ECONOMIC GROWTH AND HEALTH OUTCOMES IN SUB-SAHARA AFRICA

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ABSTRACT

This study examines the effect of economic growth on health outcomes of Sub-Sahara Africa (SSA) annual panel times series data was used on Economic Growth (GDP), Health Outcomes (HOC), Green Investment (GIN) and Carbon Emission (CO2) from 1990 to 2023. Cross-Sectional Dependency test, Fixed Effect (FE) and panel pairwise Granger causality techniques were employed for the analysis. The result of cross-sectional dependency shows the evidences of cross-sectional dependencies among both economic growth and health outcomes in SSA. However, the fixed effect result revealed that economic growth has effect on health outcomes (HOC) with coefficient -0.199 and probability value 0.000 meaning that 1% decreased in economic growth (GDP) will worsen the health outcomes by 0.199 per annum Likewise, Dumitrescu and Hurlin Granger causality test result show the existence of bidirectional causality between economic growth and health outcomes over the period of the study. Finally, based on the findings the study recommends following policies to improve the health outcomes for sustainable growth: Sub-Saharan African stakeholders should establish an effective economic block for inclusive growth and sustainable development, Countries should review their fiscal policies measures for regulations of carbon emission to achieve a desirable health outcome in SSA, SSA governments commission for green investment in order to encourage the green investment partnerships and globalization for sustainable development.

Keywords: *Economic Growth, Health, Green Investment, Carbon Emission.*
JEL CODE: *O40, I30, Q34, Q53*

INTRODUCTION

Health outcomes like life expectancy, infant mortality, maternal mortality and overall well-being are powerful reflections of a country's development. In many low-income nations, these indicators remain alarmingly poor (Bilas & Franc, 2024). This has led to a long-standing belief that boosting economic growth is key to improving public health. After all, countries with higher incomes often enjoy longer lives and fewer infant deaths, while the poorest tend to struggle with the worst health conditions (World Health Organization [WHO], 2022). Economic growth generates resources that can be invested in healthcare systems strengthening primary care, advancing medical technologies, and expanding access to services. These improvements are expected to reduce mortality and extend life expectancy. And indeed, a wealth of research supports this connection (World Bank, 2022). For example, a meta-analysis 10% increase in national income could reduce infant mortality from 50 to 45 deaths per 1,000 live births in sub-Saharan African. Another study, analyzing data from 187 nations confirmed a strong link between GDP growth and lower infant mortality (World Bank, 2022).

But economic growth is not always a smooth ride. When downturns hit like recessions or financial crises the most vulnerable populations often suffer the most. Women and children in low- and middle-income countries (LMICs) tend to bear the brunt of these shocks (Onisanwa, 2014). The 2008 global financial crisis, one of the worst since the Great Depression, is estimated to have caused between 28,000 and 50,000 infant deaths in sub-Saharan Africa, erasing hard-won progress toward the Millennium Development Goals. More recently, the COVID-19 pandemic disrupted economies and health systems worldwide. Job losses, reduced household spending, and limited access to food and healthcare all contributed to a decline in maternal and child health (WHO, 2022).

Yet, despite the widespread belief that economic growth automatically leads to better health, recent evidence paints a more complex picture. Some studies show positive affects others report mixed or negligible impacts. In fact, several sub-Saharan African countries have experienced strong economic growth while still grappling with high poverty rates and poor health outcomes (Rohne, 2021). A striking example comes from the 2004 Human Development Report, which compared Georgia and Angola two countries with similar GDP per capita (US$2,200 PPP). Georgia's health outcomes rivaled those of OECD nations, while Angola ranked 166th out of 177 countries. This disparity highlights a critical point; economic growth alone doesn't guarantee better health. Other factors like low carbon emission, green investment and whether investments reach the health sector play a crucial role (Frank, 2020).

