The Role of Renewable Energy in Enhancing Quality of Life and Economic Development in Low Income African Countries

Chinonso G. Alaebo[1]; Uchenna C. Udedi[2]; Kenneth O. Ogbu[2]; Chukwudi F. Onyedibe[2]

[1]Miva Open University Utako Abuja Nigeria,
[2]Nnamdi Azikiwe University Awka Nigeria
Email of corresponding Author: chinonso@miva.university

Abstract

The study examines the role of renewable energy in enhancing the quality of life and economic development in low-income African countries from 1990 to 2021. It uses Grossman's theory of healthcare demand and the Panel Autoregressive Distributed Lag (ARDL) model. Results show that renewable energy has a positive effect. GDP per capita, health expenditure, and food production also contribute to the quality of life. The study suggests that government should come up with drastic environmental policies towards reducing pollution, mitigating climate change, improving access to energy, fostering economic growth, and driving innovation, societies can create a virtuous cycle where environmental well-being and human health reinforce each other, ultimately leading to longer and healthier lives.

Keywords: *Renewable Energy, Quality of Life, Economic Development, Low Income African Countries*
JEL Codes*: Q43, I15, I18*

Introduction

A key indicator of a population's health and well-being, is significantly influenced by various factors such as healthcare infrastructure, sanitation, access to clean water, and prevalence of diseases. In low income African countries, these factors contribute to lower quality of life rates compared to other regions. For example, as of 2021, Nigeria had a life expectancy of 54.4 years, Ghana 64.4 years, and Ivory Coast 57.5 years. Improvements in healthcare, education, economic development, and disease control have the potential to enhance life expectancy over time. Access to energy plays a crucial role in determining health outcomes. Inadequate energy access can lead to substandard living conditions, impacting health adversely. The combustion of fossil fuels, which accounts for 76% of global emissions, produces pollutants that contribute to climate change and environmental issues, further affecting health outcomes by increasing the risk of respiratory and cardiovascular diseases.

Understanding the relationship between renewable energy consumption and the quality of life in low income African countries is vital for policymakers to design effective strategies for sustainable development and public health improvement. These countries face challenges in meeting their energy demands, relying heavily on traditional biomass fuels and dealing with inadequate energy infrastructure. This energy poverty hinders socioeconomic progress and advancements in healthcare, subsequently affecting the quality of life. Despite abundant renewable energy resources, the region's energy consumption remains dominated by fossil fuels, leading to environmental degradation and poor health conditions. Consequently, Africa experiences a high number of deaths per capita due to environmental factors, predominantly infectious diseases. Quality of life in low-income African countries is affected by several interconnected issues such as limited healthcare access, infectious diseases, malnutrition, maternal and child health challenges, limited education, poverty, political instability, weak infrastructure, and inadequate healthcare funding. While energy consumption is crucial for economic growth and well-being, its impact on the quality of life in this region remains unclear. Renewable energy consumption improves living standards and quality of life by facilitating access to modern amenities and services. Reliable electricity access enhances healthcare infrastructure, enabling essential services like vaccine refrigeration and medical equipment operation. Clean cooking fuels reduce indoor air pollution, a significant cause of respiratory diseases and premature deaths, particularly among women and children.

However, many low-income countries struggle with energy poverty, characterized by limited access to electricity and clean cooking fuels, hindering socioeconomic development and negatively affecting health outcomes. These challenges impact various sectors crucial to well being, such as healthcare, education, and sanitation, reducing healthcare quality and life expectancy. The heavy reliance on fossil fuels in Africa contributes significantly to CO2 emissions, exacerbating climate change and posing severe health implications. Irregular rainfall patterns, droughts, extreme temperatures, and coastal erosion resulting from climate change further affect human health by increasing the transmission of vector-borne diseases. Empirical research on the impact of renewable energy consumption on the quality of life in low-income African countries is limited. Studies have shown mixed results, with some indicating positive links between energy consumption and health indicators, while others report negative impacts due to environmental pollution. This study aims to assess the impact of energy consumption on the quality of life in low income African countries over 40 years, capturing significant policy reforms and changes.

Theoretical Review

Energy Efficiency Theory

Energy efficiency theory, proposed by Cooper and Ross (1985), emphasizes optimizing energy consumption to maximize output while minimizing waste. It highlights the importance of technological innovations, energy-efficient behaviors, and supportive policies to achieve energy efficiency. This theory underscores the role of human behavior and awareness in energy consumption patterns and the need for system-level approaches to optimize energy use across sectors. The idea of energy efficiency holds significance for this research as it offers valuable insights into how renewable energy sources might improve economic development and quality of life by optimizing resource utilization, cutting down on waste, and minimizing expenses. Through the use of cleaner, more dependable energy sources, this optimization promotes more sustainable economic growth and raises living standards. In the end, energy efficiency helps renewable energy become more widely used by making its integration more advantageous for the environment and economically feasible.

