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

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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 insignificant; 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.
NORTHERN ILLINOIS UNIVERSITY
DEKALB ILLINOIS
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THE ROLE OF HEALTH EXPENDITURE ON HEALTH OUTCOMES: EVIDENCE FROM WEST AFRICA COUNTRIES

BY

FESTUS EFOSA ERIAMIATOE
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A THESIS SUBMITTED TO THE GRADUATE SCHOOL IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE MASTER OF SCIENCE

DEPARTMENT OF STATISTICS AND ACTUARIAL SCIENCE

Thesis Director:
Michelle Xia
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CHAPTER ONE

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 Thesis

This thesis 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.
2.1 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.

Anyawu 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-Saharan 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:

\[ H = f(X) \]  \hspace{1cm} (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).

\[ H = F(Y, S, V, D) \]  \hspace{1cm} (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, v_2, \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.
3.1 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

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

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.
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 3.2  Descriptive Statistics**

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Sum</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>LE</td>
<td>320</td>
<td>57.56</td>
<td>6.064</td>
<td>1842</td>
<td>39.44</td>
<td>72.98</td>
</tr>
<tr>
<td>NMR</td>
<td>320</td>
<td>34.23</td>
<td>8.119</td>
<td>10954</td>
<td>9.0000</td>
<td>54.70</td>
</tr>
<tr>
<td>UMR</td>
<td>320</td>
<td>108.15</td>
<td>41.87</td>
<td>34609</td>
<td>14.90</td>
<td>227.70</td>
</tr>
<tr>
<td>DGEPC</td>
<td>320</td>
<td>0.0132</td>
<td>0.00807</td>
<td>4.0179</td>
<td>0.00241</td>
<td>0.03794</td>
</tr>
<tr>
<td>DPHEPC</td>
<td>320</td>
<td>0.0295</td>
<td>0.01844</td>
<td>9.4604</td>
<td>0.00806</td>
<td>0.12799</td>
</tr>
<tr>
<td>EHEPC</td>
<td>320</td>
<td>0.0110</td>
<td>0.01318</td>
<td>3.5216</td>
<td>0.000677</td>
<td>0.10453</td>
</tr>
<tr>
<td>CC2</td>
<td>320</td>
<td>0.3506</td>
<td>0.24570</td>
<td>112.21</td>
<td>0.05303</td>
<td>1.14261</td>
</tr>
<tr>
<td>HIV</td>
<td>320</td>
<td>0.9371</td>
<td>0.74733</td>
<td>299.90</td>
<td>0.05000</td>
<td>3.85000</td>
</tr>
<tr>
<td>GDPC</td>
<td>320</td>
<td>105.2</td>
<td>717.719</td>
<td>33674</td>
<td>222.82</td>
<td>3836</td>
</tr>
<tr>
<td>UN</td>
<td>320</td>
<td>5.3989</td>
<td>3.12179</td>
<td>1728</td>
<td>0.3200</td>
<td>12.2400</td>
</tr>
<tr>
<td>TUB</td>
<td>320</td>
<td>167.56</td>
<td>94.44325</td>
<td>53618</td>
<td>37.0000</td>
<td>367.0000</td>
</tr>
<tr>
<td>FR</td>
<td>320</td>
<td>5.2707</td>
<td>1.03260</td>
<td>1687</td>
<td>2.2420</td>
<td>7.6790</td>
</tr>
<tr>
<td>C02K</td>
<td>320</td>
<td>4.0478</td>
<td>11.62397</td>
<td>1295</td>
<td>0</td>
<td>57.4349</td>
</tr>
<tr>
<td>MAL</td>
<td>320</td>
<td>311.24</td>
<td>157.372</td>
<td>99599</td>
<td>0.00761</td>
<td>589.3257</td>
</tr>
<tr>
<td>YEARS</td>
<td>320</td>
<td>2010</td>
<td>5.77531</td>
<td>643040</td>
<td>2000</td>
<td>2019</td>
</tr>
</tbody>
</table>

**Source:** Author’s computation
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.
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.

\[
Y_{it} = X_{it}'\beta_i + Z_i\delta + \varepsilon_{it}
\]  

\[
\varepsilon \sim N(0, \delta^2 I)
\]
where $Y_{it}$ is the vector of the dependent variable and $X'_{it}$ is the vector of the covariates, $\beta_i$ is the vector of the coefficients of the covariates, $Z_i$ is the design matrix for random effects which include intercept, $\delta_i$ is the vector of subject specific and $\varepsilon_{it}$ 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:

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

The model for neonatal mortality rate is developed as follows:

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

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

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

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 Akaike's 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.