This discrepancy raises critical questions regarding the effectiveness of economic growth in addressing public health challenges in SSA. There remains a gap in understanding the specific mechanisms through which economic growth translates or fails to translate into improved health outcomes, particularly in contexts characterized by structural economic and institutional weaknesses. Given the importance of achieving the Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-being) and SDG 8 (Decent Work and Economic Growth), it is imperative to critically examine how economic growth influences health outcomes in SSA.

2. Literature Review

Health outcomes have various indicators that are commonly utilized as the dominants of public health conditions including under-five mortality rate, maternal mortality rate, and life expectancy at birth accompanied by the primary causes of death (Abubakar & Inuwa, 2020). However, health outcome is the clinical improvement and resolution of infection signs and symptoms including infection-related abnormal white blood cell count/temperature or as documented by the physicians in the clinical note (Hays et al., 2023). Also, Haslam et al. (2024) stated that health outcomes are the possible eravacycline-related to adverse effects using the common terminology criteria for adverse events were evaluated. According to Hays et al. (2023) the non-clinical health outcomes is the social prescribing initiative that deals with the health professionals connect their patients to community group and activities with an initiation of improving their health well-being by reducing loneliness and increasing illness self-management and social interaction.

Life expectancy is the number of years a newborn infant would live if prevailing pattern of mortality at the time of it birth was to stay the same throughout its life (World Bank, 2022). Deaton (2008) stated that life expectancy is the statistical measure of the average time that a person is expected to live which influenced by various factors such as genetic, lifestyle, healthcare, and environmental conditions. However, development economist mortality rate are also a conventional health indicators (under 5 and maternal mortalities); Under-five mortality is the death of women due to complications from pregnancy or childbirth. Infant mortality refers to the death of an infant before his or her first birthday. The determinants of child and under-5 mortalities are highly correlated with socioeconomic, demographic, and behavioral factors of households, the health-seeking behavior of mothers, and environmental factors (Abbasi, Karami, Daastari & Taiviar, 2024).

Under-five mortality rate is the probability of the newborn would die before reaching exactly five years of age. Expressed per 10,000 live births. In other words, under-five mortality rate is the rate at which children under five years of age are dying in the population over a given period of time (WHO, 2022). Furthermore, maternal mortality as the health indicator is the annual number of female deaths from any case related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within forty-two (42) days of termination of pregnancy, irrespective of the duration and site of the pregnancy (WHO, 2022).

Akinbode, Dipeolu, Bolarinwa, and Olukowi (2021) examined the effect of health outcome on economic growth in sub-Saharan African. The study used panel time series data on 41 countries from 2000 to 2018. Pool ordinary least square (OLS) and Fixed Random Effect regression was employed. The finding shows that health outcomes positive effect on economic growth and they are strongly correlated. The outcome recommended that effective concentration on health indicators (life expectancy and mortality rates) will robust the economic productivity. Bul, and Moracha (2020) investigated the impact of economic growth on health outcomes in SSA. Pane data was used from 1991 to 2015. Pool ordinary least square (OLS) and two-way fixed method was employed. The results showed that economic growth and mortality rates are inversely related while life expectancy was directly related with economic growth. The result recommended that; SSA countries should prioritize their economic growth in order to reduce the poverty line and makes the more accessibility to health care services.

Sede, Olu, Adegoroye, and Amos (2024) analyzed the effects of health outcomes and economic growth in Nigeria. Time series data was used from 1985 to 2021. The study employed Auto Regressive Distributive Lag (ARDL) and the outcomes explored that an inverse and long run relationships between health outcomes and economic growth in Nigeria. The study suggested that; government should formulate an effective polices that will boost the health indicators to achieved a sustainable economic growth. Sharma (2018) examined the effect of health outcomes on economic growth in 17 advanced countries from 1870 to 2013. Generalize Method Moment (GMM) and panel granger causality techniques was employed. The results revealed that health outcomes have inverse relations with all health indicators except life expectancy. Also, the result shows the bidirectional causality between health outcomes and economic growth. The finding suggested that governments should concentrate on human capital sectors in order to boost the economic growth.

