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INTERACTIVE EFFECT OF INCOME INEQUALITY AND ENVIRONMENTAL DEGRADATION ON HEALTH OUTCOMES IN NIGERIA

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Abstract

As environmental pollutants, particularly carbon dioxide (CO_2), pose increasing health risks, understanding how inequality influences this relationship becomes critical for policy and development planning. This study examines how income inequality and environmental degradation affect health outcomes (LER) using an ARDL model. The model includes CO_2, GINI, their interaction (CO2*GINI), PGDP, EC, GCE, and PST. The ARDL approach is chosen for its flexibility with mixed integration orders and inclusion of both current and lagged variables. To verify cointegration, the Bounds test and error correction model (ECM) are applied. DOLS estimation, preferred over FMOLS for addressing endogeneity and serial correlation, is also used (Mark & Sul, 2003; Osabuohien et al., 2014). Data from 1990–2023 are sourced from WDI, WGI, and CBN. Robustness checks include ARCH, Breusch-Godfrey, and Cusum tests. Results reveal that in the long run, most variables, including CO_2, GINI, and GINI*CO_2, had negative but statistically insignificant effects on life expectancy (LER), except in FMOLS where GINI*CO_2 was significantly negative. In the short run, CO_2, GINI, and their lags significantly increased LER, while GINI*CO_2 showed a mixed effect—negative initially, positive when lagged. PGDP and GCE had mixed impacts. The 12% error correction rate confirms adjustment to equilibrium. The null hypothesis is not rejected, as GINI*CO2 lacks significant long-run influence. Recommendations include implementing policies that reduce CO_2 emissions, promote equitable income distribution, and strengthen healthcare infrastructure to improve long-term health outcomes.

Keywords: income inequality, environmental degradation, health outcomes, ARDL model, Nigeria

Introduction

Income inequality and environmental degradation are two critical socio-economic and environmental factors influencing public health, especially in developing nations like Nigeria. While these two issues are often studied independently, the combined and interactive effects of income inequality and environmental degradation have profound implications for health outcomes in many regions. Nigeria, being an emerging economy with high levels of poverty, inequality, and environmental degradation, presents a unique case for studying the interaction of these two determinants of health. Income inequality refers to the unequal distribution of income and wealth among individuals or groups within a society. In Nigeria, income inequality has been persistently high, with the country consistently ranked among the most unequal nations globally (Francis, 2020). The health implications of income inequality are well-documented. According to Xiong and Wei (2025), societies with greater income inequality tend to experience worse health outcomes, including higher rates of mortality, mental health disorders, and infectious diseases. This is because income inequality can lead to reduced access to healthcare services, poor living conditions, and inadequate nutrition for lower-income groups (Johar et al, 2018). In Nigeria, this disparity manifests in stark differences in healthcare access between urban and rural populations, with the rural poor suffering from inadequate healthcare facilities, poor sanitation, and limited access to essential health services.

Furthermore, income inequality can exacerbate social tensions, reduce social mobility, and undermine social cohesion, all of which have negative consequences for mental and physical health (Fone et al, 2014). Lower-income individuals in Nigeria are particularly vulnerable to these social stressors, as they are less likely to have access to social protection mechanisms or a robust support network. The link between income inequality and health outcomes is particularly significant in Nigeria due to the high level of economic disparity and the limited scope of social safety nets available to the population (Osewe, 2024). Environmental degradation refers to the deterioration of the natural environment through factors such as pollution, deforestation, land degradation, and climate change. In Nigeria, environmental degradation is a significant concern, particularly in the Niger Delta region, which has experienced extensive oil pollution, gas flaring, and deforestation (Bamidele & Erameh, 2023). Environmental degradation has serious consequences for public health. Exposure to polluted air, water, and soil is associated with various health problems, including respiratory diseases, waterborne diseases, and increased mortality rates (Pona et al, 2021). The poor air quality in urban centers like Lagos, caused by vehicle emissions and industrial pollution, has been linked to a rise in respiratory conditions such as asthma and chronic obstructive pulmonary disease (COPD).

