Journal of Economics, Finance and Sustainability
Vol. 3, No. 2, 124–137
https://doi.org/10.5281/zenodo.18077921
Research Article / Araştırma Makalesi

Energy Consumption, Environmental Quality and Health Nexus in West African Countries: Implications for Sustainable Development

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ABSTRACT

Purpose – Most developing countries including West African countries have been experiencing declining health patterns following the lack of attention on health-related factors like energy and environment. This study therefore intends to examine the nexus among energy consumption, environmental quality and health in West African countries while employing data from 2000 to 2022.

Design/data/methodology – This study intends to examine the nexus among energy consumption, environmental quality and health in West African countries while employing data from 2000 to 2022. The study disintegrates energy consumption into renewable and non-renewable energy. Pooled Mean Group Autoregressive Distributed Lag (PMG/ARDL) model was employed for the study.

Findings – Short run estimates reveal a negative influence of non-renewable energy on life expectancy in West African countries. Similarly, non-renewable energy exerts a significant and negative influence on child mortality. Non-renewable energy also reduces health expenditure. Renewable energy was observed to increase life expectancy and reduce child mortality. The study concludes that a substantial amount of renewable energy be incorporated into the energy basket of West African countries to improve health conditions.

Originality/value – Despite the fact that Africa is rich in renewable energy sources, the continent's energy mix is dominated with the fossil fuels constituting about 90 percent, while renewable energy accounts for 10 percent. This could have deteriorating effects on the environment and subsequently on the health status of people across the continent. The study is one of the first studies using these variables and countries.

Keywords: Energy, Health, Environment, Causality, Sustainable Development

Batı Afrika Ülkelerinde Enerji Tüketimi, Çevre Kalitesi ve Sağlık Arasındaki İlişki: Sürdürülebilir Kalkınma İçin Çıkarımlar

ÖZET

Amaç – Batı Afrika ülkeleri de dahil olmak üzere çoğu gelişmekte olan ülke, enerji ve çevre gibi sağlıkla ilgili faktörlere yeterince dikkat edilmemesinin ardından sağlık modellerinde düşüş yaşamaktadır. Bu nedenle bu çalışma, 2000-2022 yılları arasındaki verileri kullanarak Batı Afrika ülkelerinde enerji tüketimi, çevre kalitesi ve sağlık arasındaki ilişkiyi incelemeyi amaçlamaktadır.

Tasarım/veri/metodoloji – Bu çalışma, 2000-2022 yılları arasındaki verileri kullanarak Batı Afrika ülkelerinde enerji tüketimi, çevre kalitesi ve sağlık arasındaki ilişkiyi incelemeyi amaçlamaktadır. Çalışma, enerji tüketimini yenilenebilir ve yenilenemeyen enerji olarak ayrıştırmaktadır. Çalışma için Havuzlanmış Ortalama Grup Otoregresif Dağıtılmış Gecikme (PMG/ARDL) modeli kullanılmıştır.

Bulgular – Kısa vadeli tahminler, Batı Afrika ülkelerinde yenilenemeyen enerjinin yaşam beklentisi üzerinde olumsuz bir etkisi olduğunu ortaya koymaktadır. Benzer şekilde, yenilenemeyen enerji çocuk ölüm oranı üzerinde önemli ve olumsuz bir etkiye sahiptir. Yenilenemeyen enerji aynı zamanda sağlık harcamalarını da azaltır. Yenilenebilir enerjinin yaşam beklentisini artırdığı ve çocuk ölüm oranını azalttığı gözlemlenmiştir. Çalışma, Batı Afrika ülkelerinin enerji sepetine sağlık koşullarını iyileştirmek için önemli miktarda yenilenebilir enerjinin dahil edilmesi gerektiği sonucuna varmaktadır.

Özgünlük/değer – Afrika yenilenebilir enerji kaynakları açısından zengin olmasına rağmen, kıtanın enerji karışımının yaklaşık %90'ını fosil yakıtlar oluştururken, yenilenebilir enerji %10'luk bir paya sahiptir. Bu durum, çevre ve dolayısıyla kıta genelindeki insanların sağlık durumu üzerinde olumsuz etkilere yol açabilir. Çalışma, bu değişkenleri ve ülkeleri kullanan ilk çalışmalardan biridir.

