

Health Care Expenditure, Health Outcome and Economic Growth in Sub-Saharan Africa: A Dynamic Panel Approach

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Abstract

Globally, there has been increase in health expenditure and life expectancy and decrease in mortality rates that has brought about optimism for future progress in economic growth. Although there is relatively enough literature on the mechanism behind these gains in life expectancy and reductions in mortality, studies that focus on health-growth relationships in sub-Saharan African (SSA) countries are few. The few studies that exist do not account for a broader array of health outcomes determinants which may have important health policy implications. We contribute in filling this gap by examining the relationship between healthcare expenditure, health outcomes and economic growth using a panel of 45 sub-Saharan African countries. Employing the dynamic Generalized Method of Moments (GMM) estimator, we focus on the period 2000-2024. The findings of this study contribute to the existing literature in diverse ways: first, we found a positive relationship between healthcare expenditures and economic growth. Second, we found a positive relationship between healthcare expenditures and life expectancy. Third, the results indicate a negative relationship between healthcare expenditures and the number of maternal, infant, and under-five deaths. Thus, an increase in government healthcare expenditure reduces maternal, infant, and under-five deaths. Overall, an increase in healthcare expenditure is associated with an increase in life expectancy and a reduction in the number of infant deaths, under-five deaths, and maternal deaths. Finally, the results from the robustness check suggest that female education, in particular, is a strong determinant for both economic growth and maternal and infant mortality reduction.

Keywords: Healthcare expenditure, Health outcome, Economic growth, Dynamic panel, Sub-Saharan Africa.

1. Introduction

Human capital investment is one of the major aspects in assuring economic growth and sustainable development (Linda, Laura & Lesley, 2019; Novignon, Olakojo & Nonvignon, 2012). As a good indicator of human capital, health has been considered a significant contributing factor to economic growth. Investment in human capital in the form of health expenditure reduces mortality and increases life span thereby enhancing economic growth (Chakraborty, 2004). Healthy people are highly productive and earn more reward (Akinci *et al.*, 2014). In contrast, sickness and debility negatively affect earnings, mainly in developing countries where most of the work requires manual labor (Novignon, Olakojo & Nonvignon, 2012). Various health economic studies underline healthcare expenditure as an essential element in clarifying disparities across countries (Liang, & Mirelman, 2014; Herzer & Peter, 2015). Making more efforts on health improvement is widely considered as the main concern and can be realized when enough health care expenditure is allocated (Richardson, Chisolm & Mary, 2017). For instance, in Sub-Saharan Africa (SSA) where resources are relatively limited, health expenditure per capita for the year 2000 was \$ 32.39 billion and later reached \$ 69.19 billion in 2015 and this has been reported insufficient as the health care load in the region outweighs the expenditure allocations (World Bank, 2016). Health expenditure comprises expenses on the delivery of health services (preventive and curative), family planning activities, nutrition activities, and emergency health aid (World Bank, 2018). Lack of considerable attention on the role of health expenditure is one of the reasons for inadequate health resource allocation in SSA. The health care sector of SSA had a financing gap of 66 billion USD in 2019 (UNECA, 2019). Moreover, mismanagement of resource allocated to the health sector and poor health care system are also among other things (Aboubacar & Xu, 2017). The low levels of health care expenditure in SSA inevitably results in low human capital levels (Kiros *et al.*, 2020). When compared to global levels, SSA has the highest level of under-five years and infant mortality rates. In 2018 alone, under-five-

years mortality rate stood at 78 deaths for every 1,000 live births as compared to the world average of 38 deaths per 1,000 live births. The region also has an average life expectancy of 60 years as compared to the world average of 72 years (World Development Indicators, 2020).

Health is indeed notably recognized across the globe as a critical aspect of the development and economic wellbeing of individuals and countries (Piabuo & Tieguhong, 2017). Indeed, there is widespread consensus in academic and policy circles that apart from being a human right, health leads to significant economic gains (Bloom *et al.*, 2001; Boachie, 2017). Health has both a cause and a consequence of economic growth (Amiri and Ventelou, 2012; Piabuo & Tieguhong, 2017). There is also evidence for a sure link between health outcomes and economic growth across regions and periods (Umar, 2017; Amiri & Gerdtham, 2013). However, the existing literature on health and growth failed to identify sufficient cross-country empirical evidence on health-growth nexus in Africa as a whole and SSA in particular based on recent data and the various health measures and health determinants used in this present study that are explained later in this paper.

Public health expenditure is one of the strategic instruments of government that has come under intense surveys over the last three decades (see for e.g. Arthur & Oaikhenan, 2017; Ashiabi *et al.*, 2016; Rad *et al.*, 2013; Maruthappu *et al.*, 2015). The focus has been to assess and justify government allocations to social sectors such as health or government involvement in general (Anyanwu & Erhijakpor, 2007). Many studies have disapproved of suggestions that government intervention in the healthcare sector is essential for health improvements. These studies typically assess the impact of public health expenditure on health outcomes and find insignificant or no evidence that public health expenditure enhances health (Yaqub *et al.* 2012; Sede and Ohemeng 2015; Richards & Vining 2016). Many of these surveys, if not all, have queried the effectiveness of public health expenditures. The controversy is that improvement in income offers a higher command over goods and services, including healthcare (Dieleman *et al.*, 2017). The rising income level or economic growth shows the appropriate means to improve welfare measures such as health.

Conversely, Hanmer *et al.* (2003) and Rajkumar & Swaroop (2008) showed that government intervention is vital to winning the fight against poor health and illiteracy, and improve many other social sector outcomes. A recent survey has lent credence to the findings of Hanmer *et al.*, and Rajkumar & Swaroop. By using various econometric techniques, these studies have shown that government expenditure on health is essential to improving health conditions (Novignon *et al.* 2012; Heijink *et al.* 2013, Kim and Lane 2013; Rad *et al.* 2013; Makuta and O'Hare 2015; Mohapatra 2016; Sirag *et al.* 2016).

Other researchers have argued that except funds are appropriately allocated within sectors, or targeted adequately to specific groups, spending may be unproductive. For example, Gupta *et al.*, (2002) established public expenditure on primary healthcare to be weak in reducing mortality among children. They recommended a proper allocation of resources within the health sector to achieve desirable outcomes. Health with significant improvements could make economic growth that leads to increased private funds for healthcare and that public spending alone is not adequate to improve health status, even though public health spending matters more to the poor as they argued (Gupta *et al.* 2003).

These varying results and positions on the effectiveness of healthcare expenditure in improving health outcomes have become one of the principal issues in health policy, in terms of the role of government (Dieleman *et al.*, 2017; Ashiabi *et al.*, 2016). Many governments in the emerging world place less emphasis on government facilitation of social services as they depend on or expect economic growth to enhance social sector outcomes (Jakovljevic *et al.*, 2017; Farahani, Subramanian & Canning, 2010; Barenberg, Basu & Soyly, 2012). Additionally, governments continue to explore new avenues to lower costs (Bein *et al.*, 2017). Thus, while governments focus on improving (equitable) access to healthcare to attain better health, they also try to maintain their budgets (Plümper & Neumayer 2013). Government cost containment or strict fiscal policy measures to control cost may affect sectors of the economy, including the health sector. They will consequently affect the number of resources devoted to health infrastructure.

This present study is innovative in the sense that, to our knowledge, none of those studies mentioned above in the literature considered a wide array of health determinants for SSA, and although Anyanwu & Erhijakpor (2009) examined all African nations, their sample study ended in 2004. They also did not assess life expectancy at birth and maternal mortality as health outcomes and instead focused solely on infant and under-five mortality. Therefore, an

empirical investigation regarding the relationship between healthcare expenditures, health outcomes, and economic growth in SSA is exceptional.

This research contributes to the health economics literature in at least three ways: First, it provides estimates of the quantitative effects of health expenditure and health outcomes on GDP based on the most recent data from SSA that has not been fully studied by previous researchers in the existing literature. Second, the study adopts a dynamic panel data model using a difference Generalized Method of Moments (GMM) estimator, which uses internal instruments and allows us to control for endogeneity in the model without succumbing to the pitfall of selecting weak theoretical external instruments. Third, different measures of health are used: on the input side, health care expenditure is measured by total health expenditure per capita. On the outcome side, health outcome is measured by infant mortality rate, under-five mortality rate, maternal mortality rate, and life expectancy at birth. To further enrich our contribution, we accounted for the role of female education in particular, in determining both economic growth and maternal and infant mortality reduction which have been absent from previous studies on the SSA region and which could have important health policy implications for the region.

2. Theoretical Framework and Model

Many scholars have shown interest and gave special attention to the different factors that influence economic growth. Solow (1956) introduced economic development model known as Solow growth model, it undertakes a neoclassical production function with diminishing returns to capital, that is, total income (Y) depends on physical capital K and effective labor AL , where effective labor is denoted as the product technology A and labor L . Moreover, Solow proposed saving rate as exogenous contributing factor to clarify disparity in economic growth rate across countries. Solow believes that a higher saving rate is expected to bring capital accumulation thereby leading to economic growth. Considering human capital as a significant element to economic growth, Mankiw *et al.* (1998) upgraded the Solow model which is called the augmented Solow growth model. They indicated that Human capital, Physical capital and Labor together could better explain economic growth differences among countries than Physical capital and Labor alone.

Health is widely considered as human capital and has a significant contribution to economic growth in several ways. Healthcare spending is expected to enhance the health of the work force and thereby improve productivity. An increase in labor productivity certainly increases economic growth.

The theoretical framework adopted in this study is on the basis of Aboubacar & Xu (2017) who followed Narayan *et al.* (2010). To build the model, the following aggregate production function has been taken in to consideration.

$$Y = AK^{\alpha}L^{\beta} \quad (1)$$

Where Y denotes GDP per capita, K denotes Capital stock and consists of variables that determines GDP per capita. A denotes total factor productivity, and L denotes labour force. Since our focus is to study the health-growth nexus, haven established that health is widely considered as human capital, we incorporated health expenditure and health outcomes indicators.

Studies on health-growth relationships usually take the form of either cross-sectional regression models or multivariate panel data. Since our interest is in the effect of health expenditure and health outcomes on economic growth and the effect of health expenditure on health outcome over time that allow past levels of growth and health outcomes to determine current levels, we adopt a dynamic panel data regression model.

To indicate the dynamic panel model that is of interest in this study and by taking the natural log and incorporating control variables we first decompose the production function in equation (1) into a simple production function specified as;

$$\ln GDP_{it} = \alpha + \beta_1 \ln HE_{it} + \beta_2 \ln HO_{it} + \beta_3 \ln EDU_{it} + \beta_4 \ln LF_{it} + \beta_5 \ln GF_{it} + \beta_6 \ln INF_{it} + \beta_7 \ln IQ_{it} + \beta_8 \ln TOP_{it} + \varepsilon_{it} \quad (2)$$

Where $GDP = GDP$ per capita, i = individual country component t = time component from 2000 to 2024, β_1 to β_8 are coefficients for our various variables and ε_{it} error term.

Health as human capital is recorded through health expenditure, the health outcome (life expectancy of an individual, infant mortality rate, under-five mortality rate, and maternal mortality) and the enclosure of control variables that can influence economic growth.

To examine the impact of health expenditures on health outcomes, we further decompose the production function in equation (1) into a simple health production function in a dynamic panel framework specified as;

$$\ln HO_{it} = \alpha + \beta_1 \ln HE_{it} + \beta_2 \ln EDU_{it} + \beta_3 \ln GDPC_{it} + \beta_4 \ln PHY_{it} + \beta_5 \ln HIVP_{it} + \beta_6 \ln ACW_{it} + \beta_7 \ln HAQ_{it} + \beta_8 \ln IQ_{it} + \beta_9 \ln CEPC_{it} + \varepsilon_{it} \quad (3)$$

Health outcomes again are measured by the same four indicators used above, while health expenditures similarly represent total health expenditures per capita in the country i and time t . and the enclosure of health determinants variables that can influence health outcome. Consequently, Equation (2) and (3) are the basis of estimating the relationship between health expenditure, health outcome and economic growth in this study.

3. Dynamic Panel Estimation Procedure

Given that the simple regression model of the production functions in equation (2) and (3) may provide some understanding into the health-growth relationship and the included variables, they are inundated by endogeneity arising from the correlation between the unobservable characteristics of the population, e.g., attitudes and cultural factors in a specific country, and some of the independent variables such as education, and GDP per capita. Additionally, the health outcome production function might be better represented as a dynamic model since healthy population in the next period might be dependent on the stock of health in the current period (Grossman, 1972). Similarly, the economic growth function might be better represented as a dynamic model since economic growth in the next period might be dependent on growth in the current period. To address these issues, equation (2) and (3) can be transformed into dynamic panel regression models by taking first differences and including time dummies to control for trend effects;

$$\ln GDP_{it} = \alpha \ln GDP_{i,t-1} + \beta X'_{it} + \gamma D_t + \varepsilon_{it} \quad (4)$$

$$\ln HO_{it} = \alpha \ln HO_{i,t-1} + \beta X'_{it} + \gamma D_t + \varepsilon_{it} \quad (5)$$

Where $\Delta \ln GDP_{it}$ and $\Delta \ln HO_{it}$ are the first differences of the log of GDP per capita and health outcomes of country i at time t , $\Delta \ln GDP_{i,t-1}$ and $\Delta \ln HO_{i,t-1}$ are their one-period lags, $\beta X'_{it}$ is a vector of the first differenced explanatory variables presented in equation (2) and (3), D_t is the vector of time dummies and $\Delta \varepsilon_{it}$ is the first differenced error term for country i at time t . The error term is given by;

$$\varepsilon_{it} = \mu_{it} + v_{it} \quad (6)$$

Where $\mu_i \sim iid(0, \delta_\mu^2)$ and $v_{it} \sim iid(0, \delta_v^2)$ are independent amongst themselves and each other.

The estimation of equation (4) and (5) poses two main challenges. First, the enclosure of the lagged value of GDP per capita and health outcomes means Ordinary Least Squares or Generalized Least Squares (GLS) (such as fixed effects estimation) will not be consistent since by construction, $GDP_{i,t-1}$ and ε_{it} in equation (4) and $\ln HO_{i,t-1}$ and ε_{it} in equation (5) are correlated (Baltagi B., 2008). Secondly, there are several time-varying and fixed un-observable variables that may be correlated with both GDP_{it} and $\ln HO_{it}$ and the variables included on the right-hand side of the equations (4) and (5) respectively. While fixed effects estimation, as many studies have done, is likely to take care of unobserved fixed effects, the problem of endogeneity persists because of the presence of dynamism—the lagged GDP and the lagged health outcomes—and unobserved time-varying omitted variables.

To account for these issues, we adopt a difference Dynamic Panel Data (DPD) estimator based on the Generalized Method of Moments (GMM) as expressed by Arellano and Bond (1990). The DPD GMM is particularly suited for our data as it performs well with a relatively large N and small T and thus fits well with our data that has $N=45$ and $T=25$. The GMM estimator is an instrumental variable (IV) estimator where endogenous variables are instrumented using their lagged values (internal instruments) and/or other variables (external instruments) that are only correlated

with GDP per capita and health outcomes through the endogenous variables (Arellano & Bond, 1991). For the estimation, the study will employ the following specification of the Dynamic Panel Data model;

$$\ln GDPC_{i,t} = \beta_1 \ln GDPC_{i,t-1} + \beta_1 \ln HE_{i,t} + \beta_2 \ln HO_{i,t} + \beta_3 \ln EDU_{i,t} + \beta_4 \ln LF_{i,t} + \beta_5 \ln GF_{i,t} + \beta_6 \ln INF_{i,t} + \beta_7 \ln IQ_{i,t} + \beta_8 \ln TOP_{i,t} + \beta D_t + \varepsilon_{it}$$

(7)

$$\ln HO_{i,t} = \beta_1 \ln HO_{i,t-1} + \beta_1 \ln HE_{i,t} + \beta_2 \ln EDU_{i,t} + \beta_3 \ln GDPC_{i,t} + \beta_4 \ln PHY_{i,t} + \beta_5 \ln HIVP_{i,t} + \beta_6 \ln ACW_{i,t} + \beta_7 \ln HAQ_{i,t} + \beta_8 \ln IQ_{i,t} + \beta_9 \ln CEPC_{i,t} + \beta D_t + \varepsilon_{it}$$

(8)

Where D_t denotes the vector of time dummies that are included as controls in the models and ε_{it} is the error term as defined in equation (6). For these models, internal instruments will be used for the lagged dependent variables, average years of schooling, health expenditure per capita for equation (7) and per capita GDP for equation (8) as they are expected to be endogenous regressors.

We estimate equations (7) and (8) where Equation (8) was estimated separately for under-five mortality, infant mortality, maternal mortality and life expectancy.

Data and Variables

We collected annual data for 45¹ Sub-Saharan African Countries. The countries considered are selected based on data availability. The variables used in our analysis are health expenditure, measured by the health expenditure per capita denoted by HE, and economic growth, measured by the gross domestic product per capita represented by GDPC, education (EDU), labour force (LF), gross fixed capital formation (GF) as a measure of physical capital, inflation (INF) and trade openness (TOP). We measured health outcomes (HO) using four dimensions; Infant mortality ratio (infant deaths per 1,000 live births) denoted by IMR, under-five mortality ratio (under-five deaths per 1,000 live births) denoted by UMR, Maternal mortality ratio (maternal deaths per 100,000 live births) denoted by MMR and Life expectancy at births (years) denoted by LE. We also used health determinants such as access to improved and safe drinking water (ACW), health access quality index denoted by HAQ (see Barber et al., 2015), Institution quality index denoted by IQ (see Kunčič, 2014 & Aljaz 2010), Carbon emission per capita (CEPC), HIV prevalence (HIVP) and number of physicians (per 1000 people). These variables were collected from the World Bank World Development Indicators database (World Bank, 2021) and other publications of the Global Health Observatory (GHO) database of the World Health Organization (WHO) [Who.int., 2018], Human Development Reports Database of the United Nations Development Programme (UNDP) [Undp.org., 2018], and Global Burden of Disease (GBD) database of the Institute for Health Metrics (IHME) [Healthdata.org., 2017]. We employed the method of data interpolation to fill in missing data for the period of study. This gives us a balanced panel and a larger sample size relative to earlier studies on SSA. Table 1 shows a summary statistics of the variables included in the models.

4. Results

Prior to computing the specified growth and health equations, the summary statistics is presented in the first instance to give a fair description of the link between health expenditure, health outcomes and economic growth for the data set collected from a panel of 45 Sub-Saharan African countries over the period 2000-2019.

Table1 Summary/Descriptive statistics of study variables

Variable	Observations	Mean	SD	Minimum	Maximum
GDPC	1125	1624.3	14.74	161.83	11925.95
HE	1125	394.52	24.73	152.18	637.36

¹Angola, Benin, Burkina Faso, Botswana, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Demographic Republic, Congo, Cote d'Ivoire, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, South Africa, Sao Tome, Senegal, Seychelles, Sierra Leone, Sudan, Swaziland, Tanzania, The Gambia, Togo, Uganda and Zambia.

IMR	1125	72.43	22.34	17.92	153.82
UMR	1125	88.44	40.98	14.50	204.60
MMR	1125	499.8451	26.9193	53.0000	1270.000
LE	1125	53.48320	2.65669	42.71	63.41
EDU	1125	85.48	12.72	69.82	109.71
LF	1125	69.48320	12.65669	45.47600	88.73300
GF	1125	5.82E+10	2.67E+11	94702564	2.39E+12
INF	1125	11.6474	1.83902	-6.8491	38.8372
IQ	1125	1.7382	0.8479	-1.7482	1.6483
TOP	1125	46.839	13.7488	15.7489	86.7488
PHY	1125	0.077102	0.412984	0.048000	0.194300
HIVP	1125	6.108451	7.828141	0.100000	28.80000
ACW	1125	61.54357	17.80991	19.89657	99.86669
HAQ	1125	47.01000	8.939000	23.30000	66.10000
CEPC	1125	1.254377	2.375228	0.027766	9.979458

From the summary statistics reported in Table 1, GDP percapita(GDPC) averaged around 1624.3(SD=14.74%) with a minimum of 161.83% and a maximum of 11925.95%. Also, health expenditure (HE) per capita has a mean value \$394.52(SD=24.73%); its minimum and maximum values are \$152.18, and \$637.36 respectively. Between 2000 and 2024, life expectancy at birth (LE) averaged at around 53.48 years with a standard deviation of 2.65 years. Hence, a newborn in Sub-Saharan Africa was expected to live for about 53 years on average. Subject to conditions at the time of birth, such a child has the potential to live a minimum of 42.71 years and maximum 63.41 years. Within the same period, the average number of deaths among infants (IMR) and children below age five (UMR) were 72.43 and 88.44 per 1000 live births respectively. Over the years, under-five and infant mortality rates have fallen. Though, the rate of decline has been slow. Similarly, maternal mortality rate (MMR) averaged at around 499.8451(SD=26.91%) per 1000,000 live birth with a minimum of 53% and a maximum of 1270%.

Moreover, the average number of people with access to improved and safe drinking water (ACW) was 61.54% (SD=17.81%) for 2000–2024. Improved and safe drinking water decreases water borne diseases. Similarly, the average health access quality index (HAQ) was 47.01% (SD=8.93%) for 2000–2024. Carbon emission per capita (CEPC) averaged at about 1.25% (SD= 2.37%) for 2000–2024 with a minimum of 0.027% and a maximum of 9.97%. HIV prevalence (HIVP) averaged at about 6.108% (SD=7.82%) with minimum and maximum values of 0.10% and 28.80% respectively. Similarly, the average number of physicians (per 1000 people) was 0.0803 (SD = 0.412). This shows that, on the average, a physician in SSA served approximately 13,000 people during the study period. The minimum and maximum concentration of physicians was 0.008 and 0.194 respectively.

4.1. Economic Growth, Health Expenditure and Health Outcomes

This sub-section shows empirical outcomes regarding the research focus. First, Table 2 reports regression results from growth regressions where health expenditure and health outcomes appear as the main variables of interest through four specifications where each variable enters the model one by one. Second, Table 3 reports the impact of health expenditure on health outcomes with an incorporation of the control variables. We reported the Post-estimation results at the bottom panels of table 2 and table 3. The models estimated have been subjected to robustness checks (tables 4 and 5).

Table 2 Estimation Results of the GDPC Model

Variables	Coefficient Estimates Dependent Variable- Log GDPC				
	Model1	Model2	Model3	Model4	Model5
lnGDPC ₁	0.3272*** (0.073)	0.4262*** (0.0638)	0.3262*** (0.0817)	0.2643*** (0.0523)	0.3242*** (0.0546)
lnHE	0.0062*** (0.0010)	0.0067*** (0.0004)	0.0063*** (0.0004)	0.0053*** (0.0007)	0.0044*** (0.0005)
EDU	0.0074*** (0.0003)	0.0076*** (0.0002)	0.0077*** (0.0007)	0.0079*** (0.0004)	0.0076*** (0.0012)
lnLF	0.0053***	0.0051***	0.0053**	0.0059***	0.0078***

	(0.0018)	(0.0001)	(0.0021)	(0.0008)	(0.0018)
lnGF	0.0052*** (0.004)	0.0062*** (0.0017)	0.0063*** (0.0003)	0.0076*** (0.0015)	0.0077*** (0.0013)
lnINF	-0.0042** (0.0006)	-0.0049*** (0.0009)	-0.0043*** (0.0013)	-0.0036*** (0.0001)	-0.0066*** (0.0015)
IQ	0.0013 (0.0231)	0.0015 (0.0176)	0.0024 (0.0861)	0.0022 (0.0731)	0.0099 (0.073)
lnTOP	0.0067*** (0.0006)	0.0061*** (0.0001)	0.0069*** (0.0006)	0.0062*** (0.0020)	0.0064** (0.0031)
HO(MMR)	- 0.0043*** (0.0002)				-0.0045** (0.0017)
HO(IMR)		-0.0062*** (0.0004)			-0.0072*** (0.0001)
HO(UMR)			-0.0023*** (0.0007)		-0.0037* (0.0019)
HO(LE)				0.0085*** (0.0015)	0.0082** (0.0031)
Time Dummies	Yes	Yes	Yes	Yes	Yes
Wald Test	426.571	320.265	419.263	402.839	360.920
AR (1)	-1.2658	-2.7382	-2.4682	-2.7741	-1.9883
AR (2)	-1.6204	-2.9262	-1.6841	-1.8482	-2.4741
Sargan Test	2.3592	2.9261	3.9731	5.2782	3.7282
Observation	900	900	900	900	900

Note; * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$, standard error in Parentheses.

In table 2, there is a clear manifestation that health matters for economic growth. First, beginning with this result, we find that higher per capita GDP in the previous year, total health expenditure, life expectancy, years of schooling, labour force and trade openness are associated with increased per capita GDP. Conversely, inflation, maternal mortality, infant mortality and under-five mortality are associated with decreased per capita GDP. Specifically, in model 1 of table 2, a 10 percent increase in health expenditure is associated with a 0.6 percent increase in per capita GDP. However, given the sample characteristics of health expenditures per capita, 0.6% increase in per capita GDP is negligible as the median increase in health expenditures over the 20 years period was approximately 394.52% (See table 1). This finding is in support of findings from different scholars; for instance, Mehrara and Musai (2011) who examined the causal relationships between health expenditure and economic growth for Iran using annual data for the period 1970-2008 via the technique of cointegration to empirically examine the long term movement between health expenditure and growth. They found health spending in Iran to have increased at a faster rate than GDP.

Arsoy et al. (2010) also found a positive relationship between health expenditure and economic development. There is a related research in Turkey conducted by Eryigit et al. (2012) from 1950 to 2005, which confirmed a positive relationship between health spending and economic growth. By applying non-linear least squares (2SLS) estimations, Bloom et al. (2004) found a positive relationship between health and growth. This is because good health had a positive and statistically significant outcome for economic growth.

The results further showed that one year gain in average years of schooling is associated with a 0.7 percent rise in per capita GDP. The impact of the years of schooling is enormous and highly positively significant in all the models. This is a clear indication that the contributions of education to economic growth cannot be overemphasized, as it has been determined as the black-box of the economic development of the United States and European Union region, whereby a snowballing level of education of labor-force expounds a considerable percentage of the rapid growth of their developed nature (Woodhall, 1987 and Schultz, 1996). Similarly, there is a relationship between a nation's income and proportion of literacy of a country's populace as opined by Lucas (1988), who is one of the endogenous growth theory advocates. The researcher signified that human capital development ensues in the form of education and learning by doing or schooling, and the resultant effect leads to endogenous growth. This same conclusion was also supported in other studies such as (Psacharopoulos and Woodhall, 1985; Barro and Lee, 2010). In the same view, the findings of Asteriou and Agiomirgianakis (2001) in Greece concludes that a significant

positive relationship occurs between long-run educational parameters and GDP per capita, while Li and Huang (2009) identified that in 28 Chinese provinces there is a positive impact of education on economic growth. Also, in the study carried out by Özsoy (2008) in Turkey shows that there is a long-run and constant association between education and growth. Correspondingly, Maksymenko, and Rabani (2011) display in their findings in India and South Korea that education exhibits a significant positive impact on economic growth. Too, Hanushek and Kimbo (2000) carried out their findings by using indexes of educational quality for 38 countries to identify the academic performance in mathematics and sciences; the outcome of the findings recommends a robust connection between educational quality and rise in GDP per capita.

Second, health outcomes matter for economic growth. Starting with the maternal mortality ratio, in model 1 of table 2, a 10% increase in the maternal mortality rate is associated with a 0.4 percent decrease in per capita GDP. In other words, if the maternal mortality rate were reduced by 43 deaths, then GDP per capita would increase by 10 percent. Similarly, in model 2 of table 2, a 10% increase in the infant mortality rate is associated with a 0.6 percent decrease in per capita GDP. In other words, if the infant mortality rate were reduced by 62 deaths, then GDP per capita would increase by 10 percent. Also, in model 3 of table 2 under-five mortality rates are negatively and significantly associated with per capita GDP. Specifically, a one-unit decrease in under-five mortality would increase real GDP per capita by 0.2 percent. In other words, if the under-five mortality rate were reduced by 23 deaths, then GDP per capita would increase by 10 percent. Interestingly, infant mortality has a more significant impact both in terms of magnitude and statistical significance since it primarily relates to immunization coverage, while under-five mortality measures the health system with a broader perspective. Conversely, when it comes to life expectancy, in model 4 of table 2, a 10% increase in the life expectancy is associated with a 0.8 percent increase in per capita GDP.

From these results, we learn that the state of health of the population of a country is a significant factor driving productivity as only a strong labor force can make meaningful contributions to the production and growth of national output. As is the case in a typical production function, the quantity/level of inputs has a corresponding effect on the quantity/level of output depending on the scale of production and returns to scale. Hence, this causes the health of the citizens of a country imperative, and as such sufficient delivery for health should be one of the primary goals of governments in the Sub-Saharan Africa region as it has a positive impact on economic growth.

Third, gross fixed capital formation, labour force, trade openness and inflation have the expected signs and are statistically significant in influencing GDP per capita in the region. A 10% increase in the labour force is associated with a 0.7 percent increase in per capita GDP. A 10% increase in the gross fixed capital formation is associated with a 0.5 percent increase in per capita GDP. A 10% increase in the trade openness is associated with a 0.8 percent increase in per capita GDP.

Table 3 Estimation Results of the Health Outcomes Model

Variables	Coefficient Estimates Dependent Variable- Log Health Outcome			
	MMR	IMR	UMR	LE
lnHO ₁	0.0653*** (0.0171)	0.0763*** (0.0193)	0.0672*** (0.0164)	0.0639*** (0.0140)
lnHE	-0.0028*** (0.003)	-0.0037*** (0.0010)	-0.0052*** (0.0014)	0.0046*** (0.0007)
EDU	-0.0014*** (0.0007)	-0.0052*** (0.0015)	-0.0054** (0.0021)	0.0013*** (0.0003)
lnGDPC	-0.0024*** (0.0005)	-0.0031*** (0.0019)	-0.0032*** (0.0012)	0.0144 (0.0547)
PHY	-0.0046*** (0.0001)	-0.0077*** (0.0023)	-0.0041** (0.0019)	0.0074*** (0.0016)
HIVP	0.0042*** (0.0016)	0.0026*** (0.0007)	0.0266 (0.0513)	-0.0032*** (0.0003)
ACW	-0.0049*** (0.0002)	-0.0047*** (0.0012)	-0.0023** (0.0011)	0.0042*** (0.0020)
HAQ	-0.0054*** (0.0013)	-0.0063*** (0.0018)	-0.0079*** (0.0014)	-0.0014*** (0.0005)

IQ	0.0331 (0.0015)	0.0455 (0.0013)	0.0537 (0.0012)	0.0426 (0.0031)
CEPC	0.0034*** (0.0005)	0.0076*** (0.0002)	0.0014*** (0.0007)	-0.0042*** (0.0014)
Time Dummies	Yes	Yes	Yes	Yes
Wald Test	214.893	402.839	360.920	195.938
AR (1)	-2.8393	-2.7741	-1.9883	-2.7891
AR (2)	-2.3082	-1.8482	-2.4741	-2.7483
Sargan Test	3.6482	5.2782	3.7282	3.6584
Observation	900	900	900	900

Note; * $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$, standard error in Parentheses.

Moving to the second research model, the empirical results for each of the four health outcome variables are presented in table 3.

Focusing on the empirical results, table 3 above shows a strong negative relationship between mortality (maternal, infant and under-five) rates and health expenditure per capita and a stable and positive relationship between health expenditures and life expectancy at birth. They are highly statistically significant and also economically meaningful. Firstly, starting with the maternal mortality model, we find that, total health expenditure, higher per capita GDP, average years of schooling, physicians per 1,000 people, health access quality index and access to improved and safe drinking water, are associated with decrease maternal mortality rate. Specifically, a 10 percent increase in health expenditure per capita reduces the maternal mortality rate by 0.28 percent maternal death. Similarly, the results further showed that one year gain in average years of schooling is associated with a 0.14 percent decrease in maternal mortality rate. A 10 percent increase in per capita GDP is associated with a 0.24 percent decrease in maternal mortality rate. However, carbon emission per capita and HIV prevalence are associated with increase in maternal mortality rate. An extra carbon emission per capita and HIV prevalence are associated to a 0.34 and 0.42 percent increase respectively in the maternal mortality rate.

Secondly, in the infant mortality model, health expenditure per capita, average year of schooling, physician per 1,000 people, health care access quality index and access to improved and safe drinking water are statistically significant at 1% level, with the expected signs. For example, a 10 percent increase in health expenditure per capita reduces the infant mortality rate by 0.37 percent. Similarly, a 10 percent increase in GDP per capita is associated with a 0.31 percent decrease in maternal mortality rate.

Thirdly, for the under-five mortality model, health expenditure per capita, average year of schooling, physician per 1,000 people, health care access quality index, access to improved and safe drinking water and carbon emission per capita are statistically significant at 1% level, with the expected signs. Consequently, our results suggest that a unit increase in the Health Care Access Quality Index is associated with a 0.79 percent decrease in the under-five mortality rate whereas an extra carbon emission per capita is associated to a 0.14 percent increase in the under-five mortality rate with both findings significant at the 1 percent level of significance. The result further shows that a 10 percent increase in health expenditure per capita reduces the under-five mortality rate by 0.52 percent.

Finally, in the life expectancy model, we find that total health expenditure, higher per capita GDP, carbon emission per capita, access to improved and safe drinking water, years of schooling, and HIV prevalence are statistically significant, with the expected signs. Specifically, a 10 percent increase in health expenditure per capita and GDP per capita increase life expectancy by 0.46 and 0.14 percent respectively. Similarly, access to improved and safe drinking water and years of schooling are associated to a 0.42 and 0.53 percent increase respectively in the life expectancy whereas an extra carbon emission per capita and HIV prevalence are associated to a 0.42 and 0.32 percent decrease respectively in the life expectancy.

In a whole, in addition to the observed direct impact of health expenditures on economic growth in table 2, table 3 also implies an indirect effect of health expenditures on growth via health outcomes. The findings in tables 3

shed light on the impact of health expenditures on health outcomes in the SSA region. These findings confirm with those of Bein et al. (2017) and Anyanwu and Erhijakpor (2007).

4.2 Robustness Check

A now frequent exercise in empirical studies is a “robustness check,” where the researcher examines how specific “core” regression coefficient estimates behave when the regression specification is modified in some way, typically by adding or removing regressors. Leamer (1983) influentially advocated investigations of this sort, arguing that “fragility” of regression coefficient estimates is indicative of specification error, and that sensitivity analyses (i.e., robustness checks) should be routinely conducted to help diagnose misspecification.

Such exercises have gained prominence nowadays that standard econometric software has modules designed to perform robustness checks automatically. A finding that the coefficients do not change much is taken to be evidence that these coefficients are “robust.” If the signs and magnitudes of the evaluated regression coefficients are also reasonable, this is generally taken as evidence that the estimated regression coefficients can be reliably interpreted as the actual causal effects of the associated regressors, with all that this may imply for policy analysis and economic insight. Results of the robustness checks are reported in table 4 and 5 for the growth equation and the health outcome equations respectively.

Table 4 Robustness Check Results of the GDPC Model

Variables	Coefficient Estimates Dependent Variable- Log GDPC				
	Model1	Model2	Model3	Model4	Model5
lnGDPC ₋₁	0.3721*** (0.084)	0.4758*** (0.0748)	0.3678*** (0.0838)	0.2845*** (0.0584)	0.3582*** (0.0575)
lnHE	0.0067*** (0.0021)	0.0068*** (0.0017)	0.0065*** (0.0009)	0.0058*** (0.0004)	0.0047*** (0.0006)
Female EDU	0.0086*** (0.0001)	0.0089*** (0.0013)	0.0084*** (0.0004)	0.0081*** (0.0005)	0.0083*** (0.0017)
lnLF	0.0057*** (0.0015)	0.0057*** (0.0011)	0.0057*** (0.0013)	0.0053*** (0.0004)	0.0081*** (0.0014)
lnGF	0.0061*** (0.0003)	0.0068*** (0.0012)	0.0067*** (0.0007)	0.0075*** (0.0018)	0.0074*** (0.0016)
lnINF	-0.0048** (0.0003)	-0.0048*** (0.0006)	-0.0048*** (0.0010)	-0.0035*** (0.0002)	-0.0067*** (0.0013)
IQ	0.0017 (0.0243)	0.0018 (0.0189)	0.0029 (0.0873)	0.0026 (0.0782)	0.0097 (0.0744)
lnTOP	0.0072*** (0.0009)	0.0063*** (0.0017)	0.0065*** (0.0011)	0.0069*** (0.0024)	0.0069** (0.0022)
HO(MMR)	-0.0047*** (0.0008)				-0.0046** (0.0013)
HO(IMR)		-0.0065*** (0.0005)			-0.0075*** (0.0002)
HO(UMR)			-0.0028*** (0.0001)		-0.0039* (0.0014)
HO(LE)				0.0083*** (0.0013)	0.0087** (0.0021)
Time Dummies	Yes	Yes	Yes	Yes	Yes
Wald Test	415.464	396.534	443.286	376.834	395.734
AR (1)	-1.6381	-2.8660	-2.6351	-2.5670	-1.5771
AR (2)	-1.7433	-2.7540	-1.7850	-1.6542	-2.3610
Sargan Test	2.4366	2.8740	3.8551	5.5811	3.6391
Observation	900	900	900	900	900

Note; * p < 0.1, **p < 0.05 and ***p < 0.01, standard error in Parentheses.

Table 5 Robustness Check Results of the Health Outcomes Model

Variables	Coefficient Estimates			
	Dependent Variable- Log Health Outcome			
	MMR	IMR	UMR	LE
lnHO ₁	0.0667*** (0.0163)	0.0794*** (0.0152)	0.0693*** (0.0171)	0.0665*** (0.0131)
lnHE	-0.0026*** (0.0031)	-0.0037*** (0.0013)	-0.0048*** (0.0015)	0.0048*** (0.0002)
Female EDU	-0.0018*** (0.0009)	-0.0058*** (0.0019)	-0.0057** (0.0031)	0.0014*** (0.0005)
lnGDPC	-0.0026*** (0.0002)	-0.0032*** (0.0018)	-0.0023*** (0.0013)	0.0153*** (0.0060)
PHY	-0.0049*** (0.0002)	-0.0073*** (0.0019)	-0.0050** (0.0018)	0.0077*** (0.0012)
HIVP	0.0043*** (0.0019)	0.0025*** (0.0004)	0.0277*** (0.0042)	-0.0034*** (0.002)
ACW	-0.0050*** (0.0005)	-0.0049*** (0.0011)	-0.0025** (0.0014)	0.0044** (0.0021)
HAQ	-0.0056*** (0.0017)	-0.0065*** (0.0012)	-0.0072*** (0.0011)	-0.0014*** (0.0006)
IQ	0.0389 (0.0016)	0.0483 (0.0113)	0.0504 (0.0014)	0.0484 (0.0035)
CEPC	0.0037*** (0.0008)	0.0035*** (0.0003)	0.0017*** (0.0004)	-0.0043*** (0.0019)
Time Dummies	Yes	Yes	Yes	Yes
Wald Test	268.391	422.183	330.654	134.786
AR (1)	-2.6334	-2.5447	-1.8454	-2.6743
AR (2)	-2.6612	-1.4560	-2.9446	-2.7944
Sargan Test	3.7552	4.6533	3.8445	3.7652
Observation	900	900	900	900

Note; * p < 0.1, **p < 0.05 and ***p < 0.01, standard error in Parentheses.

In order to verify the relative stability of our regression estimates, we carry out robustness checks by incorporating new explanatory variables average years of schooling age 15+ female measured as female education in the base regressions. The exercise entails comparing the new parameters obtained by introducing this new explanatory variable in the new model to the original estimates of the base regression. The results from the robustness checks disclose that the coefficients of all the variables in our base regressions fail to vary significantly from those of the new estimates, which show that the parameter estimates from our dynamic panel regressions are robust. This confirms the appropriateness of the estimations methods and that the model has been well specified. The robustness check in Tables 4 and 5 presents the empirical results for each of the four health outcome indicators. The main difference between table 3 & 3 and 4 & 5 is that diverse measures are used for human capital development. While table 2 and 3 utilizes the average years of schooling for both sex, which covers the 45 countries, table 4 and 5 utilizes average years of schooling for female, which also covers the 45 countries. Also, the latter indicator is of greater importance in this study. Given that female education is a critical factor in explaining maternal and child health, we tend to incorporate it in the robustness check.

The robustness results in table 5 above shows a strong negative relationship between mortality ratios (maternal, infant and under-five) and current health expenditure per capita it however shows a stable and positive relationship between health expenditures and life expectancy. They are highly statistically significant and also economically meaningful. Similar interpretation holds as in tables 2 and 3. The influence of female education on health outcomes is much more substantial and lowers the impact of health expenditures on maternal mortality. Overall, the higher is the years of schooling of female, the lower the mortality ratios, and the higher the life expectancy. Specifically, an additional year increase in female education reduces maternal mortality by approximately 1.8 percent deaths. Female education also matters for the other three health outcome indicators. An additional year increase in female education leads to approximately 5.8 percent fewer infant deaths, 5.7 percent fewer under-five deaths, and 5.4 percent

years more of expected life. Hence, female education has been proven in this study to play a critical role in reducing the mortality and increasing life expectancy in SSA.

5. Discussion and Conclusion

The relationship between health expenditure, health outcomes, and economic growth remains inconclusive in the extant literature; therefore, it is demanding to ascertain these relationships to make an evidence-based decision that would improve the situation of the health sector in SSA. Given the high rate of infant, under-five and maternal mortality, and the low life expectancy in SSA as well as the limited budgetary allocation to the health sector of the SSA economies, it became imperative to examine the link between health expenditure, health outcomes, and economic growth to justify the nature of the relationships among these key macroeconomic variables in SSA. Consequently, this survey was carried out to examine the impact of health expenditure and health outcomes on economic growth and as well as the impact of health expenditure on health outcomes (maternal mortality, infant mortality, under-five mortality, and life expectancy) in SSA using the dynamic panel regression approach. Sequel to the empirical findings of this study, we conclude that health expenditure and economic growth play critical roles in determining the health outcomes in SSA.

Specifically, the empirical results found in this study are in line with the broader health economics literature (Piabuo & Tieguhong, 2017; Liang, & Mirelman, 2014; Herzer & Peter, 2015). First, health expenditures have a direct positive impact on economic growth in SSA during the sample period. Second, health outcomes have a direct and positive impact on economic growth. Reducing maternal mortality, infant mortality, and child mortality are all growth-friendly. Finally, the results shed light on the importance of health expenditures and education on health outcomes in the SSA.

The positive impact of education on health outcomes is in conformity with both the theoretical literature and previous empirical studies (Bichaka & Anca, 2015). A plausible explanation for this effect is that even basic improvements in education and literacy are associated with increases in health outcomes via improved access to health care and higher earnings which could result in higher living standards (Feinstein et al., 2006; Hahn & Truman, 2015). However, it is noted that the short-term impact of education is much greater on mortality (maternal, infant and under-five) than life expectancy. A possible reason for this is that the effect of education on mortality may be more reflective in the short-term than that on life expectancy. A plethora studies have found direct causal relationships between education and reductions in infant and child mortality in the short-term whereas the influence of education on life expectancy tends to be long term and varies widely across populations (Anna Ó, et al., 2016; Luy et al., 2019). Consequently it follows that accelerated reductions in maternal, infant and under-five mortality in the short term can be achieved by educational policies aimed at increasing average years of schooling and improving literacy rates. This was particularly evident in the robustness result, where female education tends to have a greater influence on the health outcomes. Education policies such as the Free Primary Education Policies adopted by the majority of sub-Saharan Africa countries (Oketch & Rolleston, 2007) can be extended to encompass secondary education as empirical evidence suggests that health gains increase with levels/years of education (Feinstein et al., 2006).

Moreover, from our findings, health expenditure appears as one of the main contributors to improvements in health outcome with its effect being greater for life expectancy than maternal, infant and under-five mortalities. Increased health expenditure over the past few decades has been associated with an increase in the number of health facilities and infrastructures as well as improvements in health care services and delivery (Fagan & Zeng, 2015). Currently, as the globe moves towards worldwide coverage of health care sub-Saharan African countries are starting to embrace National Health Insurance schemes to replace previous health financing policies such as the removal of user fees (Gautier & Ridde, 2017). To derive maximum benefits in terms of improvements in life expectancy and mortality from these schemes, there is a need to ensure adequate and consistent funding of the schemes.

An amazing finding from the study was related to the relationship between health care quality and life expectancy. While it is assumed that health care quality would have a positive impact on life expectancy, this was not the case for this study. Improvements in health care access quality may not have an immediate impact on life expectancy. The negative sign may be due to the very low levels of health care access quality in the region (Barber et al., 2015). The study further found evidence that HIV prevalence, per capita GDP and carbon emission per capita were significant determinants of health measured by life expectancy which was consistent with studies in similar contexts (Fayissa & Gutema, 2005; Mba, 2008). The negative impact of the HIV/AIDS prevalence was expected since the

disease shortened the life span of the economically active population, who were most affected by the disease (Mba, 2008).

In tandem with theoretical literature, increases in per capita GDP were associated with significant improvements in life expectancy (Grossman, 1999; Pritchett & Summers, 2006). Naturally, higher income on the national level translates into greater investments into the health sector that can, in turn, be used to improve the health status of the country's population. Higher per capita GDP is also associated with an overall increase in the standard of living through greater access to health care, greater access to adequate sources of nutrition, improved housing and environmental conditions which increase the likelihood of living longer.

The main policy implication of the findings from this study is that governments in the SSA region should pay attention to improved health outcomes both as an end goal and as a means to economic growth. First, rising health expenditures, however, is one policy tool, and it requires extensive domestic resource mobilization in addition to external financing. Given the findings observed in health expenditures per capita across the region in the 2000-2019 periods, it is wise for governments to spend more but efficiently on healthcare to improve the health outcomes that they lack the most and that have a significant direct impact on economic growth. Second, since female education is a significant problem in African countries as a whole, and many nations in the region are still lagging in female education, governments should also pay more attention to reducing gender gaps in quality and quantity of education. Indeed, our results from the robustness check suggest that female education, in particular, is a strong determinant both for economic growth and for maternal and infant mortality reduction.

As in any other research, this research is not without limitations. The results in this study do not incorporate different sources of financing health expenditure. For instance, the measure used for health expenditures in this study includes the total government health expenditures. Future research can shed more light on the differential impacts of health expenditures by financing sources like private health expenditure as well. Also, the results reflect the quantity of spending rather than the quality of spending. Future research in this area could also clarify this qualification. Finally, future research could improve the identification strategy to ensure the causal interpretation of the results by using a different approach like the panel Granger causality approach.

Conflict of Interest

The authors declare no conflict of interest.

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