

Effect of Health Expenditure on Health Outcomes in Sub-Saharan Africa

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Abstract

This paper examined the effect of health outcomes on economic growth in Sub-Saharan African (SSA) countries. With the objective of improving health outcomes, these countries have appropriated and allocated huge resources to health sector by increasing health expenditure significantly over time. However, in spite of these financial commitments to health industry, health outcomes have only shown slight response, raising questions about this significance of health expenditure in improving health outcomes across the region. The data for this paper was sourced from a sample of 45 SSA countries in the 2024 World Bank data base. The paper was based on the Grossman Human Capital Model on the demand for health, and a fixed effect model was estimated to investigate the effect of health expenditure on health outcomes. The findings revealed that public, private and external health expenditures have negative and statistically significant effects on infant mortality, but have positive and statistically significant effects on life expectancy. The fixed effects showed that public, private and external health expenditures are important in reducing infant mortality by 0.0235%, 0.0257% and 0.2270%; while fixed effects showed that public, private and external health expenditures are important in increasing life expectancy by 0.0119%, 0.00678% and 0.0578. The paper concluded that there is substantial effect of health expenditure on health outcomes in Sub-Saharan Africa. Expenditure on health causes infant mortality rate to decline while it increases life expectancy at birth. The paper recommended coordinating efforts on initiatives that include raising public health spending for countries seeking to enhance their per capita income and augmenting their health-related human capital stocks.

Keywords: health expenditure, infant mortality, life expectancy, Sub-Saharan Africa

1. Introduction

The relationship that co-exists between health expenditure and health outcomes is theoretically probable and empirically supported in single and cross-country studies. However, efforts to improve the level of health in Sub-Saharan Africa (SSA) are faced with several challenges. Virtually, all human development indicators (such as life expectancy, per capita income, and education) placed the

SSA economy at the bottom of the development scale. This is because the region is characterized by the high incidence of infectious and communicable diseases, growing burdens of chronic and non-communicable diseases, a weak health system that can be partly attributed to inadequate budgetary allocation to the health sector, and poor attitude towards investment in research development (Gouda et al., 2019). These tend to have resulted in inadequate human and material resources that are needed in the health sector (Modibbo et al., 2019).

In an attempt to improve health outcomes, each of the Sub-Saharan African countries has put in appreciable efforts in raising health expenditure, however, the region only recorded a marginal improvement in health status. Health outcomes, such as life expectancy is still low, infant rates are high, and diseases such as HIV/AIDS, malaria, and other health-related problems are prevalent (Modibbo et al., 2019; World Bank, 2020). These tend to harm economic growth and raise questions on the importance of health expenditure in improving health outcomes in SSA.

Although current expenditures on health per capita in current US dollars for SSA decreased from 88.45 to 78.87 between 2010 and 2019, statistics shows that between the same period, infant mortality rates reduced from 65.10 to 51.60 and 101.0 to 78.00 per 1000 live births correspondingly, while life expectancy at birth increased from 56.7 to 61.6 within the same period (World Bank, 2022). The percentage improvement in health status over the duration as evidenced by the statistics far outweighs the improvement in health expenditure.

Some empirical studies (Aboubacar & Xu, 2017, Arthur & Oaikhenam, 2017; Yusufu et al., 2022) revealed that insufficient health expenditure partly accounts for the small positive change in health outcomes in SSA. For instance, in SSA the current expenditure of \$79 per capita on health is nowhere near the global average of \$1,122 per capita, also, the region allocates only 4.97 percent of GDP to healthcare spending relative to 9.36, 7.95, 10.22, and 12.53 percent in Europe and Central Asia, Latin American and Caribbean, Europe Area, and OECD¹ countries, respectively (World Bank, 2022). The share of GDP devoted to health expenditure in SSA is a far cry from the Abuja commitment of at least 15 percent of the national budget for the health sector, 22 years after. This, if not reversed, may constitute impediments to the attainment of good health and well-being for

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all at all ages (SDG 3), and maybe a reason for the marginal impact of health spending on health outcomes. Some other studies (Eggoh et al 2015; Ogunjimi, 2019; Olayiwola et al., 2021) tend to suggest that public and private health expenditure has no important influence on health outcomes. Hence, the curiosity is whether the small positive change in health outcomes should be attributed to health spending, or whether health expenditure does not contribute significantly to health outcomes.

Meanwhile, the debate on the relevance of health expenditure on health outcomes in SSA has not been concluded. Meanwhile, the few studies on SSA have produced mixed findings on the relationship among the variables. For instance, Novignon et al. (2012) and Akinbode et al. (2021) report that increases in health expenditure lead to important improvement in health outcomes although their medium of influence differs. Kibathi et al. (2019) agree that healthcare expenditure contributes to the growth of GDP in SSA. The study, however, uses health expenditure as a determinant of economic growth without analyzing the channel through which health spending translates into economic growth. Their finding is debatable given that not all health expenditure leads to improvement in health outcomes.