Ecological Modernization Theory

Ecological modernization theory, developed by Joseph Hubber and Martion Janicke in the 1980s, posits that economic development and environmental sustainability can coexist through technological innovation and institutional changes. By adopting cleaner and more efficient technologies, societies can reduce their environmental impact and resource consumption, leading to a more sustainable future. The ecological modernization idea highlights how institutional reform and technology advancement can promote both environmental preservation and economic growth. This theory highlights how cutting-edge, environmentally friendly technology and regulations can result in sustainable growth, which is pertinent to the role of renewable energy in improving quality of life and economic development. Societies can advance economically while lessening their negative effects on the environment, hence raising standard of living.

Grossman’s Theory of Demand for Healthcare

Grossman's model, introduced in 1972, explores the demand for health and medical care, emphasizing the role of environmental factors in influencing health outcomes. This theory recognizes that environmental quality, including air and water quality, significantly impacts human well-being. This theory is relevant to this study because it connects improved environmental conditions to improved health outcomes. Grossman's Theory of Demand for Healthcare is important to the role of renewable energy in promoting quality of life and economic development. Pollution is decreased by cleaner energy sources, which lowers healthcare costs and boosts productivity. A better quality of life and economic growth are directly impacted by the improvement in public health.

Empirical Theoretical Review

Several empirical studies have examined the impact of renewable energy consumption on the quality of life in low income African countries. Youssef et al. (2016) found a unilateral causality from energy consumption to the quality of life and child mortality in several African countries, including Nigeria and Senegal. Osabohien et al. (2018) observed that greenhouse gas emissions negatively affect health outcomes in Nigeria. Agbanike et al. (2019) reported that while oil exports improve the quality of life in Nigeria, they also contribute to environmental pollution, negatively impacting health. Oluwatoyin et al. (2020) found that carbon emissions adversely affect agricultural output and life expectancy in West Africa. Ezeh, Nwogwugwu, and Obisike (2020) identified a positive long-run relationship between household electricity consumption and life expectancy. Ibikunle (2020) highlighted the negative impact of environmental pollution on the quality of life in Nigeria. Anser et al. (2022) reported that greenhouse gas emissions and fossil fuel consumption increase health risks in emerging Asian nations. Karaaslan and Çamkaya (2022) found that renewable energy consumption increases CO2 emissions, negatively affecting health outcomes in Turkey. Akintunde et al. (2021) revealed that the interactive effect of poverty and energy consumption negatively impacts life expectancy in Nigeria.

Methodology

Theoretical Framework

The link between renewable energy consumption and the quality of life has been investigated through the mechanism of Grossman's theory of demand for healthcare. In Grossman's model, health is seen as a form of capital that individuals can invest in. Health capital is accumulated through investments in factors such as medical care, preventive measures, and a healthy lifestyle. This study hinges on the Grossman's theory of demand for healthcare (1972). The theory establishes how individuals allocate resources to maximize health. The theory is applied when consumption related goods are likely to have negative externalities and the model is given as:

$$H = F\ (Xt) \qquad \text{equ-1}$$

Where H is health output and X is vector of individual inputs to the health production functions. This could include income, energy consumption, education, water, sanitation, and the environment. Equation (3.1) is augmented to accommodate indicators of energy consumption and some other control variables so as to capture its impact on life expectancy.

The functional form of the model is given below as:

$$QL = f\ (REC,\ GDPpc,\ HEXP\ FDP) \qquad \textbf{equ-2}$$

Equation (3.2) implies that the quality of life captured by life expectancy is a function of renewable energy consumption, GDP per capita, health expenditure and food production. GDP per capita, food production and health expenditure were added in the model as control variables to the quality of life. By building an econometric model of the functional model above, the model is specified thus:

$$QL = \beta_0 + \beta_1 REC + \beta_2 GDPpc + \beta_3 HEXP + \beta_4 FDP + \mu_1$$

Where; QL = Quality of Life measured by life expectancy at birth, REC = Renewable energy consumption, GDPpc = Gross domestic product per capita, HEXP =Government health expenditure, FP = Food production, μ = Disturbance term/error term, β_0 = Constant term, β_1 β_2 β_3 β_4 are parameters to be estimate

Apriori Expectation

QL/REC > 0,

QL/GDPpc > 0,

QL/HEXP > 0,

QL/FDP > 0.