Ogunleye (2014) investigated the effects of health outcomes on economic growth in SSA. The study used time series data of 40 SSA countries. The Generalize Method of Moment (GMM) was employed and the outcome revealed that health outcomes are the determinants of economic growth. The study suggested that; health outcomes should be improved to achieved a sustainable economic growth. Furthermore, Sarpong, Nketiah-Amponsah, and Owoo, (2020) examined the nexus between health outcomes and economic growth in SSA. Panel time series data was used from 1997 to 2016, pane cointegration, Dynamic Ordinary Least Square (DOLS) and panel granger causality techniques. The results showed that there is long run relationships between health outcomes and economic growth. Also, economic growth has positive effect on life expectancy but inverse effect on mortality rates. Likewise, the result revealed the evidence of bidirectional relationship between health outcomes and economic growth in SSA.

This study aims to bridge this gap by investigating the extent to which economic growth has impacted key health indicators, including life expectancy, infant and maternal mortality rates, and healthcare access. Also, this research seeks to generate insights that can inform policy decisions and ensure that economic progress translates into meaningful and inclusive health improvements across SSA countries.

3. Methodology

Nature and Source of Data

This study will utilize annual panel data covering 1990 to 2023 for 12 Sub-Saharan African (SSA), four countries from 3 regions. The selected countries are as follows: Eastern Africa: Kenya, Malawi, Mozambique, and Zimbabwe. Central Africa: Angola, Equatorial Guinea, DR Congo, and Sao Tome and Principe. Southern Africa: Botswana, Lesotho, Namibia, and South Africa. Western Africa: Mauritania, Côte d'Ivoire, Nigeria, and Sierra Leone. The data for all variables included in the model will be sourced from the World Bank Online Database (2023). The variables to be used are: Health Outcomes (HOC), Economic Growth (GDP), Green Investment (GIN) and Carbon Emission (CO_2). These variables were selected to establish the link between economic growth and health outcomes in Sub-Saharan Africa

Description, Measurement and Source of Data

Variable	Definition of Variable	Measurements
Health Outcomes (HOC)	Health outcomes is an integration of three majors' health indicators; Life expectancy, under 5 mortality rate and maternal mortality rate	Log (%.)
Economic Growth (GDP)	This indicator provides per capita values for gross product (GDP).	USD ($)
Green Investment (GIN)	Is an investment in noncarbohydrate energy that does not produce carbon dioxide when generated. It includes hydropower and nuclear, geothermal, and solar power, among others.	USD ($).
Carbon Emission (CO_2)	CO_2 emissions from electricity and heat production are the sum of CO_2 emissions.	Metric Tons

Source: World Bank, 2024.

Models Specification

This study anchored on Romer, (1987) new endogenous growth model and Grossman, (1972) health production theory to formulate the robust model to explore the interrelationships socioeconomic and environmental factors as a determinants of health outcomes as shows the equations below:

$$Y_t = K_t^{\alpha} H_t^{\beta} (AL)_t^{1-\alpha-\beta\varepsilon_t} \ldots \ldots (1)$$

Where; Y = Output, K = Physical capital, H = Human capital, L = Labour force, A = Technology, t = Time series, α and β = Coefficients of independent variable and ε = Stochastic variable.

L and A are assumed to be grow exogenous at rates of n and g.

$$L_t = L_0^{en^t} \ldots \ldots (2)$$

$$A_t = A_0^{eg^t} \ldots \ldots (3)$$

$$k_t = s_k y_t - (n - g + \partial) k_t \ldots \ldots (4)$$

$$h_t = s_h y_t - (n - g + \partial) h_t \ldots \ldots (5)$$

Equation 4 and 5 imply that that economy converges to steady state defined by;

$$K^* = \left(\frac{Sk^{1-\beta} s_h^{\beta}}{n+g+\partial} \right) \frac{1}{1-\alpha+\beta} \ldots \ldots (6)$$

$$h^* = \left(\frac{Sk^{\alpha sh^{1-\beta}} s_h^{\beta}}{n+g+\partial} \right) \frac{1}{1-\alpha+\beta} \ldots \ldots (7)$$