Based on the arguments above, it is obvious that in addition to having very few studies on health expenditure and health outcomes in SSA, the nature of the relationship remains the subject of discussion. This is because it has led to divergent opinions among researchers on the effectiveness of health expenditure in advancing the health status in the SSA. This paper, therefore, examines the relationship between health expenditure and outcomes in Sub-Saharan Africa.

2. Literature Review

Overtime, the nexus existing between health spending and health outcomes has produced divergent views across the world and this cannot be overlooked. This nexus is seen especially among the nations that are wealthy. This is because these nations are economically stronger, healthier and wealthier than underdeveloped and developing nations respectively. In an effort to demonstrate that health, health care investment, and health outcomes are related, studies revealed the following findings:

Arthur and Oaikhenan (2017) examined the link between health spending and outcomes in sub-SSA nations. These nations have consistently increased health

spending over the years aimed at improving health outcomes. In spite of this, there has been only a modest improvement in health outcomes, which begs the question of how important health spending is in improving health outcomes. The data source for the study was the World Development Indicators (WDI) (2014) for a sample of forty SSA countries. The Grossman Human Capital Model of the demand for health served as the foundation for the empirical study, which employed the fixed effect. The findings reveal that, despite having an inelastic effect on health outcomes, health spending dramatically reduces mortality rates and raises life expectancy at birth in the SSA.

The results show that health spending significantly lowers mortality rates and increases life expectancy at birth in SSA while having an inelastic impact on health outcomes. Spending on public health care had a significant effect on declining death rates, while spending on private health care had a major effect on rising life expectancy. Despite the former's dominance over the latter, there exists a significant complimentary link between government and individual health expenditure in SSA.

Novignon and Lawanson (2017) looked into lag effects while attempting to explain the connection which exists between infant health outcomes and health expenditure. The study used panel data from the World Bank Data Base from 1995 to 2011 covering 45 Sub-Saharan African nations. There were estimated Fixed and Random effect models. The study utilised data for health outcomes arising from neonatal, infant and under-five and total health spending was divided between public and private spending. The impacts of one- and two-period expenditure delays were estimated, and the results show a positive and substantial relationship between health expenditure and child health outcomes, with elasticities of -0.11 for newborn mortality, -0.15 for under-five mortality, and -0.08 for neonatal death.

Adams et al. (2018) used contemporary econometric methodologies that take into account cross-sectional dependence in panel data to investigate the correlation between health infrastructure and growth of the economy in 30 SSA nations between 1990 and 2014. The results indicated that health infrastructure (as determined by mortality rate) have no a major influence on the growth of the economy. However, whereas variables related to the labor force and the political system show a strong correlation with economic growth, gross fixed capital formation is positively correlated with it. The findings are ample proof that,

despite significant capital investment, the labor market and political climate have not made it possible for SSA's health infrastructure to raise GDP per capita levels.

Onisanwa et al. (2018) used time series data covering 35 years employing the Model of Health Production Function as postulated by Grossman to examine the impact of public health spending on the health status in Nigeria. They discovered that Nigeria's infant mortality rate is significantly and negatively impacted by public health spending. In Nigeria, the primary barriers to providing basic healthcare facilities are insufficient funding for the healthcare industry and uneven distribution of healthcare services among regions. Infants and children below five have very high death rates. Furthermore, there are a number of states in the country with high prevalence rates of avoidable diseases like cholera, malaria, and lassa fever. HIV/AIDS, TB, and cases associated to death continue to be highly prevalent.

Olatunde and Fagbemi (2019) used panel fully modified least square (FMOLS) to examine the long-term nexus existing between public health spending and mortality rate of children below age five in fifteen countries in West Africa between 1991 and 2015. The aggregate and disaggregated models are both used in the empirical analysis. The findings signify a long-term connection between per capita health investment and under-five death rate. Additional data show that public health spending significantly impacts mortality rate of infants below age five. Thus, it becomes clear that an increase in health investment across West African nations would result in a reasonable downward trend in the region's infant death rate.