In addition, the contamination of water sources with pollutants, especially in rural and oil-producing regions, leads to a higher incidence of waterborne diseases, such as cholera, dysentery, and typhoid (Omokaro et al, 2024). Furthermore, land degradation due to deforestation and overexploitation of natural resources has led to reduced agricultural productivity, contributing to food insecurity and malnutrition, particularly among rural populations who rely heavily on agriculture for their livelihoods (Ayinde et al, 2020). The combined effect of environmental degradation and poor health outcomes creates a vicious cycle, as vulnerable populations are exposed to environmental risks while also being economically disadvantaged, preventing them from accessing health services or improving their living conditions. The interaction between income inequality and environmental degradation creates a compounded risk for public health in Nigeria. While each factor alone has significant implications for health, their combined effects exacerbate existing health disparities. Income inequality can worsen the impact of environmental degradation, as poorer individuals are often the most vulnerable to environmental risks and have fewer resources to mitigate or adapt to these risks. For example, in Nigeria, individuals in lower-income brackets are more likely to live in areas with poor environmental quality, such as slums, overcrowded settlements, or areas near industrial sites or oil fields. These individuals face higher exposure to environmental hazards, such as air and water pollution, without the means to relocate to safer areas or access healthcare for the treatment of pollution-related diseases (Nnaemeka, 2020).

Moreover, individuals with lower income often lack the financial resources to invest in protective measures, such as improved sanitation or clean water sources, making them more susceptible to the health effects of environmental degradation. For instance, in rural Nigeria, where agriculture is the primary livelihood, environmental degradation in the form of soil erosion or deforestation has led to a reduction in agricultural output, further deepening the economic hardships faced by farmers (Osabohien et al, 2020). This economic strain, coupled with the health impacts of poor nutrition and lack of healthcare, creates a cycle of poverty and poor health outcomes that disproportionately affects those in lower-income brackets. Additionally, the social determinants of health—such as education, employment, and social capital—are influenced by both income inequality and environmental degradation. High levels of income inequality in Nigeria often translate to unequal access to education and employment opportunities, which in turn limits individuals' ability to improve their health outcomes. In regions severely affected by environmental degradation, these social determinants are further compounded, as individuals with low income and limited education are more likely to live in environmentally hazardous areas, where both economic and health conditions are poor (Anwar et al,2017).

This study defines key variables related to environmental degradation and health. CO_2 emissions, a proxy for environmental degradation, are linked to adverse health effects, particularly among vulnerable populations (Anwar et al., 2017; Osabohien et al., 2020). Increased CO2 levels can lead to respiratory illnesses and even mortality. Government capital expenditure (GCE), serving as a control variable, refers to public investment in infrastructure and is associated with carbon emissions and life expectancy (Shao & Dou, 2023; Yameogo & Dauda, 2020). Political Stability and Absence of Violence/Terrorism (PST) gauges the likelihood of politically-driven violence, scored on a standard normal distribution scale. Per capita income (PGDP) is another independent control variable, representing the ratio of GDP to population, and has been tied to life expectancy and inequality in prior research (Fatukasi & Ayeomoni, 2015; Hill et al., 2019; Beyene & Kotosz, 2021). Energy consumption (EC), mainly from fossil fuels, contributes to CO2 emissions and negatively affects life expectancy (Ogede & Tiamiyu, 2022; Osabohien et al., 2020; Gao & Fan, 2023). The Gini coefficient (GINI) measures income inequality, which inversely impacts health outcomes (Drabo, 2011; Ali & Audi, 2016; Orekoya, 2022). Lastly, deforestation, quantified by forest area loss, serves as another indicator of environmental degradation due to human activity.

The urgency for studying the interactive effect of income inequality and environmental degradation on health outcomes in Nigeria is critical given the escalating challenges facing the country. Nigeria has one of the highest levels of income inequality globally, coupled with severe environmental degradation, particularly in regions like the Niger Delta (Bamidele & Erameh, 2023). Despite the recognized importance of both factors independently, limited research exists on their combined impact on public health in the Nigerian context, especially in terms of the compounded risks to marginalized populations. Current literature focuses predominantly on either income inequality or environmental degradation in isolation, neglecting the intersection of these issues. For example, studies have examined income inequality's link to health outcomes such as mortality and mental health (Gibson et al, 2021), but few integrate the role of environmental factors like pollution and waterborne diseases exacerbated by inequality. Furthermore, environmental studies often overlook the socio-economic dimensions, failing to recognize how the poorest are disproportionately affected by environmental harms. This gap in research presents a crucial opportunity to better understand and address the combined health risks posed by these interrelated factors, particularly for Nigeria's most vulnerable populations.