Substitute equation 6 and 7 into $y_t = \frac{Y_t}{(AL)_t} Y_t$ gives the steady-state output per capita effective labour as;

$$y^* = \left[\frac{S_k^{\alpha} S_h^{p}}{(n+g+\delta)\alpha+\beta} \right] \frac{1}{1-\alpha-\beta} \ldots \ldots (8)$$

but $y_t = \frac{Y_t}{(AL)_{t_t}}$

$$\frac{Y_t}{(AL)_t} = \left[\frac{S_k^{\alpha} S_h^{p}}{(n+g+\delta)\alpha+\beta} \right] \frac{1}{1-\alpha-\beta} \ldots \ldots (9)$$

$$\frac{Y_t}{(AL)_t} = A_t \left[\frac{S_k^{\alpha} S_h^{p}}{(n+g+\delta)\alpha+\beta} \right] \frac{1}{1-\alpha-\beta} \ldots \ldots (10)$$

Substitute equation 3 in 6 and taking Logs given an equation for income per capita as;

$$I_n \left[\frac{Y_t}{L_t} \right] = I_n A_0 + g_t + \frac{\alpha}{1-\alpha-\beta} I_n(s_k) + \frac{\beta}{1-\alpha-\beta} I_n(s_h) - \frac{\alpha+\beta}{1-\alpha+\beta} I_n(n+g+\delta) \ldots (11)$$

Equation (10) demonstrates how per capita income depends on accumulation of physical capital and human capital as well as population growth. Therefore, this paper used the dependent variable of equation (11) as the determinant factor of health outcomes accompanied by socioeconomic and environmental factors (Grossman, 1972).

$$Hoc = f(GDP, GIN, CO_2) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

Where; HOC= Health outcomes, GDP= Socioeconomic factor proxy economic growth, GIN and CO_2 = Environmental factors proxied Green Investment and Carbon emission.

$$HOC_t = \beta_0 + \beta_1 GDP_t + \beta_2 GIN_t + \beta_3 CO_{2_t} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (13)$$

Making the dependent variable of equation 11 as independent variable in equation 13 to determine the health outcomes in SSA;

$$HOC_t = \beta_0 + \beta_1 I_n \left[\frac{Y_t}{L_t}\right] t + \beta_2 GIN_t + \beta_3 CO_{2_t} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots..\ldots\ldots\ldots\ldots\ldots.. (14)$$

Where; $I_n \left[\frac{Y_t}{L_t}\right] t$ = GDP per capita

Therefore, logging both endogenous and exogenous variables formulate an estimated SSA health production model that is equation 15.

$$I_n HOC_t = \beta_0 + \beta_1 I_n GDP_t + \beta_2 I_n GIN_t + \beta_3 I_n CO_{2_t} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (15)$$

Where; β_0= intercept, β_1, β_2 and β_3 = coefficients of independent variables, I_n= Log, ε = stochastic variable and t = time series.

A' priori Expectation

$\beta_1, \beta_2 > 0$ and $\beta_3 < 0$

This paper anticipated that GDP and GIN have direct relations with HOC while CO_2 is inversely related with HOC.

Panel Unit Root Tests

In any time, series estimation analysis, ensuring the stationarity of variables is crucial to avoid spurious regression results. A panel unit root test will be conducted to determine whether the series are stationary at levels or require differencing, serving as a guide for selecting the appropriate technique for empirical analysis. Accordingly, this study employs the second-generation unit root tests proposed by Pesaran (2015, 2021), Juodis and Reese (2021), and Pesaran and Xie (2021) to investigate the presence of a unit root in a cross-sectionally dependent panel data set. The proposed test statistic is formulated as follows:

$$\Delta y_{it} = \alpha + py_{it-1} + \theta_1 \Delta y_{it-1} \ldots + \theta_k \Delta y_{it-k} + \mu_{it} \ldots \quad (16)$$

$$CSD\ (N,T) = N^{-1} \sum_{i=1}^{N} ti\ (N,T) \ldots \quad (17)$$

Where ti (N,T) is the cross-sectionally augmented Dickey–Fuller statistic for the ith cross section unit.

