no significant relationship between CO_2 emission and life expectancy, indicating that CO_2 emission does not granger cause life expectancy and vice versa. Empirical evidences have shown that CO_2 emission has several health hazards and associated health conditions, which are potent enough to reduce life expectancy (Osabohien *et al.*, 2020; Rjoub *et al.*, 2021; Oyelade *et al.*, 2022). Similarly, the result shows that CO_2 emission does not exert a significant influence on death rate in Nigeria, that is CO_2 emission does not instigate death in Nigeria. This result is counterintuitive as a priori expectation and empirical evidences show that many deaths have been linked to the inhalation of CO_2 emission, which has as well led to the continual depletion of the ozone layer (Bressler, 2021).

Overall, the causality testing result indicated no evidence of significant causal relationship between the CO_2 emission and the health indicators considered. This in particular, contradicts Davidson's (2003) and Murthy *et al.*'s (2020) assertion that carbon dioxide emissions are associated with more air pollution leading to health issues involving the lungs, heart and cardiopulmonary system. Such lack of causal relationship may yet be attributable to the developing characteristic of the investigated economy where industrialization process of growth and development is still very much at the premature stage (Afolabi, 2022b).

Table 4: Toda-Yamamoto-Dolado-Lutkepohl VAR Granger Causality Result

Equation Variable	*Equation 1* *Ln(CO_2)*	*Equation 2* *Ln(LE)*	*Equation 3* *Ln(DR)*
Ln(CO_2)	D.V	2.43 (0.6571)	1.67 (0.7966)
Ln(LE)	6.19 (0.1851)	D.V	49.16*** (0.0000)
Ln(DR)	7.03 (0.1341)	22.24*** (0.0002)	D.V

Note: D.V. denotes dependent variable and the probability values are in parentheses while ***, **, and * indicates significance at 1%, 5% and 10%.

5. CONCLUDING SUMMARY

Several attempts have been made to assess the health effects of CO_2 emissions in developed and developing economies. However, most of the studies used either life expectancy or mortality rate as the measure of health outcome and not the two variables together. Moreover, studies on the subject matter is particularly rare for Nigeria, which is one of the top emitter of carbon in Africa. Therefore, this study evaluated the health effect of CO_2 emission in Nigeria from 1970 to 2022. The Toda-Yamamoto-Dolado-Lutkepohl granger causality test was adopted to evaluate this relationship, particularly to determine the direction of causality between CO_2 emission and the selected health indicators. The empirical result showed the absence of causal relationship between CO_2 emission and the duo of life expectancy and death rate in Nigeria. This finding is counterintuitive, especially for a high carbon-emitting country like Nigeria. Nonetheless, it clearly signals the nascent stage of the country's industrialization process.

Based on this finding, this study recommends that the Nigerian government and policymakers should keep CO_2 emission at bay while also deploying alternative energy sources that generate less CO_2 emission. This will not only help in improving the health and wellbeing of citizens together with life expectancy but also foster sustainable economic growth in the country. More importantly, the alternative energy source must be made accessible, affordable and reliable to facilitate its acceptance. In addition, government need to increase the budgetary allocation to the health sector to empower the sector to procure state-of-the-art medical facilities in a bid to provide modern medical services to residents or visitors in the country.

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