The Role of Health Expenditure on Health Outcomes: Evidence From West Africa Countries

Festus Efosa ERIAMIATOE

Northern Illinois University
Corresponding Author e-mail: eriamiatoefestus@gmail.com

DOI: 10.29322/IJSRP.12.12.2022.p13208
http://dx.doi.org/10.29322/IJSRP.12.12.2022.p13208

Paper Received Date: 18th October 2022
Paper Acceptance Date: 24th November 2022
Paper Publication Date: 6th December 2022

Abstract: *This study investigates the role of health expenditure on health outcomes in West Africa countries. Using the Grossman theoretical framework, other variables that affect health outcomes were also examined. Sixteen countries of West Africa with yearly data spanning between the period of 19 years (2000-2019) was used in this study. The health outcomes examined include life expectancy and neonatal and under-5 mortality rates. The regressors used in the study include domestic government health expenditure per capita, domestic private health expenditure per capita, external health expenditure per capita, carbon-dioxide emission metric ton per capita, human immunodeficiency virus (HIV), unemployment, GDP per capita, tuberculosis, fertility rate, malaria and carbon-dioxide emission from gaseous fuel consumption. The study used the mixed effect regression model. The study revealed that the domestic government health expenditure per capita does not have significant impact on life expectancy and under-5 mortality; however it has a contradicting effect on neonatal mortality rate. Domestic private health expenditure per capita has significant impact on life expectancy, and external health expenditure per capita has insignificant impact on life expectancy. With respect to the neonatal mortality rate, the domestic government health expenditure per capita, domestic private health expenditure per capita, and the external health expenditure per capita are statistically significant. With respect to the under-5 mortality rate, domestic government health expenditure per capita is statistically insignifcant; however, domestic private and external health expenditure are statistically significant. The study recommends that the government and the stakeholders in the health sectors should make conscious efforts to allocate more resources to health sectors to improve health outcomes. There should be more emphasis on access to health care facilities in rural areas given that a good number of the population in West Africa live there. The introduction and proper management of health insurance to enable proper private health care access will help improve the significant impact of domestic private health care.*

Keywords: Health Expendiure, Life Expectancy, Under-5 Mortality Rate, Neonatal Mortality Rate, Health Outcomes

1. Introduction

In recent years, improving health care has been the key focus of the government of different countries and policy makers (Boachie et al., 2016). Health care investment is a key factor for countries that are development focused. To keep improving the human capital stock, the health sector of the economies must be functional and accessible by those who require health care. The quality of the health care determines the quality of the health outcome of a country. Health outcome in this case includes life expectancy, infant mortality rate, under-5 mortality rate and neonatal mortality rate (Grossman, 1972). Life expectancy is the number of years which an individual is expected to live if current death rate does not change (OECD, 2021). It is the statistical measure of the average time an organism is expected to live based on the year of birth, current age, and other demographic factors. Neonatal mortality rate is the number of deaths of infants that occur between 0 and 28 days per 1000 live births. The infant mortality rate is the number of deaths of infants that occur under age 1 year. Under-5 mortality rate is the number of deaths that occur under-5 years old.

Some children die at birth while several of them die before year 5 (WHO, 2020). Most of the deaths are associated with diseases such as measles, diarrhea, and other forms of diseases. Several of them could have escaped death if there were sufficient provision of health facilities and personnel. The availability of adequate health care facilities and personnel helps reduce the rate of mortality among adults and children. Adequate health care investment by the government and the private sector will improve health care outcomes (Anyanwu and Erhiajakpor, 2007). Government and private bodies have invested in the health sectors, the effect of which has been a general decline in the rate of mortality.

Recently, people live longer due to the presence of vaccines, antibiotics, and other advanced medical equipment (Jacqueline et al., 2018). These factors among others account for the quality of health services. These services are made possible by the provision of adequate funding by the government and other stakeholders both in the private and external sectors of the economy. Recently studies have found that health care expenditure has different impact on health outcomes of different countries in different years. Most studies found a positive and significant relationship between health expenditure and life expectancy. Some of this research, among others is Crémieux et al., (1999), Lichtenberg (2000), and Nixon and Ulmann (2006). However, some studies fail to establish an explicit relationship between health expenditure and life expectancy; some of the studies; among others, include Hitiris and Posnett (1992) and Barlow and Vissandjee (1999).

1.1 The Objective of the Paper

This paper investigates the impact of health expenditure on health outcome such as life expectancy, under-5 mortality rate, and neonatal mortality rate in West Africa countries. Other factors that affect health outcome were also investigated. Yearly data spanning a period of 19 years, (2000-2019) from was used in the study. This study is aimed at informing the government and policy makers on the implication of health care expenditures on health outcomes.

1.2 Research Questions

The research intends to answer the following questions:

- What is the effect of general government expenditure per capita on health outcomes (life expectancy, neonatal mortality rate, and under-5 mortality rates)?
- What is the effect of private health care expenditure per capita on health outcomes?
- What is the effect of external health care expenditure per capita on health outcomes?
- What is the effect of the incidence of malaria on health outcomes?
- What is the effect of HIV prevalence on health outcomes?
- What is the effect of GDP per capita on health outcomes?
- What is the effect of unemployment on health outcomes?

1.3 Hypotheses of the Study

- $H_{1:}$ There is statistically significant relationship between public health expenditure and health outcomes.
- $H_{2:}$ There is statistically significant relationship between private health care expenditure and health outcomes.
- $H_{3:}$ There is statistically significant relationship between external health care expenditure and health outcomes.

2. Empirical And Theoretical Review

2.1 Empirical Literature Review

There are several studies that have investigated the relationship between health expenditure and health outcome with different methodologies, periods, and countries.

Deshpande et al. (2014) compares health care expenditures to life expectancy using data for 181 countries. They used per capita expenditure on health as the measure of health care spending. The authors also controlled for the effects of per capita GDP, literacy rates, and density of physicians. A simple regression model between life expectancy and per capita health expenditure was estimated and a value of 0.66 was found, showing reasonably good measure of fit. In their regression results, they find that health care expenditure does not play much of a role in life expectancy in developing countries, but that health care has a significant impact on increasing the life expectancy of developed nations. In fact, for some developing countries, they find negative relationships between health care spending and life expectancy. They hypothesize that this is due to the quality of health care expenditure.

Jacqueline et al. (2018) examined the relationship between health care expenditure as a percentage of GDP and life expectancy for both males and females. They used data from 120 countries. The fixed-effect model was used, and they found a positive and significant relationship between life expectancy of both men and women and health care expenditure.

Devdatta and Linden (2019) examined the effect of public and private health expenditures on life expectancy at birth and infant mortality. They used data from 195 countries, ranging from 1995-2014. They used the GMM estimator and found that public health is more health promoting than private expenditures.

Sango-Coker and Bein (2018) investigated the private and public health care expenditure of West Africa. They obtained data from 16 West Africa countries from the World Bank and World Health Organization between 1999-2014 and used pooled regression and pairwise correlation. The pairwise correlation showed that public health care expenditure correlates positively with life expectancy at birth for females, life expectancy at birth for males and life expectancy in total, whereas the health care private expenditure has a negative correlation with life expectancy at birth for females, life expectancy at birth for males, and life expectancy in total.

Kiros et al. (2020) studied the effects of health expenditure on infant mortality in sub-Saharan Africa. Data was collected from World Development Indicators of 46 Africa countries between 2000-2015 was utilized in the study. They used the random-effect model and found that both public and external health spending have a significant negative relationship with infant and neonatal mortality.

Boussalem and Taiba (2014) investigated the causality and cointegration relationship between public spending on health and economic growth in Algeria between 1974 to 2014 using the annual data. They found that there is a long-run causality from public spending on health to economic growth.

Xu, Saksena and Holly (2011) carried out a study to determine the trajectory of health expenditure in developing countries. They used the panel data from 14 countries over 14 years from 1995 to 2008. Fixed-effects and dynamic models were used to explore the factors associated with growth of total health expenditure. They found no difference in health expenditure between tax-based and insurance-based health financing mechanism. The study also shows that external aid for health reduces government health spending from domestic sources.

Onofrei et al. (2021) investigate the relationship between public health expenditure and health outcomes among the European Union (EU) developing countries. They used the regression and factor analyses. The researchers find that public health expenditure and health outcomes have a long-run equilibrium relationship, and the status of health expenditure can improve life expectancy and reduce infant mortality.

Boachie et al. (2016) examined the effect of public health expenditure on health status of Ghana. The author used annual time series data on infant mortality rate, real GDP per capita, literacy, level, and female labor force participation rate between 1990 and 2012. The OLS estimation technique was utilized. The authors find that there is a negative relationship between per capita income, health expenditure, education, female presence in the labor market, and infant mortality rate. Hence, they conclude that public health expenditure and literacy improve health status by reducing infant mortality.

Sango-Coker and Bein (2018) investigate the private, public, and public-private health care expenditure in West Africa. The authors used pooled regression and pairwise correlation. They find a negative relation between health care expenditure and life expectancy.

Answar and Ali (2012) examined the long-run and short-run relationship between government investment in health and returns in the period 1975-2009 in Pakistan. Life expectancy at birth and infant mortality rate were used as proxies for return on health investment. The authors find that per capita government health expenditure and number of maternal and child health centers and doctors significantly affect the infant mortality rate and life expectancy at birth.

Bein et al. (2017) examine the relationship between health care expenditure and health outcomes for eight East Africa countries. The authors used the panel data regression analysis using data between 2000-2014. The result suggests that there is a positive relationship between total health care expenditure and total life expectancy. The study further revealed that there is a stronger relationship between female life expectancy and health care expenditure than male life expectancy. They also find a negative relationship between health care expenditure and neonatal, infant, and under-5 mortality rates.

Anyanwu and Erhijakpor (2007) examine the relationship between per capita income, total health expenditure, and per capita income on infant mortality rate and under-5 mortality rate. The authors used data from 47 Africa countries between 1999 and 2004. They find a significant relationship between health care expenditure and infant and under-5 mortality rates.