Panel Granger Causality Test

The panel granger causality test will be employed to investigate the causative relationships between the health outcomes and economic growth, and it will present in equations (18) to (19) respectively below:

$$\Delta lnHOC_{,it} = \varnothing_{1,j} + \Sigma_k \varnothing_{11,ik} \Delta lnHOC_{,it-k} + \Sigma_k \varnothing_{12,ik} \Delta lnGDP_{it-k} + \mu_{1,it} \ldots \quad (18)$$

$$\Delta lnGDP_{it} = \varnothing_{2,j} + \Sigma_k \varnothing_{21,ik} \Delta lnGDP_{,it-k} + \Sigma_k \varnothing_{22,ik} lnHOCit_{-k} + \mu_{2,it} \ldots \quad (19)$$

The null hypothesis of the Granger causality test is that the lagged of the explanatory variable does not justify the variation in the dependent variable. Therefore, $H_0 : \varnothing_{12ik} = 0$ or $H_0 : \varnothing_{21ik} = 0$. If the null hypothesis is rejected HOC granger cause GDP and vice-versa.

4. Data and Result Discussion

Table 1: Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
HOC	408	-6.86e-09	1.0000	-1.2030	03.5080	1.014	3.512
GDP	408	2577.097	2463.698	280.353	14222.549	1.925	7.513
GIN	408	053.444	26.9050	03.680	98.3400	0.031	1.979
CO2	408	01.5510	02.0170	0.0300	08.4470	2.004	5.995

Source: Author’s Computations Using Stata 17, (2025)

Table 1 presents the summary statistics of the series. The mean economic growth of the 12 selected SSA countries was 2,577.1, with a standard deviation of 2,463.7. the statistics of Health Outcomes (HOC) shows that the mean decline of desirable health outcomes was -6.86 in three decades, with a standard deviation of 1.000. The minimum decline was -1.2030, maximum improvement in health outcomes was

3.5080. Also, the skewness was positive 1.0414 but very slim, the kurtosis was 3.512 indicates the evidence of platykurtic possibly due to institutional changes during the study period.

The summary statistics for economic growth (GDP) in SSA show a mean of 2,577.097 million USD, with a standard deviation of 2,463.698 million USD. The minimum value was 280,353 thousand USD, and the maximum was 14.2 million USD. Also, the skewness was 1.925 meaning that the it positive but slim then the kurtosis was 7.513 which was very peak but their investment in health and green sources of energy was low over the period of the study. However, the summary statistics shows the minimum green energy investment was 3.68 million USD, while the maximum was 98.34 million USD per annum, the skewness was positive and very slim 0.031 and kurtosis 1.979 reveals that the investment in green energy was low over the study period.

Regarding investments in zero-emission energy, referred to as green investment, the mean was 53.44 million USD, with a standard deviation of 26.91 million USD., maximum 98.3 million USD. Then skewness was positive but very slim 0.031 and peak of the normal curve was platykurtic 1.979 for the periods of three decades. Lastly, for carbon emissions (CO_2), the mean value was 1.55 metric tons, with a standard deviation of 2.02. The minimum emission was 0.03 metric tons, while the maximum emission per annum was 8.45 metric tons, the skewness was 2.004 which was positive and it higher shows that awareness on the effects of carbon emission on economic growth and health outcomes is low in SSA. Likewise, the kurtosis was 5.995 that is mesokurtic meaning that the normal curve for carbon emission was peak and therefore, emission is increasing due to commitments for economic convergence in SSA.