Research Question

Does the interactive effect of income inequality and environmental degradation have impact on health outcomes in Nigeria?

Objective of the Study

The overall objective of the study is to evaluate the interactive effect of income inequality and environmental degradation on health outcomes in Nigeria.

Research Hypothesis

The interaction of income inequality and environmental degradation does not promote health outcomes in Nigeria.

Method

To achieve the study objective, that is, to understand how interacting income inequality and environmental degradation promote health outcomes, the model is stated as:

$$LER = f(CO2, GINI, \mathrm{CO2} * GIN, PGDP, EC, GCE, PST) \qquad (1)$$

Where in this case, GIN*CO_2 represents the interacting effect of income inequality and environmental degradation. Equation (1) shows that health outcomes (LER) are a function of the Gini coefficient (GINI), carbon dioxide emission (CO_2), the interacting effect of income inequality and environmental degradation (GIN*CO_2), per capita income (GDP), Political Stability and Absence of Violence/Terrorism (PST), and energy consumption (EC) as the control variable.

The generalized form of the ARDL (p, q) model is specified below;

$$LER_{\mathrm{t}} = \alpha_0 + \sum_{j=1}^{p} \beta_j LER_{t-p} + \sum_{r=0}^{q} \lambda_r CO2_{t-q} + \sum_{i=0}^{x} \gamma_i LOGGINI_{t-x} + \sum_{h=0}^{q} \pi_u GINI * CO2_{t-i} + \sum_{k=0}^{d} \delta_k \, LOGPGDP_{t-d} + \sum_{m=0}^{z} \sigma_m \, EC_{t-z} + \sum_{n=0}^{f} \emptyset_n LOGGCE_{t-f} + \sum_{s=0}^{g} \psi_s PST_{t-g} + \mu_{\mathrm{t}} \quad \ldots\ldots (2)$$

To perform the bounds test for cointegration, the conditional ARDL (p, q) model is specified below;

$$\Delta LER_t = \alpha_0 + \beta_j LER_{t-i} + \lambda_r CO2_{t-i} + \gamma_i LOGGINI_{t-i} + \pi_u GINI * CO2_{t-i} + \delta_k LOGPGDP_{t-i} + \sigma_m EC_{t-i} + \emptyset_n LOGGCE_{t-i} + \psi_s PST_{t-i} + \sum_{j=1}^{p} \beta_j LER_{t-p} + \sum_{r=0}^{q} \lambda_r CO2_{t-q} + \sum_{i=0}^{x} \gamma_i LOGGINI_{t-x} + \sum_{h=0}^{q} \pi_u GINI * CO2_{t-i} + \sum_{k=0}^{d} \delta_k LOGPGDP_{t-d} + \sum_{m=0}^{z} \sigma_m EC_{t-z} + \sum_{n=0}^{f} \emptyset_n LOGGCE_{t-f} + \sum_{s=0}^{g} \psi_s PST_{t-g} + \mu_t \quad \ldots (3)$$

We can specify both the short-run and long-run model which is the error correction model (ECM) if we can reject the null hypothesis (that is, there is cointegration). The error correction model (ECM) representation is specified as;

$$\Delta LER_t = \alpha_0 + \sum_{j=1}^{p} \beta_j LER_{t-p} + \sum_{r=0}^{q} \lambda_r CO2_{t-q} + \sum_{i=0}^{x} \gamma_i LOGGINI_{t-x} + \sum_{h=0}^{q} \pi_u GINI * CO2_{t-i} + \sum_{k=0}^{d} \delta_k LOGPGDP_{t-d} + \sum_{m=0}^{z} \sigma_m EC_{t-z} + \sum_{n=0}^{f} \emptyset_n LOGGCE_{t-f} + \sum_{s=0}^{g} \psi_s PST_{t-g} + \infty ECT_{t-i} + \mu_t \quad \ldots (4)$$

This study resorts to employing the autoregressive distributed lag (ARDL) model because of its dynamism, that is, the ARDL model is a model containing the lagged values(s) of the dependent variable, the current and lagged values of regressors or explanatory variables, unlike static models. ARDL model uses a combination of endogenous and exogenous variables, unlike a VAR model that's strictly designed for endogenous variables. And the study is interested in the behaviour of our endogenous variables given the exogenous variables.