Arthur and Oaikhenan (2017) examine the effect of health expenditure on health outcomes in sub-Sahara African (SSA) countries. The study used 40 countries in SSA. They employ the use of fixed-effect for the empirical analyses. The findings suggest that health expenditure has a significant impact on health outcomes by reducing mortality rate and increasing life expectancy at birth.

2.2 Theoretical Literature Review

The theoretical background of this topic can be traced back to 1972 when Michael Grossman developed the Grossman model of health demand:

$$H = f(X) \tag{2.1}$$

In the equation above, H is a measure of individual health output and X represents the vector of individual inputs to the health production function. The elements of the vector include nutrient intake, income, consumption of public goods, education, time devoted to health-related procedures, initial individual endowments like genetic makeup, and community endowments such as the environment (Grossman, 1972). The Grossman model was then further specified by Fiyissa and Gutema (2005).

$$H = F(Y, S, V, D) \quad (2.2)$$

The major difference between the two equations is that the original theoretical model analyzes health production on the microlevel while the revised model analyzes the production at the macrolevel. H is still a vector of health outcomes such as life expectancy at birth, infant mortality rate, under-5 mortality rate, and neonatal mortality rate. Y is a vector of per capita economic variables. These include GDP per capital, employment, health expenditure. S is a vector of social variables such as education and population age group, V is a vector of environmental factors such as sanitation, prevalence of diseases, availability of water, and carbon dioxide emission. D is a vector of health service variables such as rate of immunization.

$$H = F(y_1, y_2, \ldots, y_n; s_1, s_2, \ldots, s_n; v_1, v2, \ldots, v_n; d_1, d_2, \ldots, d_n;) \quad (2.3)$$

In its scalar form Equation (2.2) is represented by equation (2.3). where $Y = (y_1, y_2, \ldots y_n)$; $S= (s_1, s_2, \ldots s_n)$; $V = (v_1, v_2, \ldots v_n)$; and $D = (d_1, d_2, \ldots d_n)$. n represents the number of variables in each subgroup.
This reformation of the Grossman model is adopted to form the basis for the formation of the model we used for this research. The health outcomes used in this research include life expectancy, infant mortality rate, neonatal mortality, and under-5 mortality rates.

3 Empirical Method

3.1 Data and Methodology

Panel data was used, which is the combination of time series data and cross-sectional data, which implies that the results came from multiple time periods for various countries. Because of cultural factors, the difference in business climate, and natural amenities that vary across countries but are not observable, as well as factors that change over time, such as national policies, government regulations, and international agreements, a mixed-effects regression is the appropriate estimation methodology. The use of the ordinary least square where the heterogeneous factors are not put into considerations the results will bias the results. Therefore, the main reason people use mixed-effects methods is its ability to control all the characteristics of the individuals gathered; this then allows them to eliminate all the potentially significant biases (Jacqueline et al., 2018).

Table 3.1 Definition of Variables

VARIABLES	DEFINITIONS
LE	Life expectancy. (total years)
NMR	Neonatal mortality rate (per 1000 live births)
UMR	Under-5 mortality rate (per 1000 live births)
DGEPC	Domestic general government health expenditure per capita (current US$)
	Domestic private health expenditure per capita (current US$)
DPHEPC	External health expenditure per capita (current US)
EHEPC	Real GDP per capita
GDPC	Incidence of tuberculosis (per 1000 persons)
TUB	HIV prevalence (per 1000 uninfected persons)
HIV	Incidence of malaria (per 1000 population at risk)
MAL	Carbon-dioxide emissions (metric tons per capita)
CO2	Unemployment rate (% of total labor force)
UN	Carbon-dioxide emission from gaseous fuel consumption (% of total)
CO2K	Fertility rate (births per woman)
FR	Immunization, measles
MEASLES	Country-specific effect
δ	Time-specific effect
λ	

The descriptive statistics of the variables used in the empirical analyses are provided in Table 3.2 below. It shows the mean life expectancy in West Africa to be at 57.57. The mean of neonatal mortality rate stood at 34.23 per 1000 live births; this indicates that for every 1000 live births in West Africa region about 34 die before the 28th day. The mean value of under-5 mortality rate is 108.15; this indicates that for every 1000 live births about 108.15 die before the 5th birthday. The mean domestic government health expenditure per capita is 0.01256 US dollars as a proportion of GDP. The mean domestic private health expenditure per capita is 0.01100 US dollars as proportion of GDP. The mean external health expenditure per capita is 0.01100 US dollars as proportion of GDP. The mean value of HIV prevalence per 1000 people uninfected persons is 0.93; this indicates that about 7% of every 1000 persons are infected by HIV.

The mean value of GDP per capita is 1007 US dollars and the mean value of GDP per capita adjusted to the 2010 CPI level of each country is 1052. The mean incidence of malaria is 311.2456 per 1000 people. This means that for every 1000 persons about 311.2456 persons are exposed to the risk of malaria. The carbon-dioxide emission per metric ton per capita is 0.350 metric ton. The mean value of unemployment rate is 5.39%. The mean value of carbon-dioxide emission from gaseous fuel consumption is 4.048%. The mean fertility rate is 5.27 per woman. That is, on the average, women give birth to five children. The tuberculosis mean infection rate is about 167.55 for every 1000 people in West Africa.

Table 3.2 Descriptive Statistics

Simple Statistics						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
LE	320	57.56737	6.06377	18422	39.44100	72.98100
NMR	320	34.23219	8.11090	10954	9.00000	54.70000
UMR	320	108.15406	41.87822	34609	14.90000	227.70000
DGEPC	320	0.01256	0.00807	4.01789	0.00241	0.03794
DPHEPC	320	0.02956	0.01844	9.46044	0.00806	0.12799
EHEPC	320	0.01100	0.01318	3.52146	0.0006773	0.10453
CO2	320	0.35069	0.24570	112.21989	0.05303	1.14261
HIV	320	0.93719	0.74733	299.90000	0.05000	3.85000
GDPC	320	1052	717.71933	336740	222.82103	3836
UN	320	5.39894	3.12179	1728	0.32000	12.24000
TUB	320	167.55625	94.44325	53618	37.00000	367.00000
FR	320	5.27079	1.03260	1687	2.24200	7.67900
CO2K	320	4.04788	11.62397	1295	0	57.43494
MAL	320	311.24564	157.37201	99599	0.00761	589.32571
YEARS	320	2010	5.77531	643040	2000	2019

Source: Author's computation

To establish the direction and magnitude of relationship between the variables, we estimate the correlation coefficients, which are represented in Table 3.3 below.

Table 3.3: Correlation Matrix

Pearson Correlation Coefficients, N = 320
Prob > |r| under H0: Rho=0

	LE	NMR	UMR	DGEPC	DPHEPC	EHEPC	CO2	HIV	GDPC	UN	TUB	FR	CO2K	MAL	YEARS
LE	1.00000	-0.84866 <.0001	-0.91098 <.0001	0.34520 <.0001	-0.47141 <.0001	-0.13475 0.0159	0.60930 <.0001	-0.26409 <.0001	0.31733 <.0001	0.48513 <.0001	-0.44398 <.0001	-0.66665 <.0001	-0.30490 <.0001	-0.68479 <.0001	0.47238 <.0001
NMR	-0.84866 <.0001	1.00000	0.84186 <.0001	-0.37795 <.0001	0.30854 <.0001	0.08409 0.1334	-0.54377 <.0001	0.27686 <.0001	-0.36425 <.0001	-0.33791 <.0001	0.53147 <.0001	0.62381 <.0001	0.20597 0.0002	0.44643 <.0001	-0.51022 <.0001
UMR	-0.91098 <.0001	0.84186 <.0001	1.00000	-0.29215 <.0001	0.41698 <.0001	0.08424 0.1327	-0.59325 <.0001	0.11214 0.0450	-0.35308 <.0001	-0.48462 <.0001	0.33577 <.0001	0.75151 <.0001	0.09844 0.0787	0.63241 <.0001	-0.54254 <.0001
DGEPC	0.34520 <.0001	-0.37795 <.0001	-0.29215 <.0001	1.00000	-0.00108 0.9847	-0.05594 0.3185	0.26529 <.0001	0.24503 <.0001	0.33826 <.0001	0.27088 <.0001	-0.06946 0.2153	-0.41932 <.0001	-0.22768 <.0001	-0.36858 <.0001	-0.05416 0.3342
DPHEPC	-0.47141 <.0001	0.30854 <.0001	0.41698 <.0001	-0.00108 0.9847	1.00000	0.38197 <.0001	-0.41082 <.0001	0.04915 0.3809	-0.24182 <.0001	-0.32502 <.0001	0.58506 <.0001	0.07809 0.1634	-0.03766 0.5020	0.20781 0.0002	-0.01984 0.7236
EHEPC	-0.13475 0.0159	0.08409 0.1334	0.08424 0.1327	-0.05594 0.3185	0.38197 <.0001	1.00000	-0.36144 <.0001	0.07077 0.2067	-0.30841 <.0001	-0.04463 0.4262	0.32901 <.0001	0.01956 0.7275	-0.17220 0.0020	0.18093 0.0012	0.07756 0.1663
CO2	0.60930 <.0001	-0.54377 <.0001	-0.59325 <.0001	0.26529 <.0001	-0.41082 <.0001	-0.36144 <.0001	1.00000	-0.05059 0.3670	0.78813 <.0001	0.52271 <.0001	-0.29437 <.0001	-0.66984 <.0001	0.11635 0.0375	-0.58674 <.0001	0.20814 0.0002
HIV	-0.26409 <.0001	0.27686 <.0001	0.11214 0.0450	0.24503 <.0001	0.04915 0.3809	0.07077 0.2067	-0.05059 0.3670	1.00000	0.09503 0.0897	0.00630 0.9107	0.39794 <.0001	-0.16098 0.0039	0.19968 0.0003	0.04193 0.4547	-0.46753 <.0001
GDPC	0.31733 <.0001	-0.36425 <.0001	-0.35308 <.0001	0.33826 <.0001	-0.24182 <.0001	-0.30841 <.0001	0.78813 <.0001	0.09503 0.0897	1.00000	0.44745 <.0001	-0.12084 0.0307	-0.52520 <.0001	0.31132 <.0001	-0.39532 <.0001	-0.00201 0.9714
UN	0.48513 <.0001	-0.33791 <.0001	-0.48462 <.0001	0.27088 <.0001	-0.32502 <.0001	-0.04463 0.4262	0.52271 <.0001	0.00630 0.9107	0.44745 <.0001	1.00000	-0.22480 <.0001	-0.42147 <.0001	-0.04850 0.3872	-0.58833 <.0001	0.01772 0.7521
TUB	-0.44398 <.0001	0.53147 <.0001	0.33577 <.0001	-0.06946 0.2153	0.58506 <.0001	0.32901 <.0001	-0.29437 <.0001	0.39794 <.0001	-0.12084 0.0307	-0.22480 <.0001	1.00000	0.00896 0.8731	0.21089 0.0001	0.00864 0.8776	-0.14185 0.0111
FR	-0.66665 <.0001	0.62381 <.0001	0.75151 <.0001	-0.41932 <.0001	0.07809 0.1634	0.01956 0.7275	-0.66984 <.0001	-0.16098 0.0039	-0.52520 <.0001	-0.42147 <.0001	0.00896 0.8731	1.00000	0.03749 0.5040	0.58086 <.0001	-0.35183 <.0001
CO2K	-0.30490 <.0001	0.20597 0.0002	0.09844 0.0787	-0.22768 <.0001	-0.03766 0.5020	-0.17220 0.0020	0.11635 0.0375	0.19968 0.0003	0.31132 <.0001	-0.04850 0.3872	0.21089 0.0001	0.03749 0.5040	1.00000	0.24658 <.0001	-0.05586 0.3192
MAL	-0.68479 <.0001	0.44643 <.0001	0.63241 <.0001	-0.36858 <.0001	0.20781 0.0002	0.18093 0.0012	-0.58674 <.0001	0.04193 0.4547	-0.39532 <.0001	-0.58833 <.0001	0.00864 0.8776	0.58086 <.0001	0.24658 <.0001	1.00000	-0.26611 <.0001
YEARS	0.47238 <.0001	-0.51022 <.0001	-0.54254 <.0001	-0.05416 0.3342	-0.01984 0.7236	0.07756 0.1663	0.20814 0.0002	-0.46753 <.0001	-0.00201 0.9714	0.01772 0.7521	-0.14185 0.0111	-0.35183 <.0001	-0.05586 0.3192	-0.26611 <.0001	1.00000