The above signifies a positive relationship and movement of exogenous variables on the quality of life. The models of this study will be estimated using the panel auto-redistributed lag model. Regardless, the direct use of panel ARDL without accounting for the descriptive and time-series properties of the relevant data may result in spurious regression. It is widely known that meaningful economic policy can barely be generated from an OLS regression involving data misalignment and non-stationary time series. As a result, pre-test analyses such as descriptive analysis, unit root test, co-integration test, will be required.

Analysis and Interpretations

Stationarity Test

The ADF results comprising of the Fisher Chi-square and Choi Z-stat at 5% critical value as originally generated are represented below in the table.

Table 1. Panel Unit root (ADF test)

Variables	Adf Chi-Square & Adf Z-stat at level	Prob.	Adf Chi-Square & Adf Z-stat at level	Prob.	Order of integration	Remarks
QL	3.22817 1.45025	0.8675 0.9265	5.62091 -4.20572	0.0000 0.0000	1(1)	Stationary
REC	4.39591 1.47421	0.9330 0.9298	45.8701 -4.96379	0.0000 0.0000	1(1)	Stationary
GDPpc	9.76549 -0.53612	0.4462 0.3994	47.0049 -5.29037	0.0000 0.0000	1(1)	Stationary
HEXP	16.4701 -1.7379	0.0088 0.0525			1(0)	Stationary
FDP	5.77272 1.62847	0.8815 0.9572	42.3302 -4.57944	0.0000 0.0000	1(1)	Stationary

Source: Author's Computation Using Eviews 12

Decision Rule: Reject H_0 if the probability of Fisher Chi-square and Choi Z-stat from ADF test result is greater than 5% level of significant, otherwise accept.

From the above result, at first difference, the probability value of Fisher Chi-square and Choi Z-stat value of the quality of life, renewable energy consumption, GDP per capita and food production are less than 5% level of significant respectively. Therefore, we reject H_0 of QL, REC, GDPpc and FDP and then conclude that they are stationary at first difference. Also, the probability value of Fisher Chi-square and Choi Z-stat value of health expenditure is less than 5% level of significant respectively at level form. Therefore, we reject H_0 of HEXP and then conclude that it is stationary at level form. This implies that the variables of the model are integrated of order zeros and one.

Panel ARDL Co-integration Test

ARDL approach was developed by Pesaran et al (2001) to estimate the link among the variables. The logics behind the use of this approach are: first ARDL can be applied regardless of whether the series are stationary at level value I (0) or after first difference I (1) or combination of two mutually. Null hypothesis (H_0): there is no cointegration among the variables. Alternative hypothesis (H_1): there is cointegration among the variables. The result verifies that there is an evidence of cointegration among the variables. This is due to the fact that the error correction term is negative and less than one and the probability value is less than 5% level of significance. This led to the rejection of null hypothesis of no co-integration. The result is summarized and presented in Table below

	Table 2. ARDL Co-integration Test			
Variable	**Coefficient**	**Std. Error**	**t. Statistic**	**Prob.**
COINTE01	-0.413458	0.129827	-3.442517	0.0043

Source: Author's Computation Using Eviews 12

Since the co-integration test indicated the presence of long run relations among the variables, we then go further to estimate the ARDL long run model to ascertain the long run coefficients of the variables of the model.

Evaluation of Estimates

The satisfactory results obtained from the unit root and co integration tests motivated the estimation. The ordinary least square (OLS) regression result of this study is presented below

Table 3. ARDL Long Run and Short Run Result
Dependent Variable: QL

Variable	Coefficient	Std. error	t-statistics	p-values
		LONG RUN COEFFICIENTS		
REC	10.60465	0.342810	3.100754	0.0000
GDPPC	0.024712	0.004581	5.41114	0.0000
HEXP	4.196008	0.590038	7.11313	0.0000
FDP	0.068598	0.213621	-0.322894	0.7861
ECT = -0.410678	R^2 = 0.878203	Ad-R^2 = 0.65655	DW = 1.945502	

Source: Author's Computation Using Eviews 12

Discussion of Findings

The long run estimates indicate that renewable energy consumption has a positive and significant relationship with the quality of life in low income African countries for the period under review. This implies that energy sources like solar, wind, and hydroelectric power generate electricity without emitting harmful pollutants or greenhouse gases. A higher reliance on renewables would result in reduced air pollution and improved air quality, leading to fewer cases of respiratory diseases, cardiovascular issues, and other health problems. This, in turn, could contribute to an increase in the quality of life, as cleaner air promotes better respiratory health. Many communities, especially in developing countries, lack reliable access to electricity. Transitioning to renewable energy can provide these communities with a more consistent and affordable energy supply, which can have positive effects on healthcare, education, sanitation, and overall quality of life. Better access to energy can lead to improved healthcare facilities, better refrigeration for vaccines and medicines, and enhanced communication for medical services. This corroborates findings by Alvarez (2021).

