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ABSTRACT
There has been an influx of official development assistance to the health sector in developing countries especially those in the Sub-Saharan Africa (SSA) region in recent decades, but little is known about the effect of such interventions on human longevity. The study therefore assessed the effect of health aid on life expectancy using data on 46 SSA countries from 2000 to 2019 which were sourced from the World Development Indicator, Organization for Economic Co-operation and Development Creditor Reporting System, and United Nations Children's Fund. System Generalized Method of Moment (system GMM) was adopted in analyzing the data due to its appropriateness for the scenario at hand. Validity of the model was examined with autoregressive (AR) tests (AR(1) and AR(2)), while Sargan test and Hansen test assessed the validity of the instruments used in the estimation. Robustness of the system GMM was confirmed using the pooled Ordinary Least Square and fixed effect regressions. Results showed that health aid does not have any significant effect on life expectancy in SSA. Rather, life expectancy was significantly improved by school enrolment, trade openness, Gross Domestic Product per capita and physician density, while corruption significantly reduced it. The study recommended more judicious utilization of official development assistance meant for the health sector, policies capable of achieving noticeable growth and development, and improved effort to eradicate corruption in government policy implementation in the health sector to significantly improve life expectancy in the region.

Keywords: Corruption, development goals, health expenditure, physician density, system GMM,
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1 INTRODUCTION

Health can be viewed as a commodity for direct consumption as every individual aims as much as possible to have the best of it because humans derive utility from good health. Good health is also necessary to participate productively in the labor market and earn good income. Therefore, health is sometimes viewed as a derived commodity. Human longevity in the society, usually measured through life expectancy, is a popular measure of health status of the people. According to Goldin (2019), despite great improvement in the health of people in developed countries, less improvement is seen in the developing countries. The lack of good health of individuals in most developing countries has reduced their potential for economic growth and development. Common factors cited to be responsible for poor health outcome in developing countries are the scarcity of quality and affordable health care facilities, lack of or little education, and poverty (Kosack, 2003).

In 2000, all the 191 member states of the United Nations (UN) came together with a view to foster development and therefore adopted a package of development plan named the Millennium

Development Goals (MDGs). The MDGs aim to eradicate extreme poverty and hunger; achieve universal primary education; promote gender equality and empower women; reduce child mortality; improve maternal health; combat HIV/AIDS, malaria and other diseases; ensure environmental sustainability; and develop a global partnership for development (United Nations, 2014). Health was recognized as a major input in the development process and efforts and resources were planned and channeled into improving it. After the MDGs' target date of 2015 had passed, the UN General Assembly decided to build on the existing achievement to further foster global development and again adopted the Sustainable Development Goals (SDGs) with 2030 as the target date. There are seventeen goals in the SDGs with the third goal called "the health goal". The Goal 3 has thirteen targets each of which has connection with the health of individuals.

As at the time of formulation of the MDGs, it was obvious that most of the developing countries may not be able to achieve the goals as stated. Hence, the assistance of the international community was thought to be needed (Radelet, 2004). The consensus resuscitated the decision the international community first made in the late 1960s that a minimum of 0.7% of donors' Gross National Product (GNP) will be channeled to official development assistance for developing countries. Hence, there was a surge and continuous inflow of official development assistance (ODA) otherwise called foreign aid to developing countries from year 2001 with the aim of helping to achieve the various components of the MDGs. Health-aid to Sub-Saharan Africa (SSA) was US$727,056,000 in 2002 and rose to US$1,838,135,000 in 2010 and US$6,049,992,000 in 2018 (OECD, 2021).