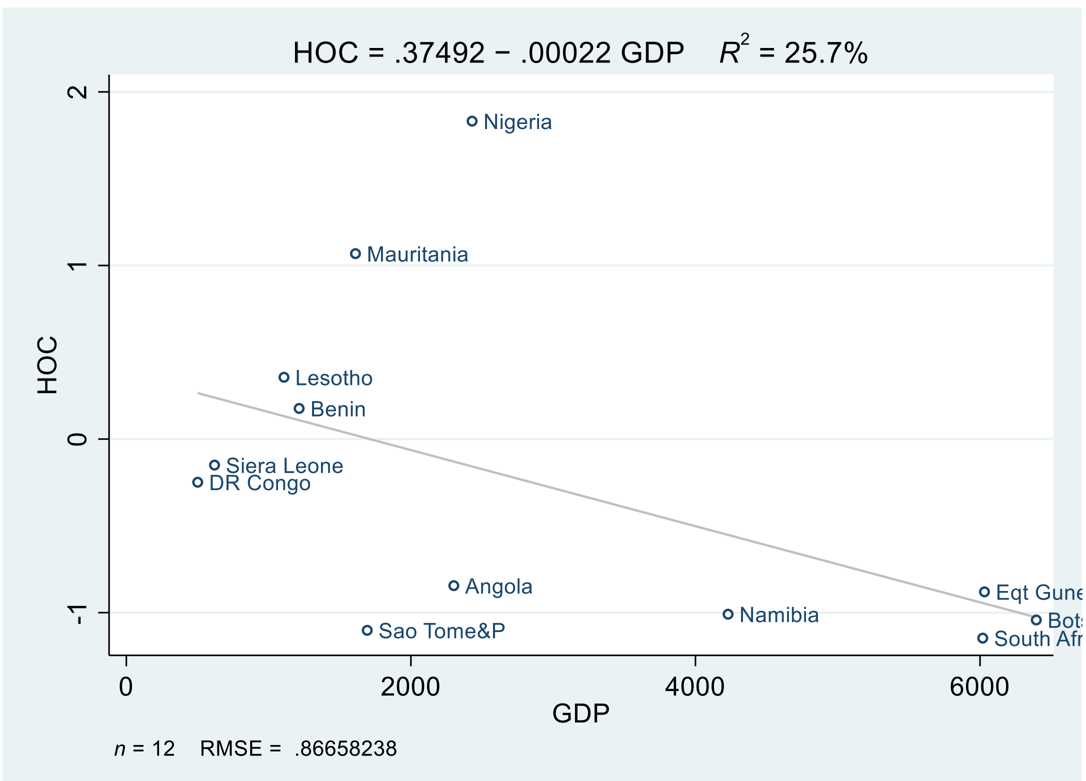
Table 2: Cross-Sectional Dependency Result

	CD	CDw	CDw+	CD*
lnHOC	22.370	3.880	230.770	-2.340
	(0.000)	(0.000)	(0.000)	(0.019)
lnGDP	24.220	-1.570	264.600	-1.770
	(0.000)	(0.117)	(0.000)	(0.077)
lnGIN	25.480	-2.170	270.030	6.080
	(0.000)	(0.030)	(0.000)	(0.000)
lnCO2	9.310	-3.540	215.290	-1.520
	(0.000)	(0.000)	(0.000)	(0.129)

p-values in parenthesis.
References: CD: Pesaran (2015, 2021), CDw: Juodis, Reese (2021), CD*: Pesaran, Xie (2021) with 4 PC(s)
Source: *Author's Computations Using Stata 17 version, 2025*