Furthermore, we present a visualization of the performance of life expectancy and neonatal mortality rate. Figure 3.1 shows the life expectancy trend in West Africa. The figure shows that there is a continuous increase in life expectancy. Cabo Verde is at the top of the life expectancy trend. Life expectancy increases in five years between 2000 and 2015, the fastest increase since the 1960s. However, there was a sharp drop in life expectancy in Africa in the 1990s because of HIV prevalence. There was a later sharp increase in Africa by about 9.4 years to about 60 years. This sharp increase is a result of progress of malaria control and expanded access to antiretroviral treatment of HIV (WHO, 2020).

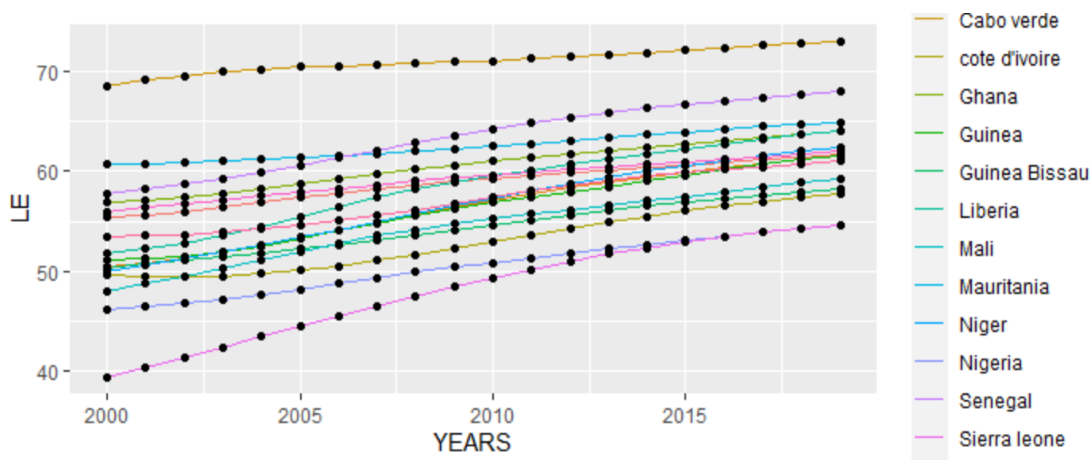


Figure 3.1: Life expectancy in West Africa.

Figure 3.2 presents the neonatal mortality trend. The figure shows a downward trend of the rate of neonatal mortality rate in West Africa region. This is attributable to improved technology, availability of antibiotics, vaccines, advanced medical equipment, and other prenatal care. According to the World Health Organization (2020), accelerated progress for neonatal survival and promotion of health and well-being requires strengthening quality of care as well as ensuring availability of quality health services for small and sick newborns. The number of neonatal deaths declined from 5.0 million in 1990 to 2.4 million in 2019. However, the decline has been slower that the under-5 mortality rate. The share of neonatal death rate among under-5 mortality rate is still relatively low in sub-Saharan Africa.

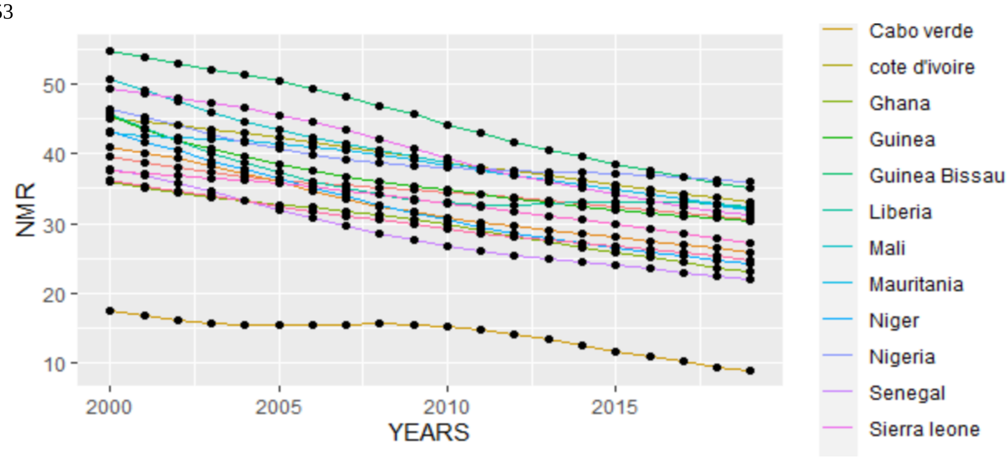


Figure 3.2: Neonatal mortality rate in West Africa.

Under-5 mortality rates in West Africa is visualized in figure 3.3 below. The line plot shows a continuous decline in the rate of under-5 mortality.

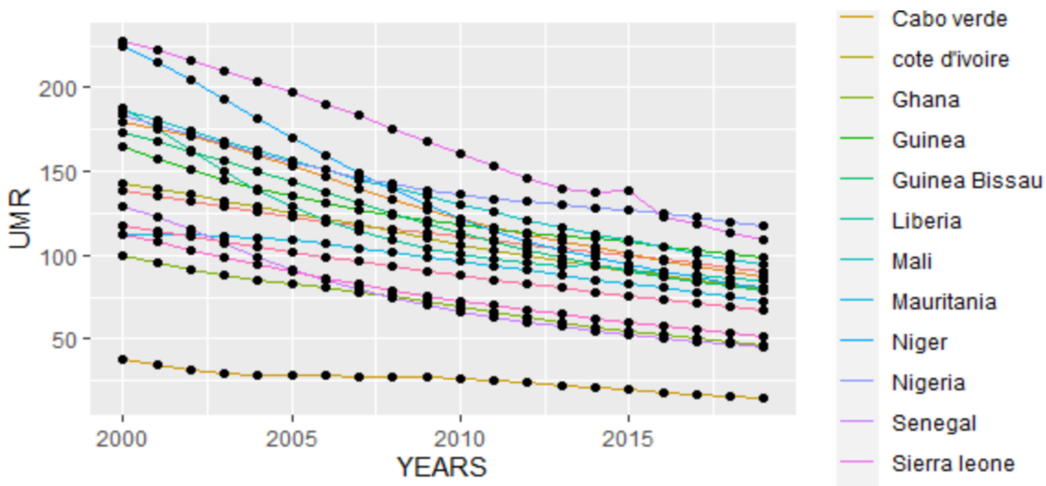


Figure 3.3: Under-5 mortality rate in West Africa.

Figure 3.4 shows the incidence of tuberculosis in West Africa region. The line plot shows that some countries' incidence of tuberculosis is very low while other countries are still very high and moving at steady levels. This trend is because of low case detection, late reporting, poor treatment and adherence leading to development of drug resistance and relapse (Asare et al, 2021).

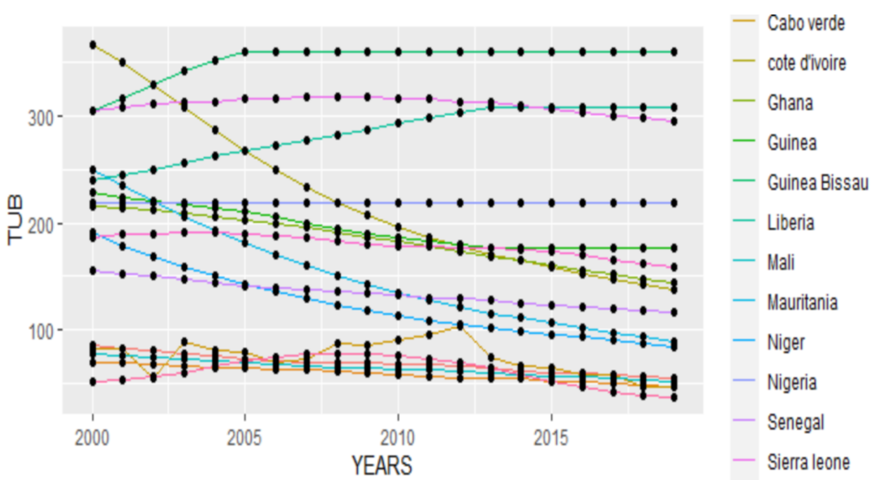


Figure 3.4: Incidence of tuberculosis in West Africa.