Kiross et al. (2020) employed panel data from WDI encompassing 46 sub-Saharan African nations from 2000 to 2015 to examine the relationship between health spending and infant mortality. The random effects model was selected over the fixed effects model using the Hausman test to ascertain if there exists a correlation between health care investment and infant and neonatal mortality. Spending on exterior and internal health care both significantly correlated negatively with baby and neonatal death. Private health spending was not, however, significantly connected to either baby or neonatal mortality. Funds from households, businesses, and nonprofit organizations are all considered private expenditures in this study. Apart from the compulsory prepayment and social health insurance premiums, domestic revenue in the form of grants, internal transfers, subsidies to voluntary health insurance recipients, non-profit

organizations that offer household services, or enterprise financing schemes is also included in public expenditures. "External health expenditure" encompasses all foreign financial inflows into the nation's health system, including government-disbursed foreign transfers as well as direct foreign payments.

Frank and Mcineka (2021) examined the impact and connection between health spending and health outcomes in SSA employing up-to-date data from 2000 to 2015. Utilizing the Partial Least Square (SEM) Structural equation modeling, a multidimensional estimating technique, and the Grossman theory on demand for health, the study examined the connections between health financing and health outcomes in 25 SSA countries. According to the research, there is a harmful and major link existing between health spending and health outcomes as showed by estimates. The results from the findings show that health finance, as defined by public and private health investment, has a positive and inverse impact on health outcomes in SSA, including the death rate for children below five years of age, the death rate for mothers, and the life expectancy at birth. The direct effect outweighs the indirect effect. Health outcomes and population size dividend, as measured by children and aged dependency ratios, are directly impacted by health financing. The enrollment in primary and secondary schools as well as the dependence ratio are both affected indirectly. The results of bad health play a part in this. According to study findings, the regional administration might improve the region's subpar health outcomes by boosting its annual budgetary allotment to the health sector.

Adegoke et al. (2022) examined the relationship between health expenditures and educational quality on three health outcomes (infant mortality, maternal mortality, and life expectancy at birth) using balanced panel data on 25 selected SSA countries from 2000 to 2020 using the panel spatial correlation consistent (PSCC) approach. Findings that were recorded are as follows. Firstly, there are sizable asymmetric quadratic effects of health spending on health outcomes. Secondly, the connections between health spending and educational quality increase life expectancy while lowering baby and maternal fatalities. Thirdly, raised educational quality above some significant thresholds of 1.49 and 1.51 can reduce maternal and child fatalities, whereas a point above 1.84 increases life expectancy, according to the interaction effects' threshold points.

Adegoke et al. (2022) used Autoregressive Distributed Lag (ARDL), a technique typically employed for large models, to examine the interaction between health

investment and other significant macroeconomic determinants on health indicators like death, infant, and child death in Nigeria, between 1995 and 2020 is the study period. The results revealed a noteworthy inverse correlation between macro-economic factors that influence health, including household consumption, total health spending, and gross fixed capital, and a noteworthy affirmative correlation between these factors and unemployment. The findings are further corroborated by out-of-sample forecast results, which indicate that in order for Nigeria to meet the SDG health targets by 2030, there will be a decrease in unemployment to 1.84 percent and increases in health spending, gross fixed capital, household consumption, and corruption control to 1,818.87 billion (naira), 94.46 billion (naira), 3.2 percent, and 4.2 percent, respectively.

Ayipe and Tanko (2023) looked into the connection between public healthcare spending and the mortality rate of children below age five in SSA low-income countries. Data from twenty low-income SSA countries were collected in a balanced panel from the World Bank dataset, which spans the years 2000–2019. Domestic health spending was the key independent variable, whereas death rate of children below five served as the outcome variable. Potential confounding factors were total female fertility rate and population percentage, open defecation usage, and diphtheria-pertussis-tetanus (DPT) vaccination. There was use of the static model. To determine whether of the fixed effect estimate and random effect estimator would be the best fit for the study, the robust Hausman test was employed. The fixed effect estimator was selected as a result of the findings. The results showed a substantial adverse relationship (Fixed Effects = 5.275; $p < 0.05$) between domestic health spending and the under-five mortality rate in low-income Sub-Saharan African nations. For every percentage point increase in domestic health spending, the under-five death rate is expected to drop by about 5.3 units. While the under-5 death rate was negatively connected ($p < 0.01$) with DPT vaccination, the female population, open defecation in rural regions, and the overall fertility rate were all positively correlated. The study arrived to the conclusion that decreasing under-5 mortality rates in low-income nations in Sub-Saharan Africa will require a sustained increase in health spending and an improvement in socioeconomic conditions.

The justifications for this study are derived from the observed gaps in the literature, three justifications were provided. Theoretically, this study employs Roman's endogenous growth theory which is centered on the Neo-classical growth theory and Grossman (1972) health capital theory. However, included in

this model are the various measures of health outcomes (life expectancy, infant mortality, maternal mortality), and health expenditure (private and public health).

Methodologically, some studies, such as Anyanwu and Ehijakpor (2009); Novingor and Akanni (2012); Shahid et al. (2021); and Bul and Moracha (2020) examined the impact of health on economic growth in SSA using Pooled Ordinary Least Square technique. The pooled least squares model is based on the assumption that the sample does not have significant country and time effects. However, the panel data model will lead to spurious and biased results if the assumptions break down. Some studies such as Kiross et al. (2020); Arthur and Oaikhenan (2017); Novignon and Lawanson (2017) examined the relationship between health outcomes and economic growth using the Random Effect estimation approach. The Random effect assumes the errors are uncorrelated with the explanatory variables, therefore, the variations across the cross sections are uncorrelated with the independent variables in the model. This may not remove a random measurement error or unobserved heterogeneity that varies over time, thereby leading to bias and inaccurate conclusions. To overcome this challenge, this study will use the Fixed Effect estimation approach. This method is well suited to deal with random measurement error and unobserved time and country effects. It eliminates the time-invariant characteristics by taking deviations of the model from the mean.

Although the relationship between health expenditure and health outcomes is of enormous importance, there exist limited studies on SSA. While there are similar studies within the region, they are either limited in geographical coverage or in terms of variable scope. Some studies (Awe & Ajayi, 2010; Bakare & Olubokun, 2011; Nasiru & Usman, 2012; Maijama'a & Mohammed, 2013; Usman, 2015) were centered on a single country and as such, their findings cannot be used for generalization because of the heterogeneity nature of the SSA region. Also, the single-country studies were centered on either the effects of diseases such as malaria or HIV/AIDS on economic growth or utilising health inputs proxied by health investment. Meanwhile, few studies were found to examine the link between health outcomes and economic growth (Usman et al., 2015). Despite the limited studies that have been carried out to examine the relationship between health and economic growth in SSA, there are no clear-cut empirical findings as evidenced by the mixed results reported in the literature.

Furthermore, there are important variables that influence health outcomes but have not been accounted for in past studies, this can influence the results and give spurious outcomes. This study will account for important determinants (such as infant mortality, and life expectancy) of economic growth in an attempt to understand the relationship among health expenditure and health outcomes. This paper will shed more light on the association among these variables for the SSA. This study will promote government investment in health in an attempt to improve health outcomes within the region. Thus, the need to understand the importance of health spending in attaining better health outcomes, and appreciates the contribution of health outcomes to economic growth. The study will broaden the knowledge of the role of health investment in the attainment of Sustainable Development Goals in the region. In addition, the paper will benefit the policymakers, government officials/administrators, private enterprises, investors and other stakeholders in policy making and implementation across SSA countries.

3. Methodology

The underlying theoretical frameworks for this work was centered on demand for health model and the augmented neoclassical growth model theory as propounded by Grossman (1972) as used by Frank (2021); Sarpong, et al (2020); Arthur (2015); Ogunleye (2014); Fayissa and Gutema (2008) and Thornton (2002).

According to Grossman's (1972) demand for health theory, investing in one's health is essential to one's overall well-being as well as that of society at large. As a result, every society should make investments in health care services if it hopes to see an improvement in health outcomes. For the individual, it involves more than just monetary investment; it also involves time and modifications to lifestyle. However, this is not only applicable to individual but the society as a whole since the society comprises individuals. However, if people fail to use the health services provided within the society by either private or public entities or institutions or move along with lifestyle and what the environment demands, health care would be incomplete (Fayissa & Gutema, 2008).

According to Arthur (2015), investing in one's health can benefit both the individual and the community as a whole. The resources invested in achieving this health must be considered as having an impact on the general health of the country or on that particular individual. It is anticipated that this increased finance in health will certainly improve health outcomes, notably lowering death rate and

extending life expectancy. This served as the foundation for Grossman's (1972) health capital model, which held that improving both an individual's and society's overall health state required public, private or external health input. For the purposes of this study, the Grossman (1972) model is discussed in the manner that follows the health production function specification for Sub-Saharan Africa provided by Fayissa and Gutema (2008). The following is the expression for the health production function:

$$HO = F(X) \dots\dots\dots 3.1$$

In the health production function (F), where *HO* measures health outcomes, while *X* is a vector of health expenditures. The components of the vector *X*, as per the Grossman (1972) model, represent income and health expenditures, which include public, private and external health expenditures.

The Grossman (1972) model was created to examine the micro-level creation of health. Nonetheless, the objective of this study is to analyze the production system at macro-level while maintaining theoretical foundation at micro level. To do this, study will utilise the per capita variables 3.2 to express the vector *X*'s elements as seen below:

$$HO = F(Y) \dots\dots\dots 3.2$$

The vector *HO* in equation 3.2 represents health outcomes, whereas the vector *Y* represents per capita economic variables, such as income and per capita health spending. Equation 3.2 can be stated in equation 3.3 in its scalar version as follows:

$$HO = F(y_2 \dots y_n) \dots\dots\dots 3.3$$

Where $Y = (y_1, y_2 \dots y_n)$ and *n* stands for number of variables. Equation 3.3 can be changed to an explicit version using calculus by creating a probability density function with *y*, *s*, *v*, and *d* as variables. Equation 3.4 expresses this as follows:

$$HO = \theta \pi y_i^{\alpha_i} \dots\dots\dots 3.4$$

According to equation, α_i is the model's elasticity and π denotes the probability density function. The model proposed by Grossman (1972) indicates the initial health stock, which is estimated by θ . By assuming that the production system had not improved nor declined in terms of health, this assesses the health status that would have been realized. θ is considered to be inherited from the parents in the Grossman model. The following equation 3.5 can be obtained by taking the logarithm of equation 3.4:

$$\ln HO = \ln \theta + \sum \alpha_i (\ln y_i) \dots\dots\dots 3.5$$

Assuming that i starts at 1, 2, 3, n , and that Σ is a sum operator that adds up each scalar variable's components. Natural logarithm, or $\ln HO$, is a unit of measurement for health outcomes. The term " $\ln y$ " refers to natural logarithm of economic variables, including per capita health expenditures from the public, private or external sectors. Grossman (1972) theory predicts that public and private health financing would improve health outcomes. Grossman (1972) model shows that there is provision for factors that could mar or enhance health production activities of individual which includes external health expenditure factors. This is provided and introduced into the model as considered suitable, due to available data or literature.

3.1 Model Specification

Employing demand for health model developed by Grossman (1972), this study investigates the relationship between health inputs and health outcomes. The effect of health inputs on health result is described as follows, taking into account both infant death rate (IMR) and life expectancy at birth (LEP) as health indices:

$$ho_{it} = f((PKHE)_{it}) \dots \dots \dots 3.6$$

The vector representing the country i 's health outcomes at time t is represented by HO_{it} in equation 3.6. $PKHE_{it}$ denotes the nation i 's per capita health expenditure at time t . The sum of health spending per capita is used to measure it. To better examine the distinct impacts of public, private and external health financing on health outcomes, this sum of expenditures on health is separated into three categories: public, private and external health expenditures.

For estimating purpose, the values from equation 3.6 above and from 3.7 to 3.8 are provided. When broken down into public health, private health and external health expenditures, equation 3.7 is further written as equation 3.8. Equation 3.7 uses overall health expenditure to assess health investment expenditure.

$$\ln ho_{it} = \alpha_0 + \alpha_1 + \alpha_3 \ln PKHE_{it} + \varepsilon_{it} \dots \dots \dots 3.7$$

$$\ln ho_{it} = \beta_0 + \beta_1 \ln puhe_{it} + \beta_2 \ln Prhe_{it} + \beta_3 \ln exhe_{it} + \varepsilon_{it} \dots \dots \dots 3.8$$

$$= 1, \dots, n; m = 1, \dots, m$$

Where:

ho_{it} - represents health outcomes in country i at time t with IMR) and LEP
 α_0 , and β_0 represent intercepts in equations 3.7 to 3.8, while ε_{it} symbolizes the error term, which is thought to be independently distributed and of identical distribution.

$\alpha_1, \alpha_2, \alpha_3$ and $\beta_1, \beta_2, \beta_3$ are the explanatory variable's coefficients, which show the effect of a single unit and percentage change in each variable on health outcomes under the assumption that other factors stay unchanged: \ln represents natural log of the variables.

ns represents total number of distinct members that are represented in the panel;

m denotes quantity of variables included in the regression analysis;

$puhe_{it}, Prhe_{it}$ and $exhe_t$ represent public, private and external health expenditures respectively in country i at time t .

3.2 Econometric method of estimation

This sub-section dwells on the technique used in explaining the relationship between health outcomes and economic growth in SSA.

In order to investigate the influence of health input on health outcomes, this study will make use of the standard panel data models of pooled least squares, random effects, and fixed effects. The pooled least squares model is represented as follows in equation 3.9:

$$y_{it} = \alpha_{it} + X_{it} \beta + \mu_{it}, i=1 \dots N; t=1 \dots T \dots \dots \dots 3.9$$

Supposing: $\mu_{it} \sim iid (0, \delta_{\mu}^2)$ and $\delta_i^2 = \delta_t^2 = \delta^2$

From According to equation 3.9, y_{it} denotes the regressed variable, X_{it} denotes the regressor, α stands in for the regressor's coefficients, and μ_{it} denotes the disturbance terms. The sample is assumed to be free of significant country and period effects using the pooled least squares model. When the large time and country effects are not supported, this type of panel data model is vulnerable to criticism. Nonetheless, statistical testing and pooling model estimate are required for validation.

The Fixed Effect (FE) model is predicated on the existence of significant cross-sectional differences that do not vary over time, as well as the possibility of interrelationships between some of the variables and the error terms in the model. It is important to note that the unobserved heterogeneity in the FE model can bias the estimates from the model if it is not controlled. The time-invariant (heterogeneity) characteristics are assumed to be unique to each cross-sectional unit and not related among the cross sections; this is the reasoning behind the assumption of a relationship between the entity's error term and the predictor variables. The FE model removes the time-invariant characteristics by measuring the model's deviations from the mean. Equation 3.10 specifies the FE model.

Another name for the word α_i is an individual/country effect or an unobserved effect

$$y_{it} = \alpha_{it} + X_{it} \beta + \mu_{it}, \quad i=1 \dots\dots N; t=1 \dots\dots T \dots\dots\dots 3.10$$

$$E(\mu_{it}) = 0 \quad \text{var}(\mu_{it}) = \delta_{\mu}^2$$

Ordinary Least Squares (OLS) is the estimator used for FE modeling. The mistakes are assumed to be uncorrelated with the explanatory variables in the random effects model. Because of this, the random effects (RE) model makes the assumption that there is no correlation between the fluctuations across the cross sections and the predictor or regressor in the model. The unobserved individual effect may have components connected to the independent variables in the model, as stated by Greene (2012), "not whether these effects are stochastic or not." This is the fundamental distinction between FE and RE. Equation 3.11 states the random effects model.

$$y_{it} = X_{it} \beta + \varphi_{it}; \quad \varphi_{it} = \alpha_{it} + \alpha \varepsilon_{it} \dots\dots\dots 3.11$$

Because of the nature of the error term, the FE model will be estimated using the Generalized Least Squares (GLS) estimator (Tripathi, 2000). To determine if fixed or random effects are present, use the Hausman (1978) test. The OLS fixed effects results are consistent when there is correlation between the explanatory variable and the individual effects, but the GLS estimates do not match. In the event that there is no association between the explanatory variable and the individual effects, the fixed effects estimator is inefficient but both estimators are consistent. There should be no variation in the estimators under the null hypothesis of no connection. Estimating the coefficients from the regressions and their covariance is a prerequisite to performing the test. OLS and GLS estimators can be used to do regression analysis for both the fixed effects and random effect models, respectively, and yield this directly.

4. Results and Discussions

Descriptive statistics for this study is presented in Table 1. Mean, standard deviation, least and highest values of variables are discussed. Average value of a variable is expressed by its mean. By showing how far variable deviates from mean, standard deviation illustrates variable's variation.

Table 1 illustrates volatile character of Sub-Sahara African economy by showing that mean per capita economic expansion for period was 4865.5070 million

United States Dollars (USD) with a standard deviation of 5711.2730 million USD. The economic growth of the Congo Democratic Republic was the lowest (690.6600 million USD) in the region occurring in the 2002, but it steadily increased to 1073.6430 million USD in 2021. Equatorial Guinea, with economic growth of 35688.6500 million USD, recorded the highest value in 2018 (See Table 2).

The health expenditure data (disaggregated into external, private and governmental health spending). External and public health expenditure have mean of 25.5709 million USD and 87.5576 million USD, while the mean expenditure on private health was 153.1921 million USD. According to the Table 2, Sierra Leone spent more on public health in 2020 compared to other nations in the region. The figure stood at 1471.6190 million USD; while in year 2000, the Democratic Republic of Congo spent the least amount (0.2694 million USD) on public health. Nevertheless, it increased to 1.0223 million USD in 2003, a period of four years before falling to 0.8022 million USD in 2004. After that, it has continued to rise and fluctuated until 2020, when it was stabilised at 86.6800 million USD. Mauritius recorded the highest (760.0536 million USD) private health spending in 2019, while Malawi recorded the lowest private health spending in 2021 at 0.1128 million USD.

The average external health spending is 25.5709 million USD. In Sub-Saharan Africa, Botswana had the lowest external health spending (11.7000 million USD) in 2004; Namibia had the highest (183.6230 million USD) in 2006. The country with highest value of mortality rate for infant of 138.6000 (13%) per 1,000 live births in 2000 was Senegal; while Benin Republic had the least value of infant mortality rate amounted to 11.7000 (1%) in year 2021 (See Table 2).

Life expectancy in SSA region is poor relative to other regions. With a 77.2366-year average life expectancy in 2020, Sierra Leone achieved the highest life expectancy between years 2000 to 2021. This country continuously maintained its lead in life expectancy, having reached 77.2366 years as early as 2000. Sierra Leone does exceptionally well in terms of life expectancy relative to other SSA countries. Zimbabwe's score was 41.957 in year 2001. Nonetheless, the nation has steadily recovered from setback, recorded a 61-year (45% increase) average life expectancy in 2018 (See Table 2).

Table 1 Descriptive Statistics

Variables	Mean	Standard Deviation	Minimum	Maximum
Puhe	87.5576	153.1921	0.2694	1471.6190
Prhe	93.6283	109.6408	0.1128	760.0536
Exhe	25.5709	25.7676	11.7000	183.6230
Imr	57.4462	23.9510	11.7000	138.6000
Lep	58.9528	6.5452	41.5970	77.2366

Source: Author’s computation (World Bank, 2024) using Eview, 2024

Table 2 Descriptive Statistics (Countries with Minimum and Maximum Values)

Year	Variable	Minimum	Country	Year	Maximum	Country
2000	Puhe	0.2694	Congo Democratic Republic	2020	1471.6190	Sierra Leone
2021	Prhe	0.1128	Malawi	2019	760.0536	Mauritius
2004	Exhe	11.7000	Botswana	2006	183.6230	Namibia
2021	Imr	11.700	Benin Republic	2000	138.6000	Senegal
2001	Lep	41.9570	Zimbabwe	2020	77.2366	Sierra Leone

Source: Author’s computation (World Bank, 2024) using Eview, 2024

4.1. Effect of health expenditure on health outcomes

In order to examine the effects of health inputs on health outcomes, this study estimates models for pooled least squares, fixed effects, random effects. Comparatively, Hausman test revealed that model for fixed effects was more suitable to that of random effects models. The results for health expenditure (divided into public, private and external expenditures) on health outcomes is shown in Table 3.

4.2. Effect of Public, Private and External Health Expenditures on Infant Mortality

The effects of public, private and external health expenditures on infant mortality in SSA is shown in Table 3. The result for Fixed Effect Model is interpreted below in Hausman’s Test, while Random Effect serves as robust estimate. In most cases,

the Random Effect coefficient conforms to the direction and relevance of the Fixed Effect coefficients.

Table 3: Public, Private and External Health Expenditure and Infant Mortality

Variables	OLS	Fixed Effects	LSDV	Random Effects
Puh	-0.0766*** (0.00619)	-0.0184*** (0.00713)	-0.0184*** (0.00713)	-0.0235*** (0.00691)
Prh	0.0106 (0.00855)	-0.0277*** (0.00979)	-0.0277*** (0.00979)	-0.0257*** (0.00951)
Ext	-0.183*** (0.0256)	-0.228*** (0.0215)	-0.228*** (0.0215)	-0.227*** (0.0213)
Constant	67.85*** (1.051)	67.49*** (0.992)	83.76*** (2.647)	67.73*** (2.682)
Observations	990	990	990	990
R-squared	0.279	0.141	0.760	
Number of country name		45		45
firm effect		YES		YES
year effect		NO	NO	NO
F-test		51.70	63.58	
Prob > F		0	0	
Wald-chi2				169.8
Prob > chi2				0
country effect			YES	

“t: statistics (standard errors) in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Author’s computation using Stata, 2024

Table 3 reveals public health expenditure (puhe) has an indirect but statistically significant effect on infant mortality. It implies that public health expenditure is important if infant mortality must be reduced. This performance could be as a result of governments’ efforts in the budgetary allocation and judicious utilisation of public funds in the provision of healthcare facilities and healthcare services; making vaccines available for nursing mothers to vaccinate their newborn babies at an age required and at appropriate times; providing information about best way to take care of the baby. It may also be due to awareness of the benefits accrue to breastfeeding; provision of better remuneration, and allowances for the health workers across the region. The statistics suggests that when public health

expenditure increases, brings about a reduction in infant mortality. However, this conforms to the work of Arthur and Oaikhenan (2017), Olatunde and Fagbemi (2019), Ayipe and Tanko (2023) which investigated relationship between health financing and health outcomes in SSA region and results show that health financing substantially reduces death rates. Public health financing have a large effect on death rate declines.

Private health expenditure (prhe) in Table 3 also reveals that there is negative and statistically significant effect on infant mortality. That is, an improvement in health expenditure by private individuals is an important factor in lowering death rate. This improved private health expenditure perhaps is as a result of more funds expend by well- to-do families on their health and who have either health insurance scheme or paying for health services out of their personal pockets. The findings signify that the more individuals commit financial resources on their personal wellbeing, the less will be infant mortality by an average of about 3% in Sub-Saharan Africa. This finding agrees with Frank and Mcineka (2021), who found that infant mortality decreases when investment on private health increases.

Similarly, Table 3 reveals that external health expenditure (exhe) propels infant mortality in SSA to decline. This may be as a results of supports from external bodies include but not limited to World Health organization (WHO), World Bank (WB) and United Nations (UN) in providing and enhancing facilities and resources to train and retrain of health personnel in the region. The findings show that when external health expenditure improves, leads to a fall in infant mortality by 2.7% in SSA. This result was in conformity with Novignon and Lawanson (2017), and Adegoke et al, (2022) demonstrating that increased health investment (external health) declines infant mortality rate.

Effect of Public, Private and External Health Expenditure on Life Expectancy

Table 4 shows result for public, private and external health expenditures (puhe, prhe & exhe) on life expectancy in SSA. Column 3 comprises Fixed Effect model's coefficients. The Fixed Effect model's coefficients are interpreted based on Hausman's test result.

Table 4: Public, Private, External Expenditure and Life Expectancy at Birth.

VARIABLES	OLS	Fixed Effects	LSDV	Random Effects
Puh	0.0176*** (0.00182)	0.0116*** (0.00203)	0.0116*** (0.00203)	0.0119*** (0.00197)
Prh	-0.000251 (0.00251)	0.00724*** (0.00278)	0.00724*** (0.00278)	0.00678** (0.00271)
Ext	-0.000908 (0.00751)	0.0604*** (0.00610)	0.0604*** (0.00610)	0.0578*** (0.00605)
Constant	57.46*** (0.309)	55.72*** (0.282)	54.05*** (0.752)	55.80*** (0.777)
Observations	990	990	990	990
R-squared	0.166	0.171	0.741	
country effect	NO		YES	
year effect	NO	NO	NO	NO
F-test	65.60	64.58	57.37	
Prob > F	0	0	0	
Number of countryname		45		45
firm effect		YES		YES
Wald-chi2				196.8
Prob > chi2				0

“t: statistics (standard errors) in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source: Author’s computation using Stata, 2024

Table 5 reveals that fixed effects coefficients for public health expenditure (puhe) is positive, as well as significant to explaining life expectancy. The result suggests that increased public health expenditure brings about improved life expectancy by an approximately 1% as model revealed.

Table 4 also reveals that external health expenditure (exhe) serves as a propeller to life expectancy in SSA. The reason may not be far-fetched from the contributions obtained from external donors to support health service delivery in SSA countries. The donors like WHO, WB, and UN are supporting provision of improved healthcare service delivery in SSA. The fixed effects’ results establish that enhanced external health spending brings about improved life expectancy by 6% in SSA.

Harmonizing public, private, and external health spending is fundamental to improving health outcomes in the SSA region, given the significance of the three

sources of funding on health outcomes. The implementation of health insurance programmes, as supported by Akanni (2012), Ogunleye (2014), and Arthur (2015), is one way to harmonize health care spending.

These results suggest that health spending is a major player when it comes to raising life expectancy and lowering the region's infant death. The findings also show that while public and external health spending are essential in determining life expectancy at birth, the later has more effect on infant mortality rates in SSA. The efficacy of external health expenditure on infant mortality rates may be attributed to the region receiving financial support from international organizations for health advancement, which is effective in lowering mortality and raising life expectancy. These results validate model developed by Grossman (1972) suggesting that outcomes improves and benefits individual if investment in health enhances. These results indicate empirical consistency to other research reporting a substantial effect of health investment on health outcomes. Among these works are Arthur (2015) and Akanni (2012). These findings, however, differ from research that found no influence of health inputs on health outcomes (Fayissa & Gutema, 2008; & Ogunleye, 2014). This study finds that expenditure on health significantly affects health outcomes.

5. Conclusion and Recommendations

This study examines relationship that exists among health outcomes and economic growth in Sub-Saharan Africa (SSA). This study investigates how health expenditures influence health outcomes in SSA. The findings reveal that health outcomes are influenced substantially by health expenditure in the region. Expenditure on health as findings further reveal causes decline in infant mortality rate, while it increases life expectancy at birth.

Given these substantial growth implications of investments in health outcomes and health improvement, the study recommends that:

- i. Policymakers to consciously devote incremental resources to health industry for building, renovating and maintaining healthcare facilities.
- ii. Hire, train and retrain more healthcare professionals.
- iii. Acquire modern, effective and efficient equipment for the delivery of healthcare.
- iv. Subsidise and possibly declare free health care services to the vulnerable individuals and families across the entire SSA member nations. These will play a major role in attaining the targeted and better health outcomes.

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