Table 2 presents the results of the second-generation panel unit root test and the cross-sectional dependency analysis of the series in the model. This study employed three different unit root and cross-sectional dependency tests to ensure conformity of stationarity and the spillover effect of the series in SSA during the study period (Pesaran, 2015, 2021; Juodis *et al.,* 2021; and Pesaran *et al.,* 2021). The results indicate that all the variables are stationery and exhibit spillover effects in SSA, as shown in the CD and CDw+ tests (Pesaran, 2015, 2021; Juodis *et al.* (2021). However, the CDw outcomes reveal that only carbon emissions ($lnCO_2$), green investment (lnGIN), economic growth (lnGDP) and Health Outcomes (lnHOC), have spillover effects. as indicated by the CDw test (Juodis *et al.,* 2021). Similarly, according to Pesaran *et al.* (2021), all demonstrate spillover effects. Thus, an effect in one variable in specific country will influence a similar variable in all SSA over the period of the study.

Figure 1: Graphical Correlations Result for Economic Growth and Health outcomes in 12 SSA Selected Countries



The figure 1 is the graphical correlation analysis result for health outcomes (HOC) economic growth (GDP) in SSA. The R^2 = 25.7% reveals positive and high correlation between health outcomes and economic growth. A change in health outcomes (life expectancy, maternal and under-five mortality rates) is associated with change in economic growth. The result reveals that Siera Leone, DR Congo, Sao Tome and Principle, Benin, Lesotho and Mauritania has lowest economic growth below 2000 USD GDP per capita but their health outcomes was very good due to effective institutions and commitments on human capital for sustainable development, the mortality rates was below the severe line (0) with exception of Mauritania, Lesotho and DR Congo they are above severe line but less than the worse point 1.5 and above. Furthermore, the correlation result reveals that economic growth of Nigeria was 2000 USD but their health outcome was very unfortunate closed to the peak of the worse point (2) due to the less concerns on public healthcare services.

However, Namibia, South Africa Boswana and Equatorial Guinea were best in both economic growth and health outcomes in SSA with the lesser mortality rate below severe line and good economic growth as shows their GDP per capita Namibia greater than 4000 USD then 6000 USD for South Africa and Equatorial Guinea while Botswana above 6000 USD. Thus, the good health outcomes in SSA are not depends on economic growth alone there some factors that can influence the changes in health outcomes such as green investment and low carbon emission.

Table 3: Hausman Test Result for Economic Growth and Health Outcomes

Objective	Chai-Square	P-Value.	Decision
Economic Growth and Health Outcomes.	96.825	0.000	FE

Source: *Author's Computations Using Stata 17 version, 2025*

Table 2 presents the results of the Hausman test specific objectives of this study, with the aim of selecting the appropriate estimation technique between Fixed Effects (FE) and Random Effects (RE), based on the probability values of the F-statistics. The objective to examining the effect of economic growth on health outcomes in Sub-Sahara Africa (SSA) the Hausman test yielded an F-statistic of 96.825 with a probability value of 0.000, which is less than the 0.05 level of significance. This result indicates that the Fixed Effects (FE) model is the appropriate estimation technique for these objectives.

Table 4: Fixed Effect Result for Economic Growth and Health Outcomes

Dependent Variable: lnHOC	Coef.	St.Err.	t-value	p-value	Sig
lnGDP	-0.199	.053	-3.72	0.000	***
lnGIN	-4.115	.83	-4.96	0.000	***
lnCO2	1.721	.43	4.00	0.000	***
Constant	77.718	8.177	9.50	0.000	***

Mean dependent var	56.173	SD dependent var	6.459
R-squared	0.202	Number of obs	408
F-test	33.058	Prob > F	0.000
Akaike crit. (AIC)	2296.397	Bayesian crit. (BIC)	2312.442

**** p<.01, ** p<.05, * p<.1*

Source: *Author's Computations Using Stata 17 version, 2025*

Table 4.9 presents the Fixed Effect (FE) regression results on the effect of economic growth on health outcomes in SSA countries. The results show that a decrease in economic growth (lnGDP) has a negative effect on health outcomes (lnHOC) with a coefficient of -0.199 and a probability value of 0.000. This indicates that a 1% decrease in economic growth will worsen the health outcomes increase the under-five and maternal mortality rates. Also, decrease in life expectancy by approximately 0.19% per annum because decrease in economic growth will result low income, less access to health care services and good nutrition which can affect all the components or health care indicators negatively (see Akinbode et al., 2021 & Ogunleye, 2024). Similarly, a decrease in green investment (lnGIN) negatively affects the health outcomes, as shown by the coefficient of -4.115 and a probability value of 0.000, meaning that a 1% decrease in green investment will lead to about a 4.1% persistent decrease in desirable health outcomes in SSA countries. Additionally, a increase in the carbon emission, (lnCO2), has direct effects on health outcomes, with a coefficient of 1.721 and a probability value of 0.000. This implies that a 1% decrease in the carbon emission will result in an 1.7% increase in both the maternal and under-five mortality rate which will result low life expectancy per annum in SSA (see Oguleye, 2024, Sarpong et al., 2020 & Moracha, 2020).

Table 5: Dumitrescu and Hurlin Granger causality test result

Null Hypothesis:	W-bar	Z-bar	Z-bar tilde	Decision
lnGDP Does not Granger Cause lnHOC	9.3255	20.3933 (0.0000)	17.8678 (0.0000)	Reject
lnHOC Does not Granger Cause lnGDP	8.4750	18.3098 (0.0000)	16.0265 (0.0000)	Reject

Source: *Author's Computations Using Stata 17 version, 2025*

Table 5 presents the Dumitrescu and Hurlin panel pairwise Granger causality test results for economic growth (lnGDP) and Health Outcomes (lnHOC) in 12 selected SSA countries from 1990 to 2023. The results reveal a bidirectional causality between green investment and economic growth, evidenced by the statistical significance of both the Z-bar statistic (20.3933, p=0.0000, 18.3098 p =0.0000) and the Z-bar tilde statistic (17.8678 p=0.0000, 16.0265 p=0.0000) over the study period. These findings align with the results of Doganlar et al. (2021) and Wan et al. (2021).

This indicates that any positive or negative economic growth will have a corresponding impact on health outcomes in SSA, and vice versa, during the study period. For instance, an increase in economic growth will improve an access to health care services and it will have a trickledown effect on life expectancy and reduction of both infant and maternal mortality rates due less dependency on public health expenditure and good access to nutrition, portable drinking water and environmental sanitations. Conversely, a decline in health outcomes would likely hinder economic growth. Similarly, changes in health outcomes directly affect economic growth in SSA. For example, a good health outcome leads to higher aggregate demand for labor, resulting in increased per capita income for sustainable development (see Ogunleye 2024, Akinbode *et al.,* 2021 & Sarpong *et al.,* 2020).

5. Conclusion and Recommendations

This paper empirically examines the effect of economic growth on health outcomes of sub-Sahara Africa (SSA) from 1990 to 2023. The study is anchored on the Grossman health production model as the theoretical framework to achieve its objectives. Cross-Sectional Dependency test, Fixed Effect (FE) and panel pairwise Granger causality techniques were employed for the analysis. The result of cross-sectional dependency shows the evidences of cross-sectional dependencies among both economic growth and health outcomes in SSA. However, the fixed effect result revealed that economic growth has effect on health outcomes. Likewise, Dumitrescu and Hurlin Granger causality test result show the existence of bidirectional causality between economic growth and health outcomes over the period of the study. Finally, based on the findings the study recommends following policies to improve the health outcomes for sustainable growth:

i. Sub-Saharan African governments should establish a strong collaborations platform that will improve the human capital development of their region.
ii. Sub-Saharan African stakeholders should establish an effective economic block for inclusive growth and sustainable development.

iii. Countries should review their fiscal policies measures for regulations of carbon emission to achieve a desirable health outcome in SSA.

iv. SSA governments commission for green investment in order to encourage the green investment partnerships and globalization for sustainable development.

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