Mark and Sul (2003) developed what is known as the Dynamic Ordinary Least Square (DOLS) estimates, which are used to test hypotheses about a cointegrating vector. DOLS is considered a superior alternative to Fully Modified OLS (FMOLS) because it is fully parametric and easy to compute, unlike FMOLS, which is nonparametric and was introduced by Pedroni (1997). Mark and Sul (2003) argue that the cointegrating vector remains the same across individuals, but allows for variations across individuals through short-run dynamics and individual-specific time trends. DOLS is proposed as an estimator to address the finite sample bias of OLS caused by endogeneity when estimating regression models with cointegrated variables. Kao and Chiang (2001) demonstrated that the asymptotic distributions of DOLS and FMOLS are the same. However, Osabuohien et al. (2014) argue that DOLS corrects issues commonly faced in time-series estimations, such as serial correlation and endogeneity, highlighting its power, efficacy, and efficiency, which makes it ideal for this study.

In examining the study objective, the researcher starts conducting some descriptive pre-estimation tests to justify the use of the data. The estimation properly examined the unit root test, multicollinearity test, and co-integration test. Under this section, some post-estimation tests are conducted to determine the robustness of the estimated outcome which includes the heteroskedasticity ARCH test, Bruesch-Godfrey Serial Correlation test, and Dynamic stability Cusum test. Table 1 presents the theoretical relationship between the dependent variable, the explanatory variable, and the control variable in the model.

Table 1: Theoretical Postulations of the Variables Included in the model

Dependent Variable	Independent Variables	Expected Parameters Signs	Remarks
LER	CO_2	- < 0	Negative
	GIN	- < 0	Negative
	GIN*CO_2	- < 0	Negative
	GDP	+ > 0	Positive
	EC	- < 0	Negative
	PST	+ > 0	Positive

Source: Researcher's Compilation (2024)

Table 2 presents the variables, and their type in the three objectives, the variables, acronym, and sources.

Table 2: Summary of Data in the Model and Description

Variable	**Acronym**	**Source**
Life expectancy	LER	World Development Indicators [WDI], (2023)
Gini coefficient	GINI	WDI (2023)
Carbon dioxide emissions	CO_2	WDI (2023)
Per capita gross domestic product	PGDP	WDI (2023)
Energy Consumption	EC	WDI (2023)
Government capital expenditure	GCE	Central Bank of Nigeria (2023)
Political Stability and Absence of Violence/Terrorism	PST	World Governance Indicators (2023)

Source: Researchers' Compilation (2025)

The data used for the study were extracted from *WDI, WGI,* and *CBN.* The data used for the study covers the year 1990 to 2023.

Results

The descriptive statistics in table 1 provide an overview of the distribution and central tendencies of the study variables across 34 observations. CO2 emissions have a mean value of (0.668), ranging from (0.478) to (0.916), with a standard deviation of (0.130), indicating moderate variability. The distribution is mildly skewed to the right (0.292) and is platykurtic (kurtosis = 1.844), suggesting a flatter distribution than normal. Life expectancy (LER) averages (49.41) years, with a minimum of (45.49) and a maximum of (53.80). It has a low standard deviation (2.86), slight left skew (-0.108), and low kurtosis (1.516), indicating a fairly symmetric but flat distribution.

Table 2: Summary of Descriptive Statistics

Variables	Obs.	Mean	Minimum	Maximum	Strd. Dev.	Jarque-Bera	Skewness	Kurtosis
CO_2	**34**	0.668461	0.478280	0.916396	0.129537	2.377161	0.291930	1.843668
LER	**34**	49.41434	45.48700	53.80351	2.856141	3.183833	-0.10784	1.516459
EC	**34**	737.5341	680.0624	788.7895	34.48471	2.441026	-0.135448	1.715596
GINI	**34**	45.96765	35.10000	57.90000	6.010431	0.879048	0.222292	2.349732
PGDP	**34**	2028.707	1429.012	2679.554	462.7116	3.940354	-0.054889	1.335856
PST	**34**	-1.648444	-2.211123	-0.432022	0.435663	7.742685	1.112000	3.720591

Source: Researchers' Computation from E-Views 10

Energy consumption (EC) has a mean of (737.53), showing a narrow spread from (680.06) to (788.79), and standard deviation of (34.48). The skewness is slightly negative (-0.135), and kurtosis is (1.716), also indicating a flat distribution. GINI, representing income inequality, averages (45.97) and ranges between (35.10) and (57.90), with moderate variation (std. dev. = 6.01). Per capita GDP (PGDP) shows a mean of (2028.71), and slight left skew (-0.055), indicating a nearly symmetric distribution. PST has a mean of (-1.65), with a wider spread and a positive skew (1.112), suggesting values cluster toward lower stability. Its kurtosis (3.72) indicates a more peaked distribution than normal. To further achieve the study objective, the study adopts the ARDL estimation technique in the model, having been established to possess a long-run relationship as presented in summary table 3.