Anahtar Kelimeler: Enerji, Sağlık, Çevre, Nedensellik, Sürdürülebilir Kalkınma

Received / Geliş Tarihi: 16.02.2025 Accepted / Kabul Tarihi: 25.7.2025

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1. Introduction

Health is a crucial element for labour productivity, economic growth and sustainable development of countries across the world. The Sustainable Development Goals (SDGs) proposed in 2015 have health and welfare as part of its core targets, while highlighting the importance of clean energy, access to clean water and sanitation as measures of improving the health conditions of people. However, as a result of human activities involving a high consumption of energy, environmental threats have increased, resulting in poor health, which can reduce life expectancy and increase mortality rates. As a complement to labor and capital, energy consumption is a prerequisite for economic growth and an enhanced standard of living. Energy consumption can be divided into renewable and nonrenewable categories. The former represents energy from sources that are replenished over time, whereas the latter's sources are not readily replenished. Although energy contributes to sustainable development, the net benefit of energy consumption depends on the type of energy consumed.

Access to energy is a crucial factor in determining health outcomes. Lack of energy access can result in substandard living conditions, such as inadequate heating and lighting, which can have a negative effect on health. In addition, inadequate access to energy can restrict access to clean water, which can have negative health effects. However, energy consumption remains the primary source of human-induced greenhouse gas emissions, accounting for approximately 76% of global emissions in 2020 (World Resources Institute, 2024). The combustion of fossil fuels produces a variety of pollutants and greenhouse gases that contribute to air pollution, climate change, and other environmental issues. In turn, these environmental issues can have negative effects on human health, including an increased risk of respiratory and cardiovascular diseases and other health issues. This can manifest in low life expectancy, an increased maternal mortality rate, an increased neonatal mortality rate, and an increase in public healthcare expenditures, among others (Matthew et al., 2018; Alege et al., 2017).

Renewable energy sources, such as solar and wind power, have the potential to mitigate the adverse health effects of energy consumption. These energy sources produce little or no air pollution and do not contribute to climate change, which can have serious health consequences. Additionally, renewable energy can provide energy access to those who lack it, thereby enhancing living conditions and health outcomes. Approximately 84 percent of the world's energy consumption is comprised of fossil fuels, also known as nonrenewable energy, while renewable energy accounts for 16 percent. The non-renewable energy mix is comprised of 36 percent crude oil, 26 percent coal, and 22 percent natural gas, while the renewable energy mix is comprised of 7 percent hydro, 5 percent nuclear, and 4 percent other renewables such as wind, solar, and biofuels (Energy Information Administration, 2019). Similarly, the World Health Organization (WHO) estimated in 2016 that 24% of the global disease burden and 23% of all fatalities were attributable to modifiable environmental factors, such as physical, chemical, and biological hazards to human health (Prüss-Ustün et al., 2016).

Despite the abundance of renewable energy resources in African countries, the region's energy consumption remains dominated by fossil fuels, exposing it to environmental degradation and consequently poor health conditions. Similarly, this group of countries is plagued by inadequate health infrastructure and insufficient energy efficiency, moving them away from achieving sustainable development (Chaabouni & Saidi, 2017; Destek & Aslan, 2017). Sub-Saharan Africa was reported to have the highest number of deaths per capita attributable to the environment, predominantly due to infectious diseases as well as noncommunicable diseases and injuries, with the disease burden being highest (36%) among children (World Health Organization, 2017).

The energy situation in West Africa is primarily characterized by a heavy reliance on crude oil and natural gas. Electricity generation in West Africa continues to rely significantly on fossil fuels, with oil and gas accounting for a significant portion of total generation capacity, particularly in oil-rich nations like Nigeria. In 2018, fossil fuels accounted for more than 77% of Nigeria's electricity generation and almost 70% of West Africa's CO2 emissions. In 2018, more than 90 percent of the electricity produced in Gambia, Benin, Guinea-Bissau, and Senegal came from fossil fuels (Mullan & Davies, 2021).

Carbon dioxide emission, which is a major gaseous component of fossil fuel combustion, is identified as a contributory factor to climate change as it multiplies and accumulates in the atmosphere (Sharma, 2017), thereby degrading the quality of the environment and posing severe implications for human health and the pursuit of sustainable development. This has significantly contributed to climate change issues in West African nations, as evidenced by irregular rainfall patterns, droughts, extreme daytime and nighttime temperatures, and ecosystem degradation. Approximately 56% of the coastlines of Benin, Côte d'Ivoire, Senegal, and Togo are eroded, making coastal degradation and erosion a significant problem in West Africa.