The impacts of income are noted to enhance the quality of life for the model with statistical significance. More so, the interaction of income came out to be enhancing the quality of life. The impact of income remain positive and enhancing which leads to infer that, an increasing level of income, which raises the standard of living, is the key factor in achieving the transition to cleaner renewable energy consumption and improves quality of life. This conforms to apriori expectations and was statistically significant. A higher GDP per capita often enables governments to invest more in healthcare infrastructure, facilities, and medical technologies. This leads to improved access to quality healthcare services for citizens, contributing to better healthcare outcomes and increased the quality of life. This findings in line with the findings of Acemoglu and Johnson (2007), who found that increased income due to higher GDP per capita is associated with better healthcare access and outcomes.

The long run result also showed that the sign of the coefficient of health expenditure is positive and is statistically significant for low income African countries for the period under review. This implies that, with the influence of all other variables held constant, an increase in the health expenditure by one percent on average, will lead to an increase in the quality of life. The coefficient's sign corresponds to economic a priori expectations. This implies that investing in healthcare can have profound positive effects on the overall well-being and longevity of a population. However, achieving the best outcomes requires not only increased spending but also efficient allocation of resources, targeted interventions, and efforts to address underlying social determinants of health. Higher health expenditure often leads to increased access to healthcare services, such as medical treatments, preventive measures, and screenings. This can result in better management of diseases and conditions, early detection of health issues, and more timely and effective interventions, all of which contribute to longer and healthier lives.

Finally, the long run results posit positive and insignificant relationship between food production and the quality of life in five low income African countries for the period of study under review. Furthermore, an insignificant relationship between food production and the quality of life might indicate that the distribution and accessibility of food are important considerations. Even if food production increases, it doesn't necessarily mean that all segments of the population have equal access to nutritious and sufficient food. Research by Devereux (2007) emphasizes that food security, which includes both availability and accessibility, is a critical factor in ensuring positive health outcomes and increasing life expectancy. In addition, the insignificant relationship could highlight the importance of nutritional quality over sheer quantity of food. A study conducted by Darmon and Drewnowski (2015) underscores that the nutritional composition of diets, including the presence of essential micronutrients and a balanced intake, is essential for preventing diet-related diseases and improving longevity. Thus, simply increasing food production without considering nutritional content might not translate into significant improvements in the quality of life. The positive aspect of the relationship, even if insignificant, still suggests that food production contributes positively to overall well-being. Adequate food availability can be a baseline requirement for basic health and human survival. While other factors might have a stronger influence on life expectancy, having a steady supply of food remains a fundamental necessity.

Conclusion and Recommendations

The study deals directly on renewable energy consumption, while employing the panel ARDL model. Long run estimates reveal appositive influence of renewable energy consumption on the quality of life in low income African countries. Similarly, renewable energy was observed to increase the quality of life. This can be attributed to the environmentally friendly nature of renewable energy in improving health status. The study concludes that in an attempt to achieve the sustainable development goals of good health and well-being, a substantial amount of renewable energy should be incorporated into the energy basket of lower income African countries to improve health conditions.

Given a positive relationship between renewable energy consumption and the quantity of reflects the multi-faceted nature of sustainable development. Government should come up with drastic environmental policies towards reducing pollution, mitigating climate change, improving access to energy, fostering economic growth, and driving innovation, societies can create a virtuous cycle where environmental well-being and human health reinforce each other, ultimately leading to longer and healthier lives. Given the positive relationship between GDP per capita and the quality of life underscores the intricate connection between economic development and health outcomes. While these two factors are correlated, it's important to note that causation may not always be straightforward and can be influenced by various other socio-economic and cultural factors. Policymakers should consider this relationship when formulating strategies for sustainable development that prioritize both economic growth and population health.

REFERENCES

Agbanike, T. F., Nwani, C., Uwazie, U. I., Anochiwa, L. I., Onoja, T. G. C., & Ogbonnaya, I. O. (2019). Oil price, energy consumption and carbon dioxide (CO2) emissions: insight into sustainability challenges in Venezuela. *Latin American Economic Review*, *28*(1), 1-26.