Table 3: The model Estimation Result (Long-run)

Dependent Variable: *LER*

Variables	Coef.	Prob.	Coef.	Prob.	Coef.	Prob.
	ARDL		DOLS		FMOLS	
CO_2	-763.136	0.3434	95.0408	0.3982	35.3544**	0.0488
LOGGINI	-632.762	0.3471	57.8761	0.5219	25.6563**	0.0222
LOGPGDP	-0.0091	0.9961	2.0315**	0.0542	1.9068*	0.0001
EC	0.5749	0.1704	0.3284	0.2020	0.4592*	0.0000
LOGGCE	-3.0371	0.5187	1.1881	0.2570	0.3397	0.2235
PST	-2.8545	0.3848	-0.1194	0.9071	0.2146	0.6312
GINI*CO_2	16.7350	0.3459	-2.2194	0.3937	-1.0183**	0.0213
C	2464.514	0.3414	-196.3785	0.5617	-65.6348	0.1133

Source: Author's computation, E-views 10

Note: * denotes significance at 1%, ** denotes significance at 5%; FMOLS denotes Fully Modified Least Squares; DOLS denotes Dynamic Ordinary Least Squares. See appendix 20 for the robustness results.

This model is differentiated from the second model with the presence of the combination of the Gini coefficient and carbon emission (Gini*CO_2) which from the results in Table 3 is identified to have a positive and insignificant impact on health outcomes in Nigeria. The result reveals that a 1% increase in Gini*CO_2, on average, increases health outcomes by 16.73 points in the long run. The result indicates that the Gini coefficient plays an effective role in moderating the effect of CO_2 emissions on health outcomes in Nigeria. This implies that improvement in the income distribution will extenuate the effects of CO_2 emissions on health outcomes in Nigeria roughly by 16.73 points.

Furthermore, the Gini coefficient, carbon emission, per capita GDP, government capital expenditure, political stability, and absence of violence/terrorism all have a negative and insignificant impact on health outcomes in the long run. More so, energy consumption has a positive and insignificant impact on health outcomes. Despite the robustness checks, ARDL's focus on dynamic error correction and its allowance for short-term and long-term equilibrium adjustments provide more reliable and real-time policy-relevant insights, making it more advantageous for forecasting in volatile economic contexts.

Table 4: The model Estimation Result (Short-run)

Dependent Variable: *LER*

Variables	Coefficient	Std. Error	T-Statistic	Prob.
D(CO_2)	46.1945*	7.7972	5.9245	0.0001
D(LOGGINI)	30.8018*	4.4254	6.9603	0.0000
D(LOGGINI(-1))	34.9539*	3.1360	11.1459	0.0000
D(LOGPGDP)	0.3054**	0.1381	2.2114	0.0455
D(EC)	-0.0086	0.0246	-0.3511	0.7311
D(LOGGCE)	-0.1468	0.0727	-2.0188	0.0646
D(LOGGCE(-1))	0.2989*	0.0631	4.7329	0.0004
D(PST)	0.1828	0.0972	1.8814	0.0825
D(GINI_CO_2)	-1.1025*	0.1809	-6.0937	0.0000
D(GINI_CO_2(-1))	0.0421*	0.0089	4.7537	0.0004
CointEq(-1)*	-0.1181*	0.0090	-13.1215	0.0000

Source: Author's computation, E-views 10

Note: * denotes significance at 1%, ** denotes significance at 5%

From Table 4, it is observed that the estimate of income inequality proxied by the Gini coefficient as well as its first lag values all had a positive impact on health outcomes. According to the result, a 1% increase in income inequality, on average, increases health outcomes by 308% in the current period, while its first lag value increases health outcomes by 350%, respectively in the short run. Similarly, the estimate of carbon emission proxied by environmental degradation has a positive impact on health outcomes in Nigeria. This is shown from the estimate that a 1% increase in carbon emission during the current period, on average increases health outcomes by 046.19