Figure 3.5 shows the rate of malaria prevalence in West Africa. The plot shows a downward movement of the line plot. This shows a continuous fall in the rate of malaria incidence. This is attributable to different measures taken by the government, private agencies, and international health and bilateral organizations to curb the incidence of malaria. Some of the measures include the provision of mosquito nets, medications, and medical personnel. However, most countries are still faced with some level of malaria incidence challenges; these countries have poor living environment and lack of potable drinking water. The body of water breeds Anopheles mosquitoes that spreads malaria through injection of plasmodium.

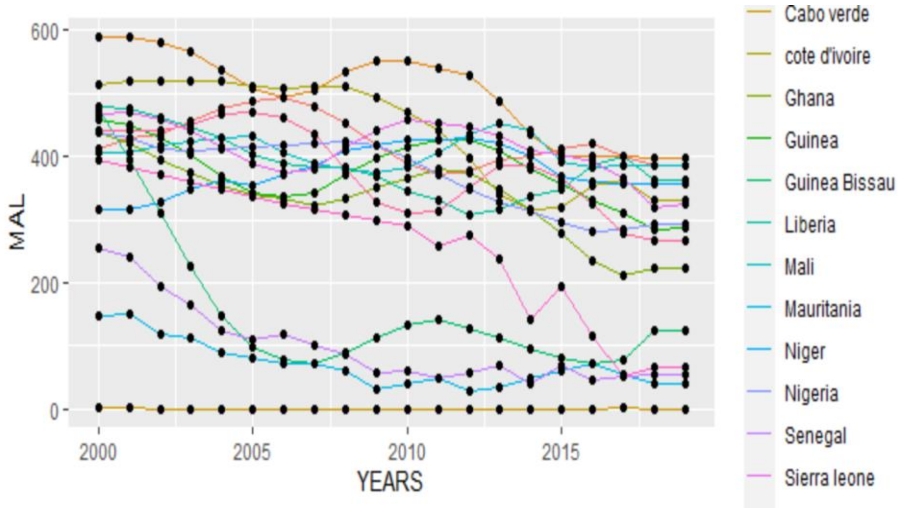


Figure 3.5: Incidence of malaria in West Africa.

3.2 Model Specification

Drawing from the theoretical reviews of Grossman (1972) and Fiyissa and Gutema (2005), we can state the equation that examines the impact of health expenditure on health outcome as proxied by life expectancy, infant mortality rate, under-5 mortality rate and neonatal mortality rate. Life expectancy is expressed in the number of years. The infant mortality rate is the number of deaths per 1000 live births. The under-5 mortality rate is the number of deaths per 1000 of population from age 5 and below. The neonatal mortality rate is the number of deaths per 1000 of live births.

$$Y_{it} = X'_{it}\beta_i + Z_i\delta + \mathcal{E}_{it} \tag{3.1}$$

$$\mathcal{E} \sim N(0, \delta^2 I)$$

where Y_{it} is the vector of the dependent variable and X'_{it} is the vector of the covariates, β_i is the vector of the coefficients of the covariates, Z_i is the design matrix for random effects which include intercept, δ_i is the vector of subject specific and $\mathcal{E}_{it}$ is vector of the error terms.

We formulate the statistical model for life expectancy, neonatal mortality rate and

under-5 mortality rates are expressed as follows:

$$LE_{it} = \alpha_0 + \alpha_1 DGEPC_{it} + \alpha_2 DPHEPC_{it} + \alpha_3 EHEPC_{it} + \alpha_4 GDPC_{it} + \alpha_5 CO2_{it} + \alpha_6 HIV_{it} + \alpha_7 MAL_{it} + \alpha_8 Unemp_{it} + \alpha_9 FR_{it} + \alpha_{10} CO2K_{it} + \alpha_{11} TUB_{it} + \delta_i + \gamma_t + \epsilon_{it} \tag{3.2}$$

The model for neonatal mortality rate is developed as follows:

$$NMR_{it} = \beta_0 + \beta_1 DGEPC_{it} + \beta_2 DPHEPC_{it} + \beta_3 EHEPC_{it} + \beta_4 GDPC_{it} + \beta_5 CO2_{it} + \beta_6 HIV_{it} + \beta_7 MAL_{it} + \beta_8 Unemp_{it} + \beta_9 FR_{it} + \beta_{10} CO2K_{it} + \beta_{11} TUB_{it} + \delta_i + \gamma_t + \epsilon_{it} \tag{3.3}$$

The model for under-5 mortality rate is developed as follows:

$$UMR_{it} = \lambda_0 + \lambda_1 DGEPC_{it} + \lambda_2 DPHEPC_{it} + \lambda_3 EHEPC_{it} + \lambda_4 GDPC_{it} + \lambda_5 CO2_{it} + \lambda_6 HIV_{it} + \lambda_7 MAL_{it} + \lambda_8 Unemp_{it} + \lambda_9 FR_{it} + \lambda_{10} CO2K_{it} + \lambda_{11} TUB_{it} + \delta_i + \gamma_t + \epsilon_{it} \tag{3.4}$$

where the subscript i (=1…n) represents the countries and t (=1…i) represents the period (years).

3.3 Research Design and Methodology

The research design adopted for this study is a cross-country research design. Sixteen countries in West Africa were studied. The research work employed basically the secondary data sourced from World Bank development indicators. The health expenditure variables were used after adjusting for the effect of inflation using the Consumer Price Index with 2010 as base year. The period of estimation is 2000-2019.

In this study, the method of data analysis is mixed-effects (fixed and random) analysis. The mixed-effect model contains both the fixed and random effects. The selection criterion used is the Akaikes information criterion (AIC) and Bayesian information criterion (BIC). The analyses were done using SAS and R statistical software.

3.4 Diagnostic Tests

To assess whether the residual in the regression analyses follows a normal distribution, we plot the density and the quantile-quantile (Q-Q), residual versus fitted, scale location and residual versus leverage plots. The life expectancy model is represented in Figures 3.6 and 3.7. The density plot follows a bell shape, so there is no need to transform the data because the residuals are normally distributed. The Q-Q plot shows the alignments of the plots along the straight line at a 45-degree angle; then we can conclude that the residuals of the data are normally distributed and consequently meet the requirement of the assumptions to confidently use the regression models. The residual versus leverage plot only shows a single outlier and we cannot conclude that the model does not approximate the points. The scale location plot shows that the constant variance assumption is met, so we can confidently rely on the probability values obtained.

Neonatal and under-5 mortality rates are represented in Figures 3.8 and 3.9 respectively. The Q-Q plots show that residual of the model is normally distributed, so there is no need to transform the models. There is no evidence for outlier in the residual versus leverage plots for both models. We can conclude that the models well approximate the points. The scale location also shows the constant variance assumption is met; hence, we can confidently rely on the probability values obtained in the two models.

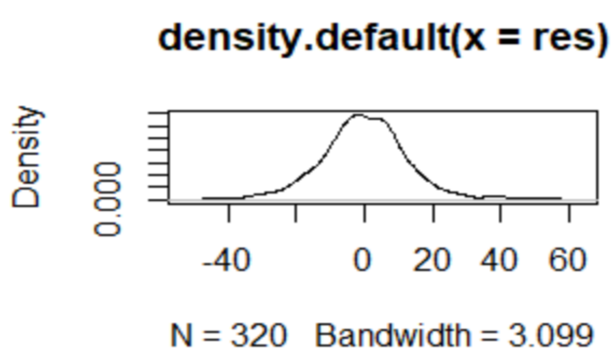


Figure 3.6: Normality test for Model 3.2.

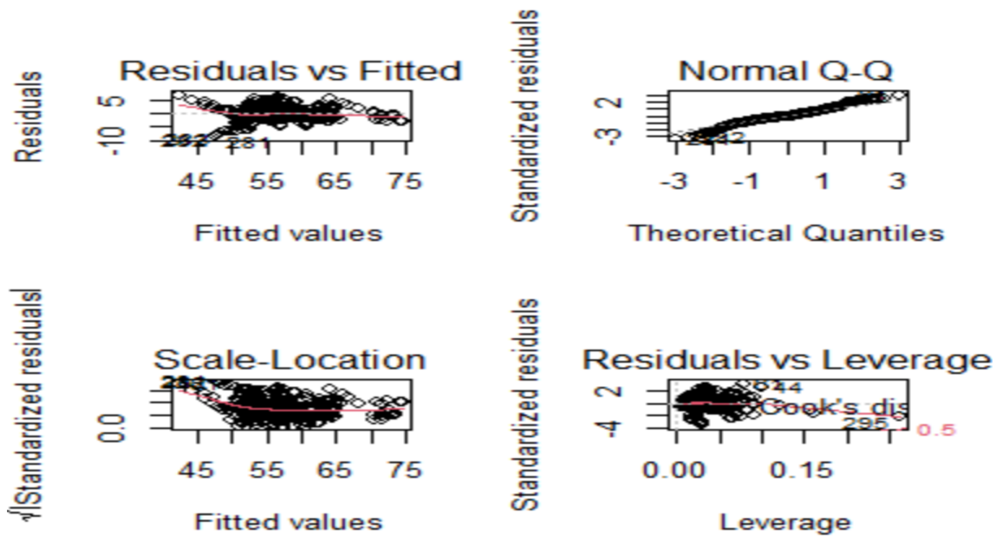


Figure 3.7: Diagnostic test for Model 3.2.