One of the key targets of health aid has been to improve life expectancy where it has been low, especially in developing countries such as those in SSA. Despite increases in health aid, the situation of health outcomes in SSA region is clearly below what is needed to achieve the global health agenda of the SDGs as the region lags behind most other developing regions of the world in common health indicators, let alone developed regions. Life expectancy at birth (LEB) in SSA has been increasing slowly over the last two decades. For instance, average LEB were 51 years, 56.7 years, and 61.3 years in 2002, 2010 and 2018, respectively in SSA region (World Bank, 2021). This observed situation in the region is incomparable with those of East Asia and the Pacific (EAP) and Latin America and the Caribbean (LAC) regions whose life expectancy as of 2018 were 76 years and 75.4 years, respectively.

Given the inflow of health aid into SSA and the relatively low life expectancy at birth being experienced, there is an urgent need to empirically investigate the nature of the effect of health-targeted aid on LEB in the region. The present study is therefore aimed at determining the effect of health aid on life expectancy in Sub-Sahara Africa. Specifically, the study attempts to:
1. Determine the effect of health aid on life expectancy in SSA
2. Assess the effect of government health expenditure on life expectancy in SSA
3. Determine the effect of physician density on life expectancy in SSA

In a bid to achieving the key objectives of the study, the following hypotheses stated in their null forms were tested:
1. H_{01}: There is no significant relationship between health aid and life expectancy in SSA
2. H_{02}: There is no significant relationship between government health expenditure and life expectancy in SSA
3. H_{03}: There is no significant relationship between physician density and life expectancy in

SSA

The present study is novel as it uses more recent available data unlike some studies such as Yogo and Mallaye (2012) that utilized data from 2000 to 2010 and Welander (2012) which used data from 1970 to 2009 which may be considered outdated at the present time. Given the dynamic nature of economies and accompanying social and health implication, the usefulness of such findings to solve present problems may be limited. The present study also utilized true yearly data unlike Gomanee et al. (2005), Wilson (2011) and Welander (2012) which made use of interval data which may mask some effects. Furthermore, the system GMM estimation procedure was adopted to address the problem of endogeneity common with foreign aid and development variables such as life expectancy, unlike Gomanee (2005), Yogo and Mallaye (2012) and Welander (2012) which adopted the fixed effect estimation procedure which may not be equipped to address endogeneity problem. The introduction of several relevant control variables is also unique, unlike Kizhakethalackal (2009) and Kotsadam et al. (2018) which failed to consider the inclusion of such. Findings from the study is expected to provide better understanding of the intrinsic relationship between health sector aid and life expectancy in SSA and chat policy directions for governments and other supporting stakeholders in the region.

2 LITERATURE REVIEW

There are several empirical works aimed at assessing the effect of official development assistance and health targeted aid on health outcome, especially life expectancy, in developing countries including countries in SSA. For instance, Williamson (2008) assessed the impact of foreign aid on human development using data from 1973 to 2004 covering all countries which received health aid and data were extracted from the 2006 World Development Indicators. Several control variables were included, and these were percentage of population who live in urban areas, political freedom, physician density and gross domestic product (GDP). Fixed effect regression was first estimated, and it served as the baseline specification followed by the instrumental variable estimation which was the main analysis and to control for reverse causality due to endogeneity. Because the study specifically analyzed aid given to the health sector, it was necessary to operationalize an instrument for health aid. Official development assistance may be endogenous due to the tendency that the present health situation in a country is likely to determine the amount of health aid received. The study reported that health aid was not effective in improving overall health of the people in the recipient countries.

Mishra and Newhouse (2009) carried out an assessment of the effect of health sector aid on infant mortality and life expectancy in a study which used data from 1973 to 2004 covering 118 developing countries. The data on health and overall aid were both obtained from the OECD database. Data on health outcome included infant mortality and life expectancy in countries receiving aid. Aid per capita, control variables which captured the country's initial economic and health status and HIV/AIDS were included in the Ordinary Least Square (OLS), the fixed effect model and the system GMM model estimated. It was reported that health aid had close to zero effect on life expectancy which was not significant.