points. However, the coefficient of the interacting effect of both the Gini coefficient and income inequality ($GINI*CO_2$) and its first lag show a mixture of negative and positive impacts on health outcomes in Nigeria, respectively. As such, a 1% increase in both the presence of income inequality coupled with environmental degradation, on average, reduces health outcomes in Nigeria by 1.102 in the current period but increases it by 0.042 points in the short run. Similarly, government capital expenditure and its first lagged value have a mixture of negative and positive impacts on health outcomes in the short run in Nigeria, respectively. This was deduced from the estimate in Table 4 that a 1% increase in government capital expenditure and its lagged value will on average; reduce health outcomes in the current period by 14.7% and in the previous period by a positive 30% increase, respectively.

More so, it can be seen that energy consumption, political stability, and absence of violence/terrorism have a negative and positive impact on health outcomes in the short run but both are not statistically significant. The result also shows that the error correction term satisfies a priori expectation as it assumed a value between 0 and 1, which is correctly signed. Its co-efficient is approximately 0.12, suggesting that the speed of adjustment from the short run back to the long run if there is disequilibrium in the model is about approximately 12%.

Table 5: Theoretical Postulations of the Variables Included in the model

The observed sign from the long run ARDL results.

The model				
Dependent Variable	**Independent Variables**	**Expected Signs**	**Observed Sign**	**Conclusion**
HO	CO_2	- < 0	-	Conform
	GIN	- < 0	-	Conform
	$GIN*CO_2$	- < 0	+	Does not Conform
	GDP	+ > 0	-	Does not Conform
	EC	+ < 0	+	Conform

Source: Researcher's Compilation (2024)

To achieve the specific objectives of the study and to make a valid evaluation of the research hypothesis, ARDL and DOLS estimation techniques were employed. The hypothesis examines the interacting effect of income inequality and environmental degradation on health outcomes. The results from the model show a mixed outcome for the interaction term ($GINI*CO_2$), with a positive but insignificant long-run impact on health outcomes. This suggests that, while income inequality may moderate the effects of environmental degradation on health, this relationship is not statistically significant in the long run. This finding implies that the interaction effect between these two factors may not be as pronounced as hypothesized, in contrast to studies suggesting that improving income distribution could mitigate environmental health risks (Yorucu & Bahramian, 2015). Therefore, the null hypothesis is not rejected, as the interacting effect is not statistically significant in the long run, indicating that income inequality does not significantly moderate the relationship between environmental degradation and health outcomes in Nigeria.

Discussion

More so, findings from the second model indicate a mix of signs and a significant impact of an interacting effect of income inequality and environmental degradation on health outcomes in Nigeria in the short and long run. That is, a 1% increase in GINI*CO_2, on average, increases health outcomes by1.102 in the short and significant but reduces it in the long run roughly by 16.73 points which is not statistically significant, respectively. This result conforms to the empirical findings of Jorgenson et al. (2020) that the negative relationship between health outcomes and PM2.5 concentration (air pollution) is larger in nations with higher levels of income inequality, and the reductions in predicted health outcomes are substantial when both PM2.5 concentration and income inequality are high. This can be said as well for Nigeria, that the negative relationship between health outcomes and environmental degradation is due to high levels of income inequality. Thus, the presence of both income inequality and environmental degradation is bad for health outcomes in Nigeria which conforms to economic expectations.

Conclusion

This study examined the interactive effect of income inequality and environmental degradation on health outcomes in Nigeria, using life expectancy as a proxy for health. Employing ARDL, DOLS, and FMOLS techniques over the 1990–2023 period, the findings revealed that while income inequality (GINI) and environmental degradation (CO_2) independently influence health outcomes, their interaction (GINI*CO_2) does not have a statistically significant effect in the long run. This suggests that income inequality does not significantly moderate the long-term impact of environmental degradation on health in Nigeria. However, in the short run, both GINI and CO_2 positively and significantly affect health outcomes, whereas their interaction has a mixed effect—negative in the current period but slightly positive when lagged. These results imply that while efforts to improve income distribution may have short-term health benefits, they are not sufficient on their own to offset the long-term health risks posed by environmental degradation. Therefore, policies aimed at improving public health in Nigeria should simultaneously address environmental sustainability and income inequality, but with greater emphasis on direct environmental interventions for long-term health improvement. A multi-sectoral strategy integrating environmental regulation, equitable economic policies, and public health initiatives is essential for sustainable development and population well-being.

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