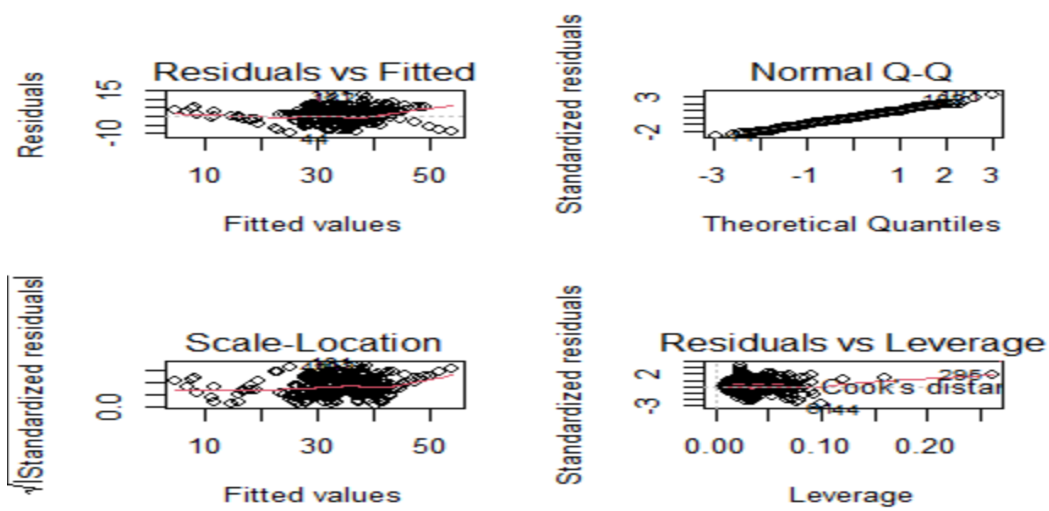
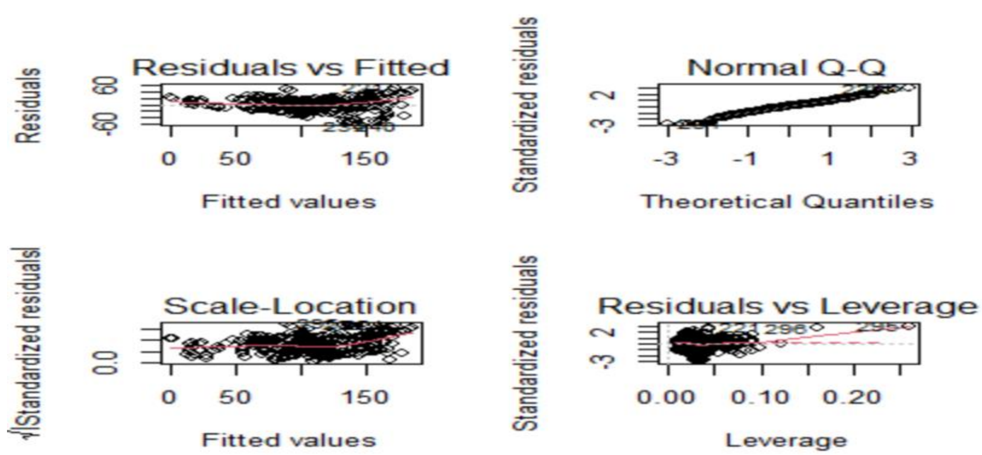


Figure 3.8: Diagnostic test for Model 3.3.



http://dx.doi.org/10.29322/IJSRP.12.12.2022.p13208

Figure 3.9: Diagnostic test for Model 3.4.

4 Presentations of Empirical Results

This study focuses on West Africa countries. We utilized the cross-section of 16 West Africa countries for the period of 2000-2019. The study utilized the mixed-effect regression model for life expectancy and neonatal and under-five mortality rate. In addition, the Akaikes information criterion (AIC) and Bayesian information criterion (BIC) are used for model selection.

Model One

Table 4.1 shows the GLM result from Model 3.2. It has F-value of 735.6 with probability value of less than 0.05. Hence the overall impact of the covariates on life expectancy is statistically significant. The R-squared is 0.985506. This indicates that about 98% of the systematic variations in life expectancy is explained by the covariates. We can conclude that the model has a good fit. The coefficient estimates from Model 3.2 is presented in Tables 4.1-4.2 and Appendix A.1. The model explains the impact of certain hypothesized variables on life expectancy. We choose the random-effect model with autoregressive structure because the AIC, AICC, and BIC are smallest, so it explains the model better. The residual variance is 0.04477. From the model, the domestic government expenditure per capital and the external health expenditure per capita are statistically insignificant. This implies that they do not significantly have effect on life expectancy. The domestic private health expenditure per capita with coefficient of 1.4269 is statistically significant at 5% level. This suggests that a unit increase in domestic private health expenditure per capita will result in increase in life expectancy by 1.4269. Carbon-dioxide metric per capita is statistically insignificant, so it has no impact on life expectancy. HIV with coefficient of -0.02826 is statistically significant. This indicates that a unit increase in HIV will decrease life expectancy by -0.02826. GDP per capita is statistically insignificant, so it does not significantly impact life expectancy. Unemployment and tuberculosis are statistically insignificant; so they do not affect life expectancy. Fertility rate with a coefficient of 0.1236 is statistically significant at 5 % level. This indicates that a unit increase in fertility rate will result to 0.1236 increase in life expectancy. Carbon-dioxide emission from gas and fuel is statistically insignificant. Malaria with a coefficient of -0.00028 is statistically significant at 5% level. This indicates that a unit increase in malaria will decrease life expectancy by -0.00028. The year-specific effect is statistically insignificant.

Table 4.1: GLM Regression Result

The GLM Procedure

Dependent Variable: LE

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	27	11559.38935	428.12553	735.36	<.0001
Error	292	170.00252	0.58220		
Corrected Total	319	11729.39186			

R-Square	Coeff Var	Root MSE	LE Mean
0.985506	1.325439	0.763021	57.56737

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	61.05750382	B	2.52604742	24.17	<.0001
DGEPC	6.18369544		9.72195466	0.64	0.5252
DPHEPC	-13.00196003		6.12758863	-2.12	0.0347
EHEPC	31.86129286		5.44723050	5.85	<.0001
CO2	-7.17642216		0.75524963	-9.50	<.0001
HIV	0.53636306		0.13667114	3.92	0.0001
GDPC	-0.00012862		0.00014435	-0.89	0.3736
UN	-0.02006031		0.04211134	-0.48	0.6342
TUB	0.00430732		0.00218851	1.97	0.0500
FR	-2.27225252		0.40494849	-5.61	<.0001
CO2K	-0.01517829		0.00871736	-1.74	0.0827
MAL	0.00237490		0.00098989	2.40	0.0171
index	0.46869593		0.02968565	15.79	<.0001
COUNTRY Benin	7.44138769	B	0.52853940	14.08	<.0001
COUNTRY Burkina Faso	3.38406758	B	0.60123421	5.63	<.0001
COUNTRY Cabo verde	17.77053802	B	1.36012749	13.07	<.0001
COUNTRY Ghana	6.15359709	B	0.53583587	11.48	<.0001
COUNTRY Guinea	2.54719564	B	0.44935242	5.67	<.0001
COUNTRY Guinea Bissau	-1.45691450	B	0.61396282	-2.37	0.0183
COUNTRY Liberia	3.36101648	B	0.50499281	6.66	<.0001
COUNTRY Mali	3.50455670	B	0.74289015	4.72	<.0001
COUNTRY Mauritania	12.31099241	B	0.64316114	19.14	<.0001
COUNTRY Niger	7.18615426	B	1.05836814	6.79	<.0001
COUNTRY Nigeria	1.31024437	B	0.47461174	2.76	0.0061
COUNTRY Senegal	12.69099162	B	0.58883423	21.55	<.0001
COUNTRY Sierra leone	-7.30702605	B	0.63835335	-11.45	<.0001
COUNTRY The Gambia	5.41598100	B	0.56578552	9.57	<.0001
COUNTRY Togo	3.25779370	B	0.54355466	5.99	<.0001
COUNTRY cote d'ivoire	0.00000000	B	.	.	.

Source: Author's estimation

Table 4.2: Random-Effect Regression Results

Covariance Parameter Estimates		
Cov Parm	Subject	Estimate
AR(1)	COUNTRY	0.9719
Residual		0.04477

Fit Statistics	
-2 Res Log Likelihood	-830.7
AIC (Smaller is Better)	-826.7
AICC (Smaller is Better)	-826.6
BIC (Smaller is Better)	-825.1

Null Model Likelihood Ratio Test		
DF	Chi-Square	Pr > ChiSq

Null Model Likelihood Ratio Test		
DF	Chi-Square	Pr > ChiSq
1	637.08	<.0001

Solution for Fixed Effects					
Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	-0.1719	0.3174	15	-0.54	0.5961
DGEPC	-0.03288	0.9682	276	-0.03	0.9729
DPHEPC	1.4269	0.5993	276	2.38	0.0180
EHEPC	-0.07067	0.4668	276	-0.15	0.8798
CO2	-0.1054	0.07561	276	-1.39	0.1646
HIV	-0.02826	0.01320	276	-2.14	0.0332
GDPC	0.000021	0.000015	276	1.41	0.1590
UN	0.004951	0.005814	276	0.85	0.3952
TUB	-0.00045	0.000389	276	-1.15	0.2524
FR	0.1236	0.04936	276	2.50	0.0128
CO2K	0.000875	0.000818	276	1.07	0.2860
MAL	-0.00028	0.000132	276	-2.09	0.0371
index	0.003018	0.004201	276	0.72	0.4731

Source: Author's estimation

Model Two

Table 4.3 shows the GLM result from Model 3.3. The model has F-value of 473.34 with a probability value of less than 0.05. This indicates that the overall impact of the covariates on under-5 mortality rate is statistically significant. The R-squared is 0.977662. This shows that 97.7% of systematic variation in under-5 mortality rate is explained by the covariates. We can conclude that the model has a good fit. The model explains the impact of certain hypothesized variables on neonatal mortality rate. We choose the fixed-effect model because AIC, AICC, and BIC are smallest, so it explains the model better. The result of the fixed-effect model is presented in Table 4.4. The domestic government health expenditure per capita with a coefficient of 86.0403 is statistically significant. However, it does not possess the a priori expectation. Domestic private health expenditure per capita and external health expenditure per capita with coefficients of -35.4925 and -44.8486 respectively indicate that a unit increase in private health expenditure per capita and external health expenditure per capita will result to a decrease in neonatal mortality rate by -35.4925 and -44.8486 respectively.

Carbon-dioxide emission metric ton per capita with coefficient of 7.6078 is statistically significant. This indicates that a unit increase in a carbon-dioxide emission metric ton per capita will increase neonatal mortality rate by 7.6078. HIV and GDP per capita are statistically insignificant. Unemployment and tuberculosis with coefficients of 0.1423 and 0.008310 are statistically significant. This indicates a unit increase in unemployment and tuberculosis will result in neonatal mortality rate by 0.1423 and 0.008310 respectively. Fertility rate, carbon-dioxide emission from gas and fuel, and malaria are statistically insignificant. The year-specific effect is statistically significant.

The country-specific effect is statistically significant except Mali. Cabo Verde with coefficient of -33.4806 has the lowest magnitude of neonatal mortality rate, so we can conclude that Cabo Verde has the least neonatal mortality rate in West Africa. For all countries under study, Benin with coefficient of -5.4629, Burkina Faso with coefficient of -5.8156, Cabo Verde with coefficient of -33.4806, Ghana with coefficient of -12.2070, Guinea with a coefficient of -2.7195, Liberia with a coefficient of -2.9126, Mauritania with coefficient of -5.6770, Niger with coefficient of -5.8371, Nigeria with a coefficient of -2.8068, Senegal with a coefficient of -14.6616, Gambia with a coefficient of -6.7080 and Togo with a coefficient of -8.4254. However, Guinea Bissau with coefficient of 4.9804 and Sierra Leone with coefficient of 3.5247 have lower rate of neonatal mortality than Cote d'Ivoire. From the estimate we can conclude that neonatal mortality rate is significantly decreasing in West Africa.

Table 4.3: GLM Regression Result

The GLM Procedure

Dependent Variable: NMR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	27	20517.20150	759.89635	473.34	<.0001
Error	292	468.77697	1.60540		
Corrected Total	319	20985.97847			

R-Square	Coeff Var	Root MSE	NMR Mean
0.977662	3.701324	1.267044	34.23219

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	44.47544943	B	4.19466186	10.60	<.0001
DGEPC	86.04025790		16.14392199	5.33	<.0001
DPHEPC	-35.49246506		10.17524934	-3.49	0.0006
EHEPC	-44.84856647		9.04547155	-4.96	<.0001
CO2	7.60779593		1.25413989	6.07	<.0001
HIV	-0.42858016		0.22695108	-1.89	0.0600
GDPC	-0.00011692		0.00023971	-0.49	0.6261
UN	0.14233271		0.06992855	2.04	0.0427
TUB	0.00830951		0.00363416	2.29	0.0229
FR	0.03861344		0.67244263	0.06	0.9542
CO2K	-0.02283528		0.01447573	-1.58	0.1158
MAL	-0.00191772		0.00164378	-1.17	0.2443
index	-0.79381893		0.04929491	-16.10	<.0001
COUNTRY Benin	-5.46287889	B	0.87767318	-6.22	<.0001
COUNTRY Burkina Faso	-5.81557524	B	0.99838751	-5.82	<.0001
COUNTRY Cabo verde	-33.48063617	B	2.25857791	-14.82	<.0001
COUNTRY Ghana	-12.20696587	B	0.88978942	-13.72	<.0001
COUNTRY Guinea	-2.71945599	B	0.74617818	-3.64	0.0003
COUNTRY Guinea Bissau	4.98041846	B	1.01952419	4.89	<.0001
COUNTRY Liberia	-2.91264564	B	0.83857258	-3.47	0.0006
COUNTRY Mali	1.28598992	B	1.23361619	1.04	0.2981
COUNTRY Mauritania	-5.67704008	B	1.06800984	-5.32	<.0001
COUNTRY Niger	-5.83714808	B	1.75748739	-3.32	0.0010
COUNTRY Nigeria	-2.80682015	B	0.78812288	-3.56	0.0004
COUNTRY Senegal	-14.66158079	B	0.97779656	-14.99	<.0001
COUNTRY Sierra leone	3.52470838	B	1.06002620	3.33	0.0010
COUNTRY The Gambia	-6.70798576	B	0.93952272	-7.14	<.0001
COUNTRY Togo	-8.42541441	B	0.90260696	-9.33	<.0001
COUNTRY cote d'ivoire	0.00000000	B	.	.	.

Source: Authors estimation

Table 4.4: Fixed-Effect Regression Result

Dimensions	
Covariance Parameters	1
Columns in X	29
Columns in Z	0
Subjects	1
Max Obs per Subject	320

Number of Observations	
Number of Observations Read	320
Number of Observations Used	320
Number of Observations Not Used	0

Covariance Parameter Estimates	
Cov Parm	Estimate
Residual	1.6054

Fit Statistics	
-2 Res Log Likelihood	1073.8
AIC (Smaller is Better)	1075.8
AICC (Smaller is Better)	1075.8
BIC (Smaller is Better)	1079.5

Solution for Fixed Effects

Effect	COUNTRY	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		44.4754	4.1947	292	10.60	<.0001
DGEPC		86.0403	16.1439	292	5.33	<.0001
DPHEPC		-35.4925	10.1752	292	-3.49	0.0006
EHEPC		-44.8486	9.0455	292	-4.96	<.0001
CO2		7.6078	1.2541	292	6.07	<.0001
HIV		-0.4286	0.2270	292	-1.89	0.0600
GDPC		-0.00012	0.000240	292	-0.49	0.6261
UN		0.1423	0.06993	292	2.04	0.0427
TUB		0.008310	0.003634	292	2.29	0.0229
FR		0.03861	0.6724	292	0.06	0.9542
CO2K		-0.02284	0.01448	292	-1.58	0.1158
MAL		-0.00192	0.001644	292	-1.17	0.2443
index		-0.7938	0.04929	292	-16.10	<.0001
COUNTRY	Benin	-5.4629	0.8777	292	-6.22	<.0001
COUNTRY	Burkina Faso	-5.8156	0.9984	292	-5.82	<.0001
COUNTRY	Cabo verde	-33.4806	2.2586	292	-14.82	<.0001
COUNTRY	Ghana	-12.2070	0.8898	292	-13.72	<.0001
COUNTRY	Guinea	-2.7195	0.7462	292	-3.64	0.0003

Solution for Fixed Effects

Effect	COUNTRY	Estimate	Standard Error	DF	t Value	Pr > |t|
COUNTRY	Guinea Bissau	4.9804	1.0195	292	4.89	<.0001
COUNTRY	Liberia	-2.9126	0.8386	292	-3.47	0.0006
COUNTRY	Mali	1.2860	1.2336	292	1.04	0.2981
COUNTRY	Mauritania	-5.6770	1.0680	292	-5.32	<.0001
COUNTRY	Niger	-5.8371	1.7575	292	-3.32	0.0010
COUNTRY	Nigeria	-2.8068	0.7881	292	-3.56	0.0004
COUNTRY	Senegal	-14.6616	0.9778	292	-14.99	<.0001
COUNTRY	Sierra leone	3.5247	1.0600	292	3.33	0.0010
COUNTRY	The Gambia	-6.7080	0.9395	292	-7.14	<.0001
COUNTRY	Togo	-8.4254	0.9026	292	-9.33	<.0001
COUNTRY	cote d'ivoire	0	.	.	.	.

Source: Author's estimation

Model Three

Table 4.5 below shows the result from the GLM from Model 3.4. It has F-value of 220.70 with a probability value of less than 0.05. This indicates that the overall impact of the covariates on the under-5 mortality rate is significant. The R-squared is 0.953287. This indicates that about 95. 3% of systematic variation of under-5 mortality rate is explained by the covariates. We can conclude that the model has a good fit. We choose the fixed-effect model because the AIC, AICC, and the BIC are smallest, so it explains the model better. The result from the fixed-effect model is presented in Table 4.6. From the model, domestic government health expenditure per capita is statistically insignificant; thus, it does not significantly impact under-5 mortality rates. The domestic private health expenditure and the external health expenditure per capita with coefficients of -158.65 and -275.75 respectively have the expected signs and are statistically significant at 5% level. This indicates a unit increase in domestic private health expenditure per capita and external health expenditure will decrease under-5 mortality rates by -158.65 and -275.75 respectively. Carbon-dioxide emissions metric ton per capita with a coefficient of 72.1525 is statistically significant. This indicates a unit increase in carbon-dioxide emission metric ton per capita will lead to 72.1525 increase in under-5 mortality rates. HIV with coefficient of -5.7355 is statistically significant; however; it does not possess the a priori expectation. GDP per capita, unemployment, tuberculosis, fertility rate, and carbon-dioxide emission from gas and fuel are statistically insignificant; thus, they have no impact on under-5 mortality rates. Malaria with coefficient of -0.02566 is statistically significant; however, it does possess the a priori expectation. The year-specific effect is statistically significant.

The country-specific effect with reference to Cote d'Ivoire is statistically significant except Niger and Nigeria. Cabo Verde with coefficient of -138.7, Benin with coefficient of -16.3853, Ghana with a coefficient of -51.7583, Mauritania with a coefficient of -54.8854, Senegal with coefficient of -69.2872, Gambia with coefficient of -33.0701, and Togo with coefficient of -19.5787 performs better than Cote d'Ivoire on under-5 mortality rates. The result shows that Cabo Verde has the least under-5 mortality rates in West Africa. This supports the line plot in Figure 3.2. Burkina Faso with coefficient of 22.3177, Guinea with coefficient of 17.0202, Guinea Bissau with coefficient of 21.1071, Liberia with coefficient of 14.8177, Mali with a coefficient of 21.7404 and Sierra Leone with coefficient of 82.8554 perform well less than Cote Ivoire.

Table 4.5: GLM Regression Result

The GLM Procedure

Dependent Variable: UMR

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	27	533323.8645	19752.7357	220.70	<.0001
Error	292	26133.7503	89.4991		
Corrected Total	319	559457.6147			

R-Square	Coeff Var	Root MSE	UMR Mean
0.953287	8.747151	9.460399	108.1541

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	135.5505104	B	31.3194908	4.33	<.0001
DGEPC	209.8686141		120.5387781	1.74	0.0827
DPHEPC	-158.6452173		75.9736155	-2.09	0.0376
EHEPC	-275.7493404		67.5381167	-4.08	<.0001
CO2	72.1524908		9.3640498	7.71	<.0001
HIV	-5.7354738		1.6945329	-3.38	0.0008
GDPC	-0.0016782		0.0017898	-0.94	0.3492
UN	0.3879775		0.5221223	0.74	0.4580
TUB	-0.0031946		0.0271345	-0.12	0.9064
FR	4.2986602		5.0208006	0.86	0.3926
CO2K	-0.0518649		0.1080832	-0.48	0.6317
MAL	-0.0256649		0.0122733	-2.09	0.0374
index	-4.7984310		0.3680610	-13.04	<.0001
COUNTRY Benin	-16.3853055	B	6.5531568	-2.50	0.0130
COUNTRY Burkina Faso	22.3178727	B	7.4544718	2.99	0.0030
COUNTRY Cabo verde	-138.3677790	B	16.8636978	-8.21	<.0001
COUNTRY Ghana	-51.7582796	B	6.6436229	-7.79	<.0001
COUNTRY Guinea	17.0202449	B	5.5713479	3.05	0.0025
COUNTRY Guinea Bissau	21.1071155	B	7.6122890	2.77	0.0059
COUNTRY Liberia	14.8177387	B	6.2612117	2.37	0.0186
COUNTRY Mali	21.7404020	B	9.2108094	2.36	0.0189
COUNTRY Mauritania	-54.8854471	B	7.9743077	-6.88	<.0001
COUNTRY Niger	25.4222784	B	13.1222997	1.94	0.0537
COUNTRY Nigeria	3.6169637	B	5.8845285	0.61	0.5393
COUNTRY Senegal	-69.2871835	B	7.3007292	-9.49	<.0001
COUNTRY Sierra leone	82.8553577	B	7.9146977	10.47	<.0001
COUNTRY The Gambia	-33.0701222	B	7.0149571	-4.71	<.0001
COUNTRY Togo	-19.5786792	B	6.7393252	-2.91	0.0040
COUNTRY cote d'ivoire	0.0000000	B	.	.	.

Source: Author's estimation

Table 4.6: Fixed-Effect Regression Result

Dimensions	
Covariance Parameters	1
Columns in X	29
Columns in Z	0
Subjects	1
Max Obs per Subject	320

Number of Observations	
Number of Observations Read	320
Number of Observations Used	320
Number of Observations Not Used	0

Covariance Parameter Estimates	
Cov Parm	Estimate
Residual	89.4991

Fit Statistics	
-2 Res Log Likelihood	2247.9
AIC (Smaller is Better)	2249.9
AICC (Smaller is Better)	2249.9
BIC (Smaller is Better)	2253.6

Solution for Fixed Effects						
Effect	COUNTRY	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		135.55	31.3195	292	4.33	<.0001
DGEPC		209.87	120.54	292	1.74	0.0827
DPHEPC		-158.65	75.9736	292	-2.09	0.0376
EHEPC		-275.75	67.5381	292	-4.08	<.0001
CO2		72.1525	9.3640	292	7.71	<.0001
HIV		-5.7355	1.6945	292	-3.38	0.0008
GDPC		-0.00168	0.001790	292	-0.94	0.3492
UN		0.3880	0.5221	292	0.74	0.4580
TUB		-0.00319	0.02713	292	-0.12	0.9064
FR		4.2987	5.0208	292	0.86	0.3926
CO2K		-0.05186	0.1081	292	-0.48	0.6317
MAL		-0.02566	0.01227	292	-2.09	0.0374
index		-4.7984	0.3681	292	-13.04	<.0001
COUNTRY	Benin	-16.3853	6.5532	292	-2.50	0.0130
COUNTRY	Burkina Faso	22.3179	7.4545	292	2.99	0.0030
COUNTRY	Cabo verde	-138.37	16.8637	292	-8.21	<.0001
COUNTRY	Ghana	-51.7583	6.6436	292	-7.79	<.0001
COUNTRY	Guinea	17.0202	5.5713	292	3.05	0.0025

Solution for Fixed Effects						
Effect	COUNTRY	Estimate	Standard Error	DF	t Value	Pr > |t|
COUNTRY	Guinea Bissau	21.1071	7.6123	292	2.77	0.0059
COUNTRY	Liberia	14.8177	6.2612	292	2.37	0.0186
COUNTRY	Mali	21.7404	9.2108	292	2.36	0.0189
COUNTRY	Mauritania	-54.8854	7.9743	292	-6.88	<.0001
COUNTRY	Niger	25.4223	13.1223	292	1.94	0.0537
COUNTRY	Nigeria	3.6170	5.8845	292	0.61	0.5393
COUNTRY	Senegal	-69.2872	7.3007	292	-9.49	<.0001
COUNTRY	Sierra leone	82.8554	7.9147	292	10.47	<.0001
COUNTRY	The Gambia	-33.0701	7.0150	292	-4.71	<.0001
COUNTRY	Togo	-19.5787	6.7393	292	-2.91	0.0040
COUNTRY	cote d'ivoire	0	.	.	.	.

Source: Author's estimation

4.1 Discussion of Results

Many people have advocated for higher health care expenditure but very few empirical works have been carried out to determine the impact on health outcomes (Anyanwu and Erhiajakpor, 2007). This research provides empirical support for the advocacy for the increase in health care expenditure in West Africa region. The result shows that domestic government health expenditure per capita has a insignificant impact on life expectancy and under-5 mortality rate. However, it significantly impacts neonatal mortality rate but does not possess the expected sign. This could be attributable to the state of poor management of resources and administrative bottlenecks in West Africa. Health care resources and budgets may not be properly deployed judiciously. The domestic private health expenditure per capita has significant impact on life expectancy, neonatal mortality rate, and under-5 mortality rates. This conforms to the findings of Bein et al. (2017), Anyanwu and Erhiajakpor (2007), Arthur and Oaikhenan (2017). The health resources from private donors, out-of-pocket health expenditure, and stakeholders' contribution are properly utilized. The external health expenditure per capita has no significant impact on life expectancy. However, it has significant impacts on neonatal mortality rate and under-5 mortality rate. These findings are consistent with the finds of Anyanwu and Erhiajakpor (2007) and Arthur and Oaikhenan (2017). Carbon-dioxide emission does not significantly impact life expectancy. It however significantly affects neonatal and under-5 mortality rate. This suggests that carbon- dioxide emission metric ton per capita is sensitive to age. Children's health is essentially vulnerable to environmental health condition. This is consistent with the finding of Glinianaia et al. (2004). GDP per capita has no significant impact on life expectancy, neonatal, and under-5 mortality rates. This conforms to the findings of Anand and Ravallion (1993). The authors argued that social outcomes such as health status can be enhanced through the reduction in income poverty; hence, per capita income growth alone does not matter in reducing mortality rate. This further suggests that GDP per capita does not directly affect health outcomes. It could affect health outcome through other forms of channels.

Unemployment does not significantly impact life expectancy and under-5 mortality rates; however, it affects neonatal mortality rate. Tuberculosis significantly impacts neonatal mortality rate. It does not significantly affect life expectancy and under-5 mortality rates. This is attributed to much health resources channeled to curbing the devastating effect of tuberculosis in West Africa. Fertility rate significantly affects life expectancy but does not significantly affect under-5 and neonatal mortality rates. This suggests that the number of children which a woman bears in West Africa affects the life expectancy. Carbon-dioxide emission from gas and fuel has no significant impact on life expectancy, neonatal mortality rate, and under-5 mortality rates. Malaria significantly impacts life expectancy and under-5 mortality rates. However, it does not affect neonatal mortality rates.

For country-specific effect, the results reveal that Cabo Verde has best performance in health outcomes. This suggests that Cabo Verde government and health stakeholders are efficient in the management of health care resources. This finding is also supported with the line plots.

5 Summary and Recommendations

This research investigates the impact of health expenditures on health outcomes in West Africa region. The health care expenditures examined in this study include domestic government health expenditure per capita, private health expenditure per capita, and external health care expenditure per capita. After controlling for other factors that affect health outcomes such as HIV, tuberculosis, unemployment, carbon-dioxide emission, immunization, GDP per capita, and malaria, the results revealed the importance of health expenditure on health outcomes. Hence it is recommended that government and stakeholders in the health sector in West Africa region make conscious efforts to allocate more resources to the health sector to improve health outcomes. There should be conscious efforts to improve accessibility of health care facilities both in the rural and urban areas of the countries. Increase in health care expenditures will help build primary health care centers for those in the rural areas who may not be able to access the secondary and tertiary care in the urban centers. Building and improving secondary and tertiary health care centers cannot be overemphasized. Proper funding of the health care sector will help in the training and retraining of medical personnel and the provision of vaccines and other forms of medications. The introduction of health insurance to help improve the effectiveness of the private health assessment will be of very paramount importance. The West Africa region should make conscious efforts to reduce the prevalence of HIV cases and incidence of malaria in the region through proper sex education and provision of clean and potable water and educate the citizens on the importance of living in a clean environment that will not give room for the breeding of mosquitoes.

Conflict of interest: The project was solely authored and funded by the Author.

Data availability :The Data used in this research work was obtained from the World Development indicator and the prepared data can be obtained from my GitHub account: https://github.com/efosa24/efosa24

REFERENCES

Anand S, & Ravallion M (1993) "Human Development in Poor Countries: On the Role of Private Incomes and Public Services". *The Journal of Economic Perspectives,* 7(1): 133-150.http://dx.doi.org/10.1257/jep.7.1.133.

Answar S. and Ali M. (2012). "Evaluation of the contribution of public Health Expenditure on Parkistan: A Time Series Analysis". *The Empirical Economic letters*, 11910) ISSN 16818997.

Anyanwu C. John and Erhijakpor A.E (2007) "Health Expenditures and Health Outcomes in Africa". *Africa Development Bank Economic Research Working paper series*.

Arthur E. and Oaikhenan H.E. (2017) "The Effect of Health Expenditure on Health Outcome in Sub-Sahara Africa". *Africa Development Review*, Vol.29, No 3, 524-536.

Asare et al. (2021). "Health and well-being of rotation workers in the mining, offshore oil and gas, and construction industry: a systematic review" *BMJ Global Health*, 6:e005112. doi:10.1136/ bmjgh-2021-005112

Barlow R. & Vissandjée B. (1999) "Determinants of National Life Expectancy" Canadian Journal of Development Studies / Revue canadienne d'études du développement, 20:1, 9-29.

Bein et al (2017) "Health Care Spending and Health Care Outcomes: Evidence from Selected East Africa Countries". *Africa Health Science* Vol. 17 issue 1.

Fiyissa B. and Gutema P. (2005) "Estimating Health Production Function for Sub-Sahara Africa (SSA)". *Article in Applied Economics*.

Boachie et al. (2016) "Effect of Public Health Expenditure on Health Status in Ghana", International Journal of Health. 4(1) pp. 6-11.

Boussalem F. and Taiba A. (2014) "The relationship between public spending on health and economic growth in Algeria: Testing for cointegration and Causality*". International Journal of Business and Management,* Vol. II (3).

Crémieux P-Y, Ouellette P, & Pilon C (1999)" Health Care Spending as Determinants of Health Outcomes". *Health Economics*, 8(7):627-639. http://dx.doi.org/10.1002/(SICI)1099- 1050(199911) 8:73.0.CO;2-8.

Deshpande et al. (2014). "The Effect of National Health Expenditure on Life Expectancy", *Georgia Institute of Technology*.

Devdatta et al. (2019) "Health expenditure, longevity, and child mortality, dynamic panel data approach with global data", *Int J Health Economics Management*. (2020) 20:99–119https://doi.org/10.1007/s10754-019-09272-z.

Glinianaia et al. (2004) " Does particulate Air pollution Contribute to Infant Death? *A Systematic Review. Health Review.*

Grossman, M. (1972) "On the Concept of Health Capital and the Demand for Health", *Journal of Political Economy*, 80, 223-255.

Hitiris, T. and Posnett, J. (1992). "The Determinants and Effects of Health Expenditure in Developed Countries", *Journal of Health Economics*, 1, 173-181. http://dx.doi.org/10.1016/0167-6296(92)90033-W.

Jacqueline et al. (2018). "The effect of Health care expenditures as a percentage of GDP on life expectancies", *Research in Applied Economics*.

Kiros et al. (2020). "The effects of Health expenditure on infant mortality in Sub-Saharan Africa: evidence from panel data analyses", *Health Economics Review*.

Lichtenberg, F. (2000). Sources of U.S. longevity increase, 1960–1997. CES-info wp-405.

Nixon J , & Ulmann P (200 6) "The Relationship between Health Care Expenditure and Health Outcomes: Evidence and Caveats for a Causal Link*", European Journal of Health Economics*, 7(1):7 -18. http://dx.doi.org/10.1007/s1019 8 -005 -0336 - 8.

OECD (2021), Life expectancy at birth (indicator). doi: 10.1787/27e0fc9d-en

Onofrei et al. (2021). "Government Health Expenditure and Public Health Outcomes: A Comparative Study Among EU Developing Countries", *International Journal of Environmental Research and Public Health.*

Sango-Coker E. and Bein M. A. (2018) "The impact of Health Care Spending on Life Expectancy: Evidence from Selected West Africa Countries'. *Africa Journal of Reproductive Health.*

Urhoghide, R.O. and Emeni, F.K. (2014). Corporate governance and audit fee determination in Nigeria, *ESUT Journal of accountancy*, Vol.5 No.2.

WHO (2020). World health statistics 2020. Geneve: WHO.

Xu K, Saksena P. and Holly A. (2011) "Determinants of Health expenditure: A Country Level Panel Data Analysis" *World Health Organization Working Paper*.

Appendix

A.1 Fixed Effect Model Result for Model 3.2

Class Level Information		
Class	Levels	Values
COUNTRY	16	Benin Burkina Faso Cabo verde Ghana Guinea Guinea Bissau Liberia Mali Mauritania Niger Nigeria Senegal Sierra leone The Gambia Togo cote d'ivoire

Dimensions	
Covariance Parameters	1
Columns in X	29
Columns in Z	0
Subjects	1
Max Obs per Subject	320

Number of Observations	
Number of Observations Read	320
Number of Observations Used	320
Number of Observations Not Used	0

Covariance Parameter Estimates	
Cov Parm	Estimate
Residual	0.5822

Fit Statistics	
-2 Res Log Likelihood	777.7
AIC (Smaller is Better)	779.7
AICC (Smaller is Better)	779.7
BIC (Smaller is Better)	783.3

Solution for Fixed Effects						
Effect	COUNTRY	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		61.0575	2.5260	292	24.17	<.0001
DGEPC		6.1837	9.7220	292	0.64	0.5252
DPHEPC		-13.0020	6.1276	292	-2.12	0.0347
EHEPC		31.8613	5.4472	292	5.85	<.0001
CO2		-7.1764	0.7552	292	-9.50	<.0001
HIV		0.5364	0.1367	292	3.92	0.0001
GDPC		-0.00013	0.000144	292	-0.89	0.3736
UN		-0.02006	0.04211	292	-0.48	0.6342
TUB		0.004307	0.002189	292	1.97	0.0500
FR		-2.2723	0.4049	292	-5.61	<.0001
CO2K		-0.01518	0.008717	292	-1.74	0.0827
MAL		0.002375	0.000990	292	2.40	0.0171
index		0.4687	0.02969	292	15.79	<.0001
COUNTRY	Benin	7.4414	0.5285	292	14.08	<.0001
COUNTRY	Burkina Faso	3.3841	0.6012	292	5.63	<.0001
COUNTRY	Cabo verde	17.7705	1.3601	292	13.07	<.0001
COUNTRY	Ghana	6.1536	0.5358	292	11.48	<.0001
COUNTRY	Guinea	2.5472	0.4494	292	5.67	<.0001
COUNTRY	Guinea Bissau	-1.4569	0.6140	292	-2.37	0.0183
COUNTRY	Liberia	3.3610	0.5050	292	6.66	<.0001
COUNTRY	Mali	3.5046	0.7429	292	4.72	<.0001
COUNTRY	Mauritania	12.3110	0.6432	292	19.14	<.0001
COUNTRY	Niger	7.1862	1.0584	292	6.79	<.0001
COUNTRY	Nigeria	1.3102	0.4746	292	2.76	0.0061
COUNTRY	Senegal	12.6910	0.5888	292	21.55	<.0001
COUNTRY	Sierra leone	-7.3070	0.6384	292	-11.45	<.0001
COUNTRY	The Gambia	5.4160	0.5658	292	9.57	<.0001
COUNTRY	Togo	3.2578	0.5436	292	5.99	<.0001
COUNTRY	cote d'ivoire	0	.	.	.	.

A.2 Random Effect Model Result for Model 3.3

Covariance Parameter Estimates	
Cov Parm	Estimate
COUNTRY	70.4895
Residual	1.6104

Fit Statistics	
-2 Res Log Likelihood	1184.1
AIC (Smaller is Better)	1188.1
AICC (Smaller is Better)	1188.1
BIC (Smaller is Better)	1189.6

Solution for Fixed Effects

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	34.7413	4.5588	15	7.62	<.0001
DGEPC	85.5156	16.1504	292	5.29	<.0001
DPHEPC	-33.3339	10.1517	292	-3.28	0.0011
EHEPC	-41.6904	8.9753	292	-4.65	<.0001
CO2	7.3229	1.2502	292	5.86	<.0001
HIV	-0.4284	0.2268	292	-1.89	0.0599
GDPC	-0.00017	0.000239	292	-0.71	0.4753
UN	0.1211	0.06955	292	1.74	0.0827
TUB	0.009786	0.003603	292	2.72	0.0070
FR	0.6095	0.6419	292	0.95	0.3432
CO2K	-0.02419	0.01446	292	-1.67	0.0954
MAL	-0.00136	0.001633	292	-0.83	0.4047
index	-0.7483	0.04715	292	-15.87	<.0001

A.3 Random Effect model Result for model 3.4

Covariance Parameter Estimates	
Cov Parm	Estimate
COUNTRY	1912.99
Residual	90.1765

Fit Statistics	
-2 Res Log Likelihood	2409.2
AIC (Smaller is Better)	2413.2
AICC (Smaller is Better)	2413.2
BIC (Smaller is Better)	2414.7

Solution for Fixed Effects

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	83.9268	31.0178	15	2.71	0.0163
DGEPC	210.12	120.71	292	1.74	0.0828
DPHEPC	-125.69	75.6851	292	-1.66	0.0979
EHEPC	-240.73	66.6150	292	-3.61	0.0004
CO2	68.4321	9.3122	292	7.35	<.0001
HIV	-5.6778	1.6931	292	-3.35	0.0009
GDPC	-0.00224	0.001781	292	-1.26	0.2089
UN	0.1120	0.5170	292	0.22	0.8286
TUB	0.01153	0.02668	292	0.43	0.6659
FR	10.5769	4.5931	292	2.30	0.0220
CO2K	-0.07333	0.1079	292	-0.68	0.4973
MAL	-0.01820	0.01213	292	-1.50	0.1347
index	-4.2828	0.3381	292	-12.67	<.0001

Conflict of interest: There is no conflict of interest in this manuscript. The project was solely funded by the Author.

The Data used in this research work was obtained from the World Development indicator and the prepared data can be obtained from my Github account: https://github.com/efosa24/efosa24