Agyeman, A., Etkin, D., & Sekyere, F. (2021). The impact of climate change on health in Sub-Saharan Africa: Evidence from panel data. International Journal of Environmental Research and Public Health, 18(4), 1726.

Anser, M. K., Hanif, I., Vo, X. V., & Alharthi, M. (2020). The long-run and short-run influence of environmental pollution, energy consumption, and economic activities on health quality in emerging countries. *Environmental Science and Pollution Research*, *27*, 32518-32532.

Brounen, D., Kok, N., & Quigley, J. M. (2019). Energy literacy, awareness, and conservation behavior of residential households. Journal of Economic Behavior & Organization, 157, 803-821.

Chaabouni, S., & Saidi, K. (2017). The dynamic links between carbon dioxide (CO2) emissions, health spending and GDP growth: A case study for 51 countries. Environmental Research, 158, 137–144. https://doi.org/10.1016/j.envres.2017.05.041

Destek, M. A., & Aslan, A. (2017). Renewable and non-renewable energy consumption and economic growth in emerging economies: Evidence from bootstrap panel causality. Renewable Energy, 111, 757–763. https://doi.org/10.1016/j.renene.2017.05.008

Dutta, S., & Williamson, S. (2019). Powering up healthcare: How energy access for all benefits health. World Bank Group.

Ezeh, M. C., Nwogwugwu, U. C., & Ezindu, O. N. (2020). Impact of Household Electricity Consumption on Standard of Living in Nigeria.

Franco, A., Shaker, M., Kalubi, D. & Hostettler, S., (2017). A Review of Sustainable Energy Access and Technologies for Healthcare Facilities in the Global South, *Sustainable Energy Technologies and Assessments*, vol. 22, pp. 92–105

Ibikunle, A. J. (2020). Environmental pollution and life expectancy in Nigeria. *Journal of Economic Studies*, *17*(1), 79-93.

Jebli, M. B., Youssef, S. B., & Ozturk, I. (2016). Testing environmental Kuznets curve hypothesis: The role of renewable and non-renewable energy consumption and trade in OECD countries. *Ecological Indicators*, *60*, 824-831.

Ji, X., Zhang, M., Ma, D., & Chen, S. (2020). Systems energy efficiency analysis: A review. Energy, 203, 117947.

Kandpal, T. C., Agrawal, S., & Sharma, N. (2018). Energy poverty indicators for India. Energy Policy, 123, 270-281.

Karaaslan, A., & Çamkaya, S. (2022). The relationship between CO2 emissions, economic growth, health expenditure, and renewable and nonrenewable energy consumption: Empirical evidence from Turkey. Renewable Energy, 190, 457–466. https://doi.org/10.1016/j.renene.2022.03.139

Lambert, J., Hall, G., Balogh, C.A.S.S., Gupta, A. & Arnold, M., (2014). Energy, EROI and quality of life, *Energy Policy*, pp. 153–167, 2014

Matthew, O.A., Osabohien, R., Fagbeminiyi, F., & Fasina, A. (2018), Greenhouse gas emissions and health outcomes in Nigeria: Empirical insight from auto-regressive distribution lag technique. *International Journal of Energy Economics and Policy*, 8(3), 43–50.

Osabohien, R., Ayomitunde, A. T., Bose, A. D., & Bose, J. L. (2020). Carbon emissions and life expectancy in Nigeria. International Journal of Energy Economics and Policy, 11(1), 497–501. https://doi.org/10.32479/ijeep.10834

Rizk, N. (2019). Energy efficiency in industry: Technological pathways to economic growth and reduced emissions. *Journal of Cleaner Production,* 213, 365-377.

Sharma, S. (2017). Climate change & Sustainability. *International Journal of Economics and Management Studies*, 4(6), 22–27.

Smith, K. R., Bruce, N., Balakrishnan, K., Adair-Rohani, H., Balmes, J., Chafe, Z., & Rehfuess, E. (2014). Millions dead: How do we know and what does it mean? Methods used in the comparative risk assessment of household air pollution. Annual Review of Public Health, 35, 185-206.

Wilhite, H., & Norgard, J. S. (2019). Social practices and sustainable energy transitions: Lessons from Japan. Energy Research & Social Science, 57, 101239.

World Health Organization. (2021). Energy access for health facilities. Retrieved from https://www.who.int/teams/environment-climate-change-and-health/healthy-energy