Increasing temperature and irregular rainfall patterns are also being observed, which has a significant impact on human health in the region by increasing the transmission of vector-borne diseases such as malaria, yellow fever, and dengue fever, among others (UNFCCC, 2020). The remaining parts of the paper as a follow up to this introductory section include section two, which presents a brief overview of the related literature; section three deals with the theoretical framework and the methodology adopted for the study. Section four is the presentation of results and discussion, while section five concludes the study and provides policy recommendations.

2. Literature Review

This study examines two strands of literature regarding the relationship between energy, environment, and health. While the first strand of literature examines studies on non-renewable energy consumption, the environment, and health, the second strand examines studies on renewable energy, the environment, and health. Balani (2016) examined the causal relationship between environmental quality, as measured by CO2 emissions, and human health, as measured by life expectancy, for 25 European Union (EU) countries from 1995 to 2013. The study recorded a causal relationship between environmental quality, education, and health. Arafat et al. (2022) examined the causal nexus between energy consumption, environmental degradation, financial development, and health outcomes by using life expectancy and infant mortality as proxies. The causality analysis reveals unidirectional causality from energy consumption and environmental degradation to health outcomes, while bidirectional causality was discovered between financial development and health outcomes in the long run.

Similarly, Anser et al. (2022) examined the effect of energy use, greenhouse gas emissions, and economic activities on health hazards using the mortality rate and incidence of respiratory diseases for emerging Asian nations. They reported that emissions of greenhouse gases, consumption of fossil fuels, and depletion of natural resources in the region are major contributors to rising health hazards. Zhong et al. (2022) analyzed the relationship between CO2 emissions, sustainable development, energy efficiency, energy intensity, and health expenditures from 2000 to 2020 in a study for SSARC countries. Using Fully modified Ordinary Least Square Regression (FMOLS) and Dynamic OLS (DOLS), the long-run effect of energy and CO2 emissions on health expenditures was validated.

In an additional study for the SAARC-BIMSTEC region, Rahman and Alam (2021) investigated the relationship between health status and health expenditure, energy consumption, and environmental pollution. Health expenditures was unbundled into public and private. Data from 2002 to 2017 were analyzed using both the Panel Autoregressive Distributed Lag (ARDL) model and the heterogeneous panel causality test. They reported a negative relationship between pollution and health. Taghizadeh-Hesary et al. (2020) in a study for 18 Asian countries reported that increased consumption of nonrenewable energy sources may lead to more air pollution, resulting in negative health impacts in a society. While employing the generalized method of moments for data from 18 Asian countries (both low- and middle-income) from1991 to 2018, findings established that fossil fuel energy consumption increases the risk of lung and respiratory diseases in the region. In addition, they reported the significant effect of CO2 emissions and fossil fuel consumption on undernourishment and death rates.

Aladejare (2023) examined the nexus between human well-being and environmental degradation for 29 African countries from1970 to 2019. While employing the Panel auto-regressive distributed lag model and the Dumitrescu-Hurlin causality approach, findings showed that the environment enhanced human well-being indicators such as globalization, life expectancy and human capital development in the short and long term. Beyene and Kotosz (2021) also examined the impact of environmental quality on life expectancy in 24 African countries using data ranging from 2000 to 2016 with the Panel Autoregressive Distributed Lag (ARDL) method. They established that improvements in environmental quality significantly increased life expectancy for the countries studied.

Alimi et al. (2020) investigated the causal linkage between environmental quality and healthcare expenditure in 15 ECOWAS countries over the period 1995–2014. The empirical evidence is based on three estimators, viz pooled OLS, fixed effects and system GMM, respectively; while disaggregating healthcare expenditure into aggregate (national), public and private, respectively. From the empirical findings, carbon emission is found to exert a positive statistically significant impact on both public and national healthcare expenditure on the one hand, while no relationship seems to exist between environmental pollution and private healthcare expenditure on the other hand. Findings showed a negative relationship between environmental degradation and health.

In a study for Nigeria, Matthew et al. (2018) analysed the effect of greenhouse gas emissions on health outcomes within an ARDL framework for data spanning from 1985 to 2016. The study established a positive relationship between GHG emission and mortality rate. However, Afolayan and Aderemi (2019) in another study for Nigeria, reported a non-significant relationship between CO2 emissions and mortality rate. However, they established that electricity consumption, government healthcare expenditure and fossil fuel combustion have positive effect on mortality rate.

While literature on renewable energy, environment and health are sparse, the second strand of literature examines the nexus among the tripartite. Majeed et al. (2022) examined the role of renewable energy and environmental pollution on health and the income status of the household in 20 Middle East and North African (MENA) economies. The study employed Pooled Mean Group (PMG) regression on data from 2000 to 2019. The findings show that renewable energy significantly improves health of individuals and reduces environmental pollution.

Similarly, in a study for Turkey, given the country's heavy dependence on non-renewable energy, Karaaslan and Çamkaya(2022) examined the relationship among energy consumption, CO2 emissions, economic growth and health expenditure, while disaggregating energy consumption into and renewable and non-renewable energy consumption for data spanning over 1980 to 2016. The autoregressive distributed lag (ARDL) method was used to examine long- and short-term effects, while the Toda–Yamamoto causality test was also employed to observe causal relationships between the variables. Results established that non-renewable energy increases CO2 emission in the long run, while renewable energy increases CO2 emission in the short run. Toda–Yamamoto causality test results, a unidirectional causality relationship exists from renewable and non-renewable energy to CO2.

Omri and Belaid (2021) also examines the role of renewable energy in moderating the effects of CO2 emissions on human development and economic growth for 31 transitional economies. Findings showed that a negative influence of CO2 emission on human development and economic growth; while renewable energy reduces the effect of CO2 emissions on human development and economic growth. Alvarez (2021) examined the relationship between health and air pollution for 29 European countries from 2005 to 2018. Results indicate that air pollutants have a negative impact on life expectancy, while investment in renewable energies has a positive effect.

The review of literature suggests that the relationship among energy consumption, environmental degradation, and health is complex and multidimensional depending on the choice of energy adopted by various countries.

3. Yöntem / Method

The ECOWAS countries considered include Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo, respectively. The theoretical foundation of this study hinges on the Grossman's theory of demand for healthcare (1972). The theory establishes how individuals allocate resources to maximize health. Grossman's health demand model assumes that health is a capital good. In literature, the Grossman demand for healthcare is applied when consumption related goods are likely to have negative externalities as in the case of energy-health nexus. The theoretical health production function is given as:

$$H = F(Xt) \quad (1)$$

Where H is health output and X is vector of individual inputs to the health production function. This could include nutrient intake, income, energy consumption, education, access to clean water, access to sanitation, and the environment.

Therefore, following studies like Novignon and Atakorah (2016) as well as Arafat et al. (2022) with some modification, health is expressed a s a function of energy consumption, Co2 emissions and other health-related variables in a panel form as:

$$H = F(EN, CO2, SA, WAT, GDPPC) \quad (2),$$

where energy consumption is unbundled into renewable and non-renewable. For non-renewable energy consumption, the model is given as:

$$H_{it} = \alpha_0 + \alpha_1 NEN_{it} + \alpha_2 LNCO_{2it} + \alpha_3 SA_{it} + \alpha_4 WAT_{it} + \alpha_5 GDPPC_{it} + \mu_{1it} \quad (3)$$

$$H_{it} = \beta_0 + \beta_1 REN_{it} + \beta_2 LNCO_{2it} + \beta_3 SA_{it} + \beta_4 WAT_{it} + \beta_5 GDPPC_{it} + \mu_{2it} \quad (4)$$

where H is a vector of health indicators measured by life expectancy, child mortality and health expenditure, NEN denotes non-renewable energy consumption, REN is renewable energy consumption, CO2 denotes carbon-dioxide emissions, SA represents percentage of people with access to basic sanitation, WAT represents percentage of people with access to clean water and GDPPC represents GDP per capita. $\alpha 0$, $\beta 0$, and μt are intercepts and error terms in the respective models, α_{1-5} as well as β_{1-5} are slope coefficients, i represents country; and t is time. The data were sourced from the database (World Development Indicators) of the World Bank (2023) and African Development Bank database. Due to data availability, the scope of the study spans the period 2000 through 2022.

In this study, the Pooled Mean Group-Autoregressive Distributed Lag (PMG-ARDL) model was employed. The technique has its advantages over other estimation techniques by being applicable where variables have mixed order of integration. Similarly, it is effective for small samples and produces both short and long run coefficients simultaneously. In examining the nexus among energy consumption, environmental quality and health, the ARDL model is specified as:

$$\begin{aligned}\Delta H_{it} &= \alpha_{10} + \alpha_{11} EN_{it-1} + \alpha_{12} LNCO_{2it-1} + \alpha_{13} SA_{it-1} + \alpha_{14} WAT_{it-1} \\ &+ \alpha_{15} GDPPC_{it-1} + \sum_{i=1}^{n} \beta_{11} \Delta NEN_{it-1} + \sum_{i=1}^{n} \beta_{12} \Delta CO_{2it-1} \\ &+ \sum_{i=1}^{n} \beta_{13} \Delta SA_{it-1} + \sum_{i=1}^{n} \beta_{14} \Delta WA_{it-1} \\ &+ \sum_{i=1}^{n} \beta_{15} \Delta GDPPC_{it-1} + \mu_{3it} \ldots\ldots\ldots\ldots (5)\end{aligned}$$

The long run model is specified as

$$\begin{aligned}H_{it} &= \alpha_{20} + \alpha_{21} EN_{it-1} + \alpha_{22} LNCO_{2it-1} + \alpha_{23} SA_{it-1} + \alpha_{24} WAT_{it-1} \\ &+ \alpha_{25} GDPPC_{it-1} + \mu_{4it} \ldots\ldots\ldots\ldots --- (6)\end{aligned}$$

The ARDL specification of the short run dynamics can be derived by constructing an error correction model of the form:

$$\begin{aligned}\Delta H_{it} &= + \sum_{i=1}^{n} \beta_{21} \Delta EN_{it-1} + \sum_{i=1}^{n} \beta_{22} \Delta CO_{2it-1} + \sum_{i=1}^{n} \beta_{23} \Delta SA_{it-1} + \sum_{i=1}^{n} \beta_{24} \Delta WA_{it-1} \\ &+ \sum_{i=1}^{n} \beta_{25} \Delta GDPPC_{it-1} + ECM_{it} \ldots\ldots\ldots\ldots (7)\end{aligned}$$

Where H is a vector of health indicators measured with life expectancy, child mortality and healthcare expenditure; and EN is a vector of energy disintegrated into renewable and non-renewable energy. The study also employed the panel causality test proposed by Dumitrescu and Hurlin (2012) to examine the causal relationship among the variables.

4. Results and Discussion

Descriptive statistics, cross sectional dependence test and unit root test are presented below. Table 1 shows descriptive statistics of the variables.

Table 1. Descriptive Statistics

	GDPPC	NEN	REN	CO2	WA	SA	LE	CM	HE
Mean	2.099	13.909	4.186	0.326	63.794	24.542	58.030	66.972	2.099
Median	1.992	13.628	4.334	0.242	63.710	17.329	57.877	66.300	1.992
Max.	4.762	17.887	4.520	1.126	88.215	77.475	76.593	138.100	4.762
Min.	0.119	9.952	3.034	0.052	36.847	5.197	45.050	12.200	0.119
S.D.	0.937	1.593	0.355	0.234	-0.128	15.887	5.946	23.709	0.937

Source: Author's Computation

The cross-sectional dependence test result is presented in Table 2.

Table 2. Cross Sectional Dependence

Variables	Breusch-Pagan LM	Pesaran LM	Pesaran CD
GDPPC	648.780(0.000)	37.524(0.000)	5.338(0.000)
NEN	532.599(0.000)	29.507(0.000)	7.295(0.000)
REN	566.754(0.000)	31.864(0.000)	13.365(0.000)
CO2	523.536(0.000)	28.881(0.000)	8.267(0.000)
WA	543.171(0.000)	30.237(0.000)	5.407(0.000)
SA	579.176(0.000)	32.721(0.000)	14.377(0.000)
LE	623.806(0.000)	35.801(0.000)	18.696(0.000)
CM	396.452(0.000)	20.112(0.000)	9.851(0.000)
HE	451.725(0.000)	23.926(0.000)	11.266(0.000)

In this study, Levin-Lin-Chiu, Im-Pesaran-shin and Breitung tests were used for unit root testing. This helped to ascertain whether the variables are stationary at levels or first difference. These tests are used to control for spurious regression.