Welander (2012) attempted to determine whether foreign aid and globalization affect health in developing countries using data on 93 developing countries from 1970 to 2009 which were analyzed with a fixed effect model while health outcome was proxied with infant mortality, life expectancy and child mortality rate. Explanatory variables outside the main regressor (health aid) were KOF index (an index of the degree of globalization of countries conceived by Axel Dreher at the Konjunkturforschungsstelle of Swiss Federal Institute of Technology Zurich, in Switzerland), real per capita GDP, dependency ratio, physician density, urban population, nutrition, average year of schooling, democracy and government consumption. The study found no significant relationship between health aid and life expectancy.

Yogo and Mallaye (2012) utilized data covering the period 2000 to 2010 from 28 countries in SSA, to examine the effect of foreign aid meant for the health sector on health outcomes. The study took care of the likely endogeneity, used the instrumental variable and reported that health aid improved health outcomes in SSA. Specifically, additional unit of health aid increased life expectancy by 0.14 years. These effects operated mostly through the improvement in the primary school completion rate of female. The study further reported that the Oaxaca-Blinder decomposition showed that the differences in the quantum of foreign aid for the health sector received did not account for the gap in the health outcomes between stable countries and countries that are just coming out of conflicts.

Ssozi and Amlani (2015) assessed the effectiveness of health expenditure on proximate and ultimate goals of healthcare in SSA covering 43 countries which were chosen solely due to availability of data from 1995 to 2011. Data used included health expenditure, life expectancy, infant and child mortality rates, and the study model was estimated within the GMM framework. The health expenditure was decomposed into public and non-public expenditures. The regression results showed a positive effect (magnitude of coefficients of public and non-public health expenditure as explanatory variables) on immunization and nutrition, and a negative effect on HIV/AIDS which were classified as proximate goals but very small value (low effects) on life expectancy which was regarded as the ultimate goal.

Toseef et al. (2019) assessed the effects of total foreign aid and health sector aid on the health of residents of countries which received foreign aid since the inception of the MDGs. The study utilized data from 2001 to 2015, covering 90 aid recipient developing countries. Fixed effects multivariate regressions with alternative specifications were estimated for each of the measures of health considered in the study. The multilevel mixed model and the system GMM were also estimated. The system GMM model took care of the dynamic nature of the panel data and gave room for the likelihood that aid and other control variables may not have instantaneous effects on population health. The study modeled the effects of one-period lagged aid and other covariates on current health outcomes including the one-period lagged health outcome. The study found some evidence that foreign aid has improved life expectancy in developing countries, but the effect was very small. The study advocated that continuous attention should be paid to the relationship existing between official development assistance and health outcomes to obtain values for the fund invested.

Although, extensive research efforts have been made on investigating the effect of health aid on health outcomes, especially for developing countries, there are still obvious gaps in most of the existing literatures. Studies such as Ssozi and Amlani (2015) and Welander (2012) did not try alternative analytical procedures such as two stage least square (2SLS), instrumental variable (IV) models and GMM models which are capable of addressing the inherent endogeneity problem. Welander (2012), for example, failed to take care of reverse causality between foreign aid and development (health) in the study which may weaken the reliability of the results. Data used in some other studies (e.g., Yogo & Mallaye, 2012; Gomanee et al., 2005; and Welander, 2012) were outdated while some failed to include relevant control variables in their models (e.g., Kotsadam et al., 2018; Youde, 2010; Kizakethalackal, 2009). The present study intends to include as many relevant control variables as possible such as government effectiveness, corruption, GDP per capita etc., which are also important to health outcome. Finally, the study used available up-to-date data with a view to address perceived deficiencies in some of the existing literatures.

3 METHODOLOGY

3.1 Model Specification

As explained in the Solow growth model, the saving portion of income is needed to accumulate sufficient capital per effective labor. The model gives the growth of capital per labor ratio and shows that the growth of capital per labor is a function of savings and cost of capital. The shortage of savings in developing economies led to their need for foreign aid to achieve development which include health goals. Thus, extracting from the exposition of Robert Solow, capital growth can be stated as:

$$k = f(S) \text{ ……………..……………….. