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Carbon emissions, out-of-pocket expenditure and life expectancy of reproductive age women in West Africa

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ABSTRACT

In recent years, many residents of West Africa have been facing a perpetual rise in out-of-pocket expenses alongside environmental pollution, which could instigate serious health challenges for the vulnerable population in the region. Against this backdrop, this study investigated the nexus among carbon emissions, out-of-pocket expenditure, and life expectancy of reproductive-age women within the West Africa subregion from 2000 to 2020. After subjecting the collected data to empirical analysis, the following conclusions evolved from the study: carbon emissions contributed a significant positive effect on the life expectancy of reproductive-age women. However, out-of-pocket expenditure caused a significant reduction in the life expectancy of reproductive women. Arising from these findings, this study makes the following recommendations: whenever policymakers in West Africa want to improve the life expectancy of reproductive women in their region, policies such as health subsidies that would reduce out-of-pocket expenditures to healthcare providers should be implemented. Similarly, policies that would drive the expansion of GDP per capita should be encouraged so that reproductive women in the region would have the economic and financial power to live a quality of life that catalyzes an increase in life expectancy.

Contribution/ Originality: The motivation for embarking on this study with reference to West Africa lies in the fact that within West Africa, a paucity of studies regarding the gender perspective, especially concerning reproductive-age women on this subject matter, has been observed in the literature. Thus, the existence of this gap motivates further empirical investigation. Therefore, the study examines the nexus among carbon emissions, out-of-pocket expenditure, and life expectancy of reproductive-age women in West Africa.

1. INTRODUCTION

A lot of energy must be expended to achieve sound economic growth. This is because all aspects of the economy—manufacturing, farming, offering services, and looking after other sectors—need energy (Osabohien, Aderemi, Akindele, & Jolayemi, 2021). Because of this, developing nations place a great deal of strain on natural resources as they work to expand their economies, and their increasing production results in higher CO_2 emissions and industrial waste (Sapkota & Bastola, 2017; Sebri & Ben-Salha, 2014). The state of a nation's health is a crucial indicator of its standard of living and, to a significant extent, of its rate of economic expansion (Erçelik, 2018). Fossil fuel use, which

has been identified as a significant contributor to CO_2 emissions, worsens the climate and increases the amount of money allocated for healthcare, according to Balan (2016). Protection against financial risk for healthcare expenditures has been given top priority by the Sustainable Development Goals (SDGs) of the United Nations, which call for strengthening national policies in both developed and emerging economies. In addition to geographic accessibility, obtaining universal health coverage now also heavily depends on financial accessibility to essential treatment (OECD, 2018; World Bank Group, 2019b).

The community is shielded from the financial risks connected to illness by a well-planned health system (World Health Organization, 2000). However, the lack of simple access to quality medical treatment contributes to the poor health of many African nations, which has a significant impact on numerous macroeconomic and microeconomic variables (Opeloyeru, Lawal, & Agbatogun, 2021). According to World Health Organization statistics, a nation's level of development and health spending are related since people's health has an impact on how much work they can accomplish (World Bank Group, 2019a). Due to the phenomenon of population aging, there has been a notable rise in the incidence of chronic illnesses, and with the availability of more expensive, technically complex therapies, healthcare expenses are rising more quickly than they ever have. In middle- and low-income nations, a significant portion of the financing of the healthcare system comes from the household contribution of direct healthcare expenses. The terms "out-of-pocket (OOP) payments" or "out-of-pocket health spending" are frequently used to describe this. According to Molla, Chi, and Mondaca (2017), out-of-pocket health spending is the portion of healthcare costs that families pay directly to healthcare providers. Since it has been reported that more than 150 million persons experience financial catastrophe and that roughly a significant number of individuals, around 100 million, experience a decline into poverty annually due to the financial burden of healthcare expenses (Evans & Etienne, 2010), this global issue highlights the growing recognition of the detrimental impact that out-of-pocket payments for healthcare may have on household living standards, making it a crucial aspect to address in the financing of health systems (Organisation for Economic Co-operation and Development (OECD), 2003; World Health Organization (WHO), 2001).

Consequently, out-of-pocket payments are surprisingly the most common way to pay for healthcare in African nations. Over 70% of health expenditures in Nigeria are private, and 96% of that spending consists of patient contributions (World Health Organization, 2010). The World Health Organization (WHO) (2013) discovered that in almost half of the countries in Africa, household out-of-pocket expenses account for at least 40% of overall health spending. This implies that for certain households to receive quality care, they may have to spend a lot of money on it and potentially fall into poverty. Life expectancy is one of the most significant factors in the Human Development Index. The average number of years a person has left to live at a given age is their life expectancy. It demonstrates how different age groups have varying mortality rates (Sen, 1998). Better productivity, a major factor in long-term economic growth, is correlated with good health and a long life (Raffin & Seegmuller, 2014). Studies by Bein, Unlucan, Olowu, and Kalifa (2017), Jaba, Balan, and Robu (2014), and Ranabhat, Atkinson, Park, Kim, and Jakovljevic (2018) all demonstrate that healthcare spending significantly affects life expectancy.

During the Abuja Declaration in 2001, African leaders made a commitment to allocate 15% of their total budget towards healthcare. The main objective was to lessen "out-of-pocket payments," which would facilitate access to healthcare for more individuals. However, in recent years, many African nations have continued to struggle to realize this objective (Opeloyeru et al., 2021). Rising out-of-pocket expenses have been attributed to factors such as inadequate health insurance coverage and poverty (Saleh, 2012).

Meanwhile, past empirical studies have affirmed that in the majority of developing economies, high mortality and low life expectancy have always been the end products of environmental pollution and rising out-of-pocket expenses (Assadzadeh, Faranak, & Amir, 2014; Nkalu & Edeme, 2019; Opeloyeru et al., 2021; Zaidi & Saidi, 2018). However, within West Africa, a paucity of studies regarding the gender perspective, especially concerning reproductive-age women on this subject matter, has been observed in the literature. Thus, the existence of this gap motivates further empirical investigation. Therefore, to fill this gap, the study provides answers to the research question: What is the

nexus among carbon emissions, out-of-pocket expenditure, and life expectancy of reproductive-age women in West Africa?

2. LITERATURE REVIEW

In the past, numerous studies have examined the relationship between greenhouse gas emissions, quality of life, and health care costs. Among these studies are the following.

Zaidi and Saidi (2018) conducted a study that assessed the correlation between expenditure on health, environmental pollutants (specifically CO_2 emissions and nitrous oxide emissions), and the economic expansion process in Sub-Saharan African nations from 1990 to 2015. The estimation methodology employed in this study was the autoregressive distributed lag (ARDL) model, which was utilized to model both the long-term and short-term relationships. Furthermore, to validate the direction of the association, the study utilized the vector error correction model (VECM) methodology. Based on the results of the autoregressive distributed lag (ARDL) analysis, it was evident that there existed a positive relationship between economic growth and human well-being (HE). Conversely, the long-term impacts of greenhouse gas emissions and nitrous oxide emissions were found to have adverse effects on HE. In contrast, the VECM data unveiled a unidirectional relationship between the human development index and GDP per capita. On the contrary, it was found that there existed a reciprocal association between greenhouse gas emissions and GDP per capita, as well as between human energy consumption (HE) and greenhouse gas emissions. In a study on the connection between healthcare spending and economic growth, Wang (2015) found that economic growth was impacted in a similar way as healthcare spending rose. Kurt (2015) also looked at the relationship between government health spending and economic growth in Turkey using time series data from 2006 to 2013. The results showed that this relationship was both positive and substantial.

Based on the efficiency of public health spending in enhancing health outcomes in South Africa, Bidzha, Greyling, and Mahabir (2017) have made an argument from a different angle. From 2005 to 2014, their study used panel estimating methods in nine South African provinces. In general, their study found that raising public health spending per capita improved both the under-five death rate and birth weight. However, it was discovered that public health spending did not statistically contribute much to economic growth. As significant drivers of health outcomes in the nation, control factors like real GDP per capita, access to formal housing, female literacy rate, vaccination coverage ratio, and HIV/AIDS prevalence have been identified. Zaman, Ahmad, Hamzah, and Yusoff (2016) estimated how environmental influences and health indicators in Sub-Saharan African nations were related. A series of environmental indicators in seven nations from SSA countries, such as Botswana, Cameroon, Kenya, Nigeria, Senegal, South Africa, and Sudan, were used. It was reported from the study that carbon dioxide emissions led to a rise in per capita health spending. In another development, Zaidi and Saidi (2018) utilized yearly data between 1990 and 2015 to explore a model that investigates the nexus between health expenditure, environmental pollution, and economic growth across Sub-Saharan African nations. An ARDL estimation approach was used to represent the long-run and short-run dynamics in the study. In the same vein, the VECM Granger causality test was employed to establish the direction of the causal chain. From the findings of the ARDL test, it could be observed that there was an existence of a direct relationship between economic growth and health expenditure in the studied countries. Meanwhile, long-term nitrogen oxide emissions (NOE) and carbon dioxide (CO_2) emissions exhibited a disastrous impact on health expenditure. The results of the study showed that a 1% rise in per capita GDP is associated with a corresponding increase of 0.332% in health expenditure. Conversely, a 1% increase in CO_2 emissions and NOE is linked to a decrease in health expenditures by 0.066% and 0.577%, respectively. The findings of the VECM Granger causality analysis proved the existence of a unidirectional association between the development of human capacity and GDP per capita.

Moreover, Nkalu and Edeme (2019) assessed environmental risk factors and their implications for African life expectancy, utilizing a case study of Nigeria from 1960 to 2017. To ensure the precision of the study's findings, the generalized autoregressive conditional heteroscedasticity (GARCH) model was employed to estimate the total

number of 58 observations spanning a period of 58 years. The outcomes of the research indicated a statistically significant decline in life expectancy by a duration of one month and three weeks due to environmental issues related to the emission of carbon dioxide (CO_2) from the use of solid fuels. Further evidence showed that there is a marginal increase of one year and six months in life expectancy (LEX), motivated by economic growth. However, this gain is statistically insignificant. On the other hand, growth in population is shown to have a more substantial impact on life expectancy, resulting in a rise of five years and five months. This could be a result of the expansion of human capital and labor, which subsequently improved agricultural production in the African region.

In addition, Issaoui, Toumi, and Touili (2015) evaluated the effects of carbon dioxide (CO_2) emissions on different socio-economic factors such as energy consumption, economic expansion, urbanization, life expectancy, and welfare in the North Africa and Middle East region. The research focused on the period between 1999 and 2010, utilizing dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS) methodologies. The findings from the study demonstrated that carbon dioxide (CO_2) emissions had a detrimental effect on life expectancy in all Middle East and North Africa (MENA) countries, both in the short and long run. The results also indicated that there was a statistically significant direct relationship between energy consumption per capita and carbon dioxide (CO_2) emissions. As a result of the non-polluting sector's activities and the economic policies of the MENA countries, the results also stated that income per capita has a long-term negative impact on CO_2 emissions.

Consequently, Assadzadeh et al. (2014) investigated the connection between environmental quality and lifespan in the Organization of the Petroleum Exporting Countries (OPEC) during the periods of 2000 and 2010. The study discovered that rising CO_2 emissions spurred a higher cost to human health, while rising life expectancy at birth resulted in lower costs in the short term. In the same vein, Egbichi, Ojamaliya, Victoria, Abigail, and Oluwapelumi (2018 applied a symmetrical ARDL model to assess the impacts of energy consumption on economic growth in Nigeria from 1986 to 2016. The results from the symmetrical ARDL indicated that the growth of Nigeria's economy had not substantially improved due to the ongoing changes in the supply of energy in the country. The findings from the study also showed that gas consumption in Nigeria had not contributed to a beneficial economic impact because of the issues related to gas flaring episodes and other environmental pollution in some major oil-producing states in the Niger Delta region. Meanwhile, the outcomes proved that oil consumption, as opposed to petrol consumption, directly impacted the betterment of the Nigerian economy.

While exploring ten oil-producing African countries (Angola, Congo, Sudan, South Africa, Equatorial Guinea, Gabon, Republic of Congo, Algeria, and Libya) from 2000 to 2010, Opeloyeru et al. (2021) analyzed the linkage between total health expenditure, health spending from public, private, personal, and external sources, life span, rate of maternal mortality, under-5 mortality rate, rate of infant death, neonatal mortality rate, and CO_2 emissions. From the study's findings, health spending improved the quality of life in those countries. In another related study, Wang, Temsah, and Carter (2016) investigated how health insurance coverage affected out-of-pocket health expenditures in Rwanda, Namibia, the Democratic Republic of the Congo, and Liberia. The findings of the research indicated that health insurance coverage had a strategic contribution in determining the extent of out-of-pocket (OOP) expenditures across all the sampled countries. Meanwhile, Gustafsson-Wright and Schellekens (2013) opined that insurance on health is anticipated to play a crucial part in the realization of Universal Health Coverage (UHC) by improving accessibility and utilization of healthcare services through the reduction of healthcare spending.

Several previous studies conducted by Van Der Wielen, Channon, and Falkingham (2018); AZuogu, Madubueze, Alo, Ogbonnaya, and Ajayi (2016); Adewole and Osungbade (2016) and Badu, Agyei-Baffour, Ofori Acheampong, Preprah Opoku, and Addai-Donkor (2018) have provided empirical evidence indicating that the scheme has failed to accomplish its intended goals, as it only provides coverage to less than 5% of the total population.

3. METHODOLOGY

To consider the most suitable research design for this article, an ex-post facto type was used for this study because the direction of the research is the investigation of viable relationships among carbon emissions, out-of-pocket expenditure, and life expectancy of reproductive-age women in West Africa.

3.1. Model Specification

In developing an adequate model to assess the nexus among carbon emissions, out-of-pocket expenditure and life expectancy, the study adapted its model from similar studies like Osabohien et al. (2021); Aderemi, Opele, Okoh, and Al-Faryan (2023); Omotayo, Ayomitunde, Afolakemi, and Aromoke (2019) and Afolayan and Aderemi (2019) in this manner.

$$Life\ expectancy\ (LEP) = f\ (Carbon\ emissions, CE, out-of-pocket\ expenditure, OPE) \quad (1)$$

If model (1) is restated econometrically with the introduction of some control variables into the model to enhance its robustness in estimating the objective of the study, model 2 emerges as this.

$$LEP_{it} = \alpha_0 + \alpha_1 CE_{it} + \alpha_2\ OPE_{it} + \alpha_3 MVD_{it} + \alpha_4 HE_{it} + \alpha_5\ GDPCA_{it} + u_{it} \quad (2)$$

Table 1. Measurement of variables.

Abbreviation	Variable	Operational definition	Expected sign
LEP	Life expectancy.	Life expectancy of women of reproductive age at birth, total (Years)	Dependent variable
CE	Carbon emissions.	Co_2 emissions (Metric tons per capita)	-
OPE	Out-of-pocket expenditure.	Out-of-pocket expenditure as percentage of current health expenditure.	+
MVD	Industrial output.	Manufacturing value added as percentage of GDP	+
HE	Health expenditure.	Domestic general government health expenditure per capita (Current US dollars)	+
GDPCA	GDP per capita.	GDP per capita growth (Annual percentage.	+

In Table 1, the operational definitions of various variables in the study are discussed as follows.

Moreover, t represents the scope of the study, which spans from 2000 to 2020, and i stands for fourteen (14) ECOWAS countries as follows: Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo. This selection was driven by data availability.

4. ANALYSIS AND DISCUSSION OF FINDINGS

In order to present the results of the data estimation, this section has been created, and the findings in the study are discussed as follows.

Table 2. Descriptive statistics of the study's variables.

Descriptive statistics	LEP (Years)	CE (Mt/Ca)	OPE (%)	MVD (%)	HE ($)	GDPCA (%)
Mean	58.3	0.34	49.4	8.53	14.5	3.33
Median	58.1	0.25	50.9	7.92	7.31	6.98
Maximum	76.5	1.07	78.3	21.5	111	5.74
Minimum	45.0	0.05	9.84	1.53	1.12	4.87
Std. dev.	6.03	0.24	16.9	4.38	21.6	9.12
Skewness	0.80	1.17	-0.29	0.61	3.11	4.11
Kurtosis	4.09	3.78	2.11	18.4	12.2	19.4
Jarque-Bera	46.1	75.3	13.6	2.94	151	414
Probability	0.00	0.00	0.00	0.00	0.00	0.00
Sum	171	100	145	250	428	9.79
Sum sq. dev.	106	17.3	845	562	137	2.44
Observations	294	294	294	294	294	294

In Table 2, efforts have been made to summarize the descriptive statistics of all the indicators employed to proxy the variables of the study; thus, firstly, from 2000 to 2020, on an average basis, the life expectancy of women of reproductive age in West Africa is 58 years. This is far less than the current life expectancy of women of reproductive age in Northern Africa (75 years), Eastern Africa (66 years), Southern Africa (64 years), and Middle Africa (62 years), respectively. Meanwhile, carbon emissions have a mean value of 0.341155 metric tons per capita. This is far below 6 metric tons per capita, which is currently recorded in the low- and middle-income countries in the East Asia and Pacific region. In the same vein, the out-of-pocket expenditure on health in West Africa has a mean value of 49.46%. This means that the residents of West Africa pay almost 50% of their total health expenses directly from their pockets to healthcare providers. This is far greater than the situation reported for the residents of Sub-Saharan Africa, who pay 30.35%, East Asia and Pacific, who pay 25.28%, EU countries, who pay 14.44%, and South Africa, who pay 5.36% respectively.

However, the average value of MVD in West Africa is 8.53%. This implies that, in the past two decades, the manufacturing sector has contributed less than 9% to the sub-regional GDP on an average basis. However, government health expenditure has a mean value of $14.5. This shows that, on an average basis, the domestic general government health expenditure per capita in West Africa is $14.5. In the same vein, GDPCA has an average value of 3.3%. This indicates that, on an average basis, the GDP per capita growth in West Africa is 3.3% over the last two decades.

Table 3. Results of panel fully modified least squares (FMOLS) of carbon emissions, out-of-pocket expenditure and life expectancy of reproductive age women in West Africa.

Dependent variable: LEP				
Variable	**Coefficient**	**Std. error**	**t-statistic**	**Prob.**
CE	17.4**	3.57	4.87	0.00
OPE	-0.13**	0.02	5.14	0.00
MVD	0.00	0.10	0.02	0.98
HE	0.04	0.03	1.31	0.18
GDPCA	2.03**	5.07	3.99	0.00
R-squared	0.88	Mean dependent var		58.6
Adjusted R-squared	0.87	S.D. dependent var		5.95
S.E. of regression	2.11	Sum squared resid		117
Long-run variance	10.0			

Note: (**) indicates significance at a 1% probability level.

In estimating the nexus among carbon emissions, out-of-pocket expenditure, and life expectancy of reproductive-age women, FMOLS was utilized, with the results displayed in Table 3. As such, the results are discussed as follows: the parameters of carbon emissions and out-of-pocket expenditure contradict the a priori expectation. Whereas the R-squared in the regression outputs affirms that the explanatory variables explained about 88% of the variation in life expectancy, which is the dependent variable, and left the rest of 12% to the factors outside the model. Carbon emissions and life expectancy of reproductive-age women had a significant positive relationship in West Africa, contrary to the study's expectation. From this result, a unit change in carbon emissions brings about a 17% rise in the life expectancy of reproductive women in West Africa. The reason for this finding might be attributed to the low level of carbon emissions in West Africa due to the lack of industrial concentration in this subregion.

However, out-of-pocket expenditure and life expectancy of reproductive women in West Africa have a significant negative relationship. Therefore, a unit change in out-of-pocket expenditure leads to a reduction in life expectancy of reproductive women by 0.13% in the region. This result might emanate from insufficient out-of-pocket expenditure from the residents of West Africa due to a high level of multidimensional poverty in the region.

Consequently, the GDP per capita growth and life expectancy of reproductive women in West Africa have a positive and significant relationship. A unit change in GDP per capita initiates a rise in the life expectancy of reproductive women in West Africa by 2%.

In addition, both domestic general government health expenditure per capita and industrial output had an insignificant positive relationship with the life expectancy of reproductive women in West Africa.

5. CONCLUSION AND POLICY IMPLICATIONS

This study investigated the nexus among carbon emissions, out-of-pocket expenditure, and life expectancy of reproductive-age women within the West Africa subregion from 2000 to 2020. After subjecting the collected data to empirical analysis, the following conclusions evolved from the study: the average life expectancy of women of reproductive age in West Africa is 58 years. Meanwhile, carbon emissions have a mean value of 0.341155 metric tons per capita. Additionally, the residents of West Africa pay almost 50% of their total health expenses directly out of their pockets to healthcare providers.

Consequently, carbon emissions contributed a significant positive effect on the life expectancy of reproductive-age women in West Africa, contrary to the study's expectations. However, out-of-pocket expenditure caused a significant reduction in the life expectancy of reproductive women in West Africa. Additionally, GDP per capita growth and life expectancy of reproductive women in West Africa had a positive and significant relationship. Arising from these findings, this study makes the following recommendations: whenever policymakers in West Africa aim to improve the life expectancy of reproductive women in their region, policies such as health subsidies that would reduce out-of-pocket expenditures to healthcare providers should be implemented. Similarly, policies that would drive the expansion of GDP per capita should be encouraged so that reproductive women in the region can have the economic and financial power to live a quality of life that catalyzes an increase in life expectancy.

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