Table 3. Unit Root Test

Variables	Levels (I0)			First Difference (I1)			Decision
	LLC	IPS	BREIT	LLC	IPS	BREIT	
GDPPC	-2.378	-4.390	1.606	----	-----	-3.615	I(1)
NEN	-3.076	-1.284	-1.946	-13.215	-10.537	-5.467	I(1)
REN	-3.563	-3.505	-2.324	------	------	------	I(0)
CO2	-3.562	-3.504	-2.322	------	------	------	I(0)
WA	-2.064	0.655	-3.393	--------	-3.616	------	I(1)
SA	-2.674	-12.174	-0.1553	----	-1.831	--------	I(1)
LE	-29.570	-42.291	3.5081	-----	-----	-4.042	I(1)
CM	-2.175	0.185	0.581	-----	-1.632	2.713	I(1)
HE	-1.624	2.429	-0.821	-6.752	-8.777	-7.725	I(1)

Unit root test shows a mixed order of integration for the variables employed. While some variables are stationary at levels, others become stationary at first difference. The empirical result from the ARDL estimation is presented below:

Table 4. Non-Renewable Energy, Environment and Health

Variables Selected model (2,2,2,2,2,)	Life Exp	Child mortality	Health expenditure
Short Run			
D(life exp(-1)	0.116(0.202)	--------	---------
D(child mortality(-1)	--------	-0.337(0.044)	-------
D(Health exp(-1)	----------	----------	-0.210(0.025)
D(NEN)	-0.809(0.001)	-4.336(0.064)	-0.469(0.000)
D(NEN(-1)	-0..555(0.035)	-3.228(0.124)	-0.179(0.000)
D(CO2)	-16.985(0.000)	67.882(0.029)	-1.874(0.039)
D(CO2(-1)	-10.736(0.000)	-23.992(0.675)	-4.581(0.000)
D(Water)	-0.360(0.000)	1.223(0.014)	-0.042(0.000)
D(water(-1)	-0.203(0.000)	1.004(0.011)	-0.026(0.053)
D(sanitation)	-0.387(0.000)	-0.836(0.159)	0.002(0.751)
D(sanitation(-1)	-0.084(0.000)	-0.305(0.178)	0.036(0.000)
DGDPPC	15.523(0.000)	7.066(0.666)	2.485(0.000)
DGDPPC(-1)	11.633(0.000)	21.399(0.383)	2.210(0.000)
C	175.010(0.000)	48.761(0.001)	0.407(0.000)
ECT	-0.97(0.000)	-0.884(0.002)	-0.727(0.000)
Long Run			
NEN	-0.845(0.000)	3.402(0.000)	0.487(0.000)
CO2	11.124(0.000)	-116.486(0.000)	2.945(0.000)
Water	0.219(0.000)	-1.434(0.000)	0.070(0.000)
Sanitation	0.120(0.000)	0.737(0.001)	-0.018(0.000)
GDPPC	-3.929(0.000)	11.759(0.368)	-1.509(0.000)

Source: Author's Computation

Short run estimates reveal a negative and significant relationship between nonrenewable energy and life expectancy in West African countries. A percentage increase in non-renewable energy reduces life expectancy by 0.8 and 0.5 percent in the current and one lagged period respectively. This suggests that greenhouse gas emissions associated with renewable energy consumption will pose severe health implications on people and therefore reduce life expectancy. This corroborates findings by Ibrahim et al. (2022) and Shah et al (2021). Similarly, non-renewable energy exerts a significant and negative influence on child mortality. A percentage increase in non-renewable energy reduces child mortality by 4.3 and 2.3 percent in the current and one past period. Non-renewable energy reduces health expenditure in the present and past period as a percentage increase in non-renewable energy reduces health expenditure by 0.5 and 0.2 percent respectively.

An increase in CO2 emission, decreases life expectancy and health expenditure in the short run. Conversely, an increase in CO2 emission increases child mortality, the magnitude being 67.8 percent, following a percentage increase in CO2 emissions. Access to water reduces life expectancy and health expenditure, while access to water increases child mortality. Similarly, improved sanitation reduces child mortality and increases health expenditure. An increase in GDP per capita increases life expectancy, child mortality and health expenditure in the countries studied.

Long run estimates reveal a negative relationship between life expectancy and non-renewable energy. However, a positive relationship is established between energy consumption and child mortality as well as heath expenditure.CO2 emissions have increasing effect on life expectancy and healthcare expenditure, as well as a decreasing effect on child mortality. Access to water has positive relationship with life expectancy and health expenditure and a reducing effect on child mortality rate.

Table 5. Renewable Energy, Environment and Health

Variables	Dependent variables Selected model: ARDL(2,2,2,2,2,2)		
	Life exp	**Child mortality**	**Health expenditure**
Short Run			
D(life exp(-1)	-0.352(0.006)	--------	---------
D(child mortality(-1)	--------	-0.564(0.002)	-------
D(Health exp(-1)	----------	----------	0.143(0.060)
D(REN)	1.914(0.522)	-28.312(0.295)	0.869(0.006)
D(REN(-1)	1.050(0.554)	-9.459(0.727)	-0.553(0.154)
D(CO2)	-12.896(0.005)	73.065(0.282)	-1.829(0.087)
D(CO2(-1)	-7.277(0.036)	-103.86(0.077)	-3.619(0.000)
D(Water)	0.161(0.000)	0.727(0.081)	-0.013(0.070)
D(water(-1)	-0.313(0.000)	0.010(0.989)	-0.017(0.147)
D(sanitation)	-0.092(0.001)	-0.756(0.050	0.021(0.001)
D(sanitation(-1)	0.070(0.012)	-0.010(0.661)	0.026(0.000)
DGDPPC	10.461(0.000)	19.576(0.355)	0.250(0.000)
DGDPPC(-1)	7.523(0.000)	33.035(00.163)	(0.7350.004)
C	234.177	-42.598(0.027)	3.670(0.000)
ECT	0.546(0.00)	-0.685(0.015)	-0.611(0.000)
Long Run			
REN	-11.679	43.928(0.004)	-1.035(0.000)
CO2	3.864	110.805(0.002)	0.798(0.000)
Water	0.338	-1.482(0.00)	0.001(0.639)
Sanitation	0.026	0.492(0.123)	-0.009(0.000)
GDPPC	-9.971	-0.453(0.951)	0.589(0.000)

Source: Author's Computation

Short run estimates indicate that renewable energy does not pollute the environment and therefore has an increasing effect on life expectancy and reducing effect on child mortality. This corroborates findings by Alvarez (2021) as well as Liu and Zhong (2022). However, an increase in renewable energy increases healthcare expenditure in the present period. CO2 emission reduces life expectancy and healthcare expenditure, while increasing child mortality. Access to water increases life expectancy and reduces health expenditure. Access to sanitation, reduces life expectancy and child mortality, while increasing healthcare expenditure. Per capita income is seen to increase life expectancy, child mortality and health expenditure.

In the long run, renewable energy has decreasing effect on life expectancy and health expenditure. CO2 emission has increasing effect on life expectancy, child mortality and healthcare expenditure. Increased access to water increases life expectancy and healthcare expenditure, while increased access to sanitation reduces health expenditure while increasing life expectancy and child mortality.

5. Results and Discussion

The study examined the relationship among energy consumption, environmental quality and health in West African countries from 2000 to 2019. The ECOWAS countries considered include Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo, respectively.

The study disintegrates energy consumption into renewable and non-renewable energy. Pooled Mean Group Autoregressive Distributed Lag (PMG/ARDL) model was employed for the study. Short run estimates reveal a negative influence of non-renewable energy on life expectancy in West African countries. Similarly, non-renewable energy exert a significant and negative influence on child mortality. Non-renewable energy also reduces health expenditure.

Renewable energy was observed to increase life expectancy and reduce child mortality. The study concludes that a substantial amount of renewable energy be incorporated into the energy basket of West African countries to improve health conditions. This will help to attain the sustainable development goals of good health and well-being alongside with affordable, reliable and sustainable use of energy for all.

Acknowledgements

We thank the editors and referees for their support and contributions.

Conflict of interest

The author declares that there are no potential conficts of interest with respect to the research, authorship and publication of this article.

Ethical approval

This study does not require ethical approval.

Funding

No funding source was used in this study.

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