**Figure 3.9:** Diagnostic test for Model 3.4.
CHAPTER FOUR

PRESENTATION 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 capita 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

![Table 4.1: GLM Regression Result]

(Continued on following page)
Table 4.1 (continued)

| Parameter         | Estimate   | Standard Error | t Value | Pr > |t| |
|-------------------|------------|----------------|---------|------|---|
| Intercept         | 61.05750382 | 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                | -0.0206031   | 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   | 0.52853940     | 14.08   | <.0001 |   |
| COUNTRY Burkina Faso | 3.38406758 | 0.60123421     | 5.63    | <.0001 |   |
| COUNTRY Cabo verde | 17.77053802 | 1.36012749     | 13.07   | <.0001 |   |
| COUNTRY Ghana     | 6.15359709   | 0.53583567     | 11.48   | <.0001 |   |
| COUNTRY Guinea    | 2.54719564   | 0.44935242     | 5.67    | <.0001 |   |
| COUNTRY Guinea Bissau | -1.45691450    | 0.61396282    | -2.37   | 0.0183 |   |
| COUNTRY Liberia   | 3.36161648   | 0.50499281     | 6.66    | <.0001 |   |
| COUNTRY Mali      | 3.50455670   | 0.74289015     | 4.72    | <.0001 |   |
| COUNTRY Mauritania| 12.31099241  | 0.64316114     | 19.14   | <.0001 |   |
| COUNTRY Niger     | 7.18615426   | 1.05836814     | 6.79    | <.0001 |   |
| COUNTRY Nigeria   | 1.31024437   | 0.47461174     | 2.76    | 0.0061 |   |
| COUNTRY Senegal   | 12.6909162   | 0.58883423     | 21.55   | <.0001 |   |
| COUNTRY Sierra leone | -7.30702605 | 0.633835335   | -11.45  | <.0001 |   |
| COUNTRY The Gambia| 5.41598100   | 0.56578552     | 9.57    | <.0001 |   |
| COUNTRY Togo      | 3.25779370   | 0.54355466     | 5.99    | <.0001 |   |
| COUNTRY cote d'Ivoire | 0.00000000 | .          | .   | . |   |

Source: Author’s estimation
**Table 4.2:** Random-Effect Regression Results

<table>
<thead>
<tr>
<th>Covariance Parameter Estimates</th>
<th>Cov Parm</th>
<th>Subject</th>
<th>Estimate</th>
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<td>Residual</td>
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<td>0.04477</td>
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<td>AIC (Smaller is Better)</td>
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</tr>
<tr>
<td>AICC (Smaller is Better)</td>
<td>-826.6</td>
<td></td>
</tr>
<tr>
<td>BIC (Smaller is Better)</td>
<td>-825.1</td>
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</tbody>
</table>

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<tr>
<th>Null Model Likelihood Ratio Test</th>
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<table>
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<th>Effect</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>DF</th>
<th>t Value</th>
<th>Pr &gt;</th>
<th>t</th>
<th></th>
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<tbody>
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<td>0.5961</td>
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<td>0.005814</td>
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<td>276</td>
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<td>0.3952</td>
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<td>276</td>
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<td>0.2860</td>
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<td>0.0371</td>
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<td>0.004201</td>
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<td>276</td>
<td>0.72</td>
<td>0.4731</td>
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</table>

**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

(Continued on following page)
Table 4.3 (Continued)

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<tr>
<th>Source</th>
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<th>Mean Square</th>
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<td>Error</td>
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<td>Corrected Total</td>
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Table 4.3 (Continued)

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Source: Authors estimation
**Table 4.4:** Fixed-Effect Regression Result

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Table 4.4 (Continued)

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<td>index</td>
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<td>COUNTRY</td>
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<td>COUNTRY</td>
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<td>0.0003</td>
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</table>

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

(Continued on following page)
Table 4.5 (Continued)

The GLM Procedure
Dependent Variable: UMR

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<th>Source</th>
<th>DF</th>
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<th>Coeff Var</th>
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<tr>
<td>0.953287</td>
<td>8.747151</td>
<td>9.460399</td>
<td>108.1541</td>
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</tbody>
</table>

| 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 9.3604988 | 7.71 | <.0001 |
| HIV              | 5.7354738 1.6945329 | -3.38 | 0.0008 |
| GDPC             | -0.0016782 0.0017898 | -0.94 | 0.3492 |
| UN               | 0.3878776 0.5221223 | 0.74 | 0.4560 |
| TUB              | -0.0031946 0.0271345 | -0.12 | 0.9084 |
| FR               | 4.2986602 5.0208005 | 0.86 | 0.3926 |
| CO2K             | -0.6518649 0.1008032 | -0.48 | 0.6317 |
| MAL              | -0.0266549 0.0122733 | -2.09 | 0.0374 |
| Index            | -4.7984310 0.3880610 | -13.04 | <.0001 |
| COUNTRY Benin    | -16.3853055 6.5531568 | -2.50 | 0.0130 |
| COUNTRY Burkina Faso | 22.3178727 7.4544718 | 2.99 | 0.0030 |
| COUNTRY Cabo verde | -138.367790 16.856978 | -8.21 | <.0001 |
| COUNTRY Ghana    | -51.7582796 6.6436229 | -7.79 | <.0001 |
| COUNTRY Guinea   | 17.6202449 5.5713479 | 3.05 | 0.0025 |
| COUNTRY Guinea Bissau | 21.1071155 7.6122890 | 2.77 | 0.0059 |
| COUNTRY Liberia  | 14.8177387 6.2512117 | 2.37 | 0.0186 |

| Parameter        | Estimate | Standard Error | t Value | Pr > |t| |
|------------------|----------|----------------|---------|------|---|
| COUNTRY Mali     | 21.7404020 B 9.2108094 | 2.36 | 0.0189 |
| COUNTRY Mauritania | -54.8864417 7.9743077 | -6.68 | <.0001 |
| COUNTRY Niger    | 25.4222784 13.1223997 | 1.94 | 0.0537 |
| COUNTRY Nigeria  | 3.6166637 5.8845285 | 0.61 | 0.5393 |
| COUNTRY Senegal  | -69.2871836 7.3097292 | -9.40 | <.0001 |
| COUNTRY Sierra leone | 62.8553577 7.9146977 | 10.47 | <.0001 |
| COUNTRY The Gambia | -33.0701222 7.0149571 | -4.71 | <.0001 |
| COUNTRY Togo     | -19.5786792 6.7393252 | -2.91 | 0.0040 |
| COUNTRY cote d’ivoire | 0.0000000 . . | . . | . . |

Source: Author’s estimation
Table 4.6: Fixed-Effect Regression Result

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<tr>
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**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**

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**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

(Continued on following page)
Table 4.6 (Continued)

| Effect | COUNTRY | Estimate | Standard Error | DF | t Value | Pr > |t| |
|--------|---------|----------|---------------|----|---------|------|------| |
| Intercept |     | 135.55   | 31.3195       | 252 | 4.33    | <0.0001 | |
| DGEPC  |     | 209.87   | 120.54        | 252 | 1.74    | 0.0827 | |
| DPHEPC |     | -158.65  | 75.9736       | 252 | -2.09   | 0.0376 | |
| EHEPC  |     | -275.75  | 67.5381       | 252 | -4.03   | <0.0001 | |
| CO2    |     | 72.1525  | 9.3640        | 252 | 7.71    | <0.0001 | |
| HIV    |     | -5.7355  | 1.6945        | 252 | -3.38   | 0.0008 | |
| GDPC   |     | -0.00168 | 0.001790      | 252 | -0.94   | 0.3492 | |
| UN     |     | 0.3980   | 0.5221        | 252 | 0.74    | 0.4580 | |
| TUB    |     | -0.00319 | 0.02713       | 252 | -0.12   | 0.9064 | |
| FR     |     | 4.2987   | 5.0208        | 252 | 0.85    | 0.3926 | |
| CO2K   |     | -0.05186 | 0.1081        | 252 | -0.48   | 0.6317 | |
| MAL    |     | -0.02566 | 0.01227       | 252 | -2.09   | 0.0374 | |
| index  |     | -4.7984  | 0.3681        | 252 | -13.04  | <0.0001 | |
| COUNTRY Benin |     | -16.3853 | 6.5532        | 252 | -2.50   | 0.0130 | |
| COUNTRY Burkina Faso |     | 22.3179   | 7.4545        | 252 | 2.99    | 0.0030 | |
| COUNTRY Cabo verde |     | -136.37  | 16.8637       | 252 | -8.21   | <0.0001 | |
| COUNTRY Ghana |     | -51.7583 | 6.6436        | 252 | -7.79   | <0.0001 | |
| COUNTRY Guinea |     | 17.0202 | 5.5713        | 252 | 3.05    | 0.0026 | |

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 women 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.
CHAPTER FIVE

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.
REFERENCES


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


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


## APPENDIX

### A.1 Fixed Effect Model Result for Model 3.2

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#### Number of Observations

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<td>Number of Observations Used</td>
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<td>Number of Observations Not Used</td>
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#### Covariance Parameter Estimates

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#### Fit Statistics

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## A.2 Random Effect Model Result for Model 3.3

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**Fit Statistics**

- \(-2 \text{ Res Log Likelihood}\) 1184.1
- \(\text{AIC (Smaller is Better)}\) 1188.1
- \(\text{AICC (Smaller is Better)}\) 1188.1
- \(\text{BIC (Smaller is Better)}\) 1189.6

**Solution for Fixed Effects**

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A.3 Random Effect model Result for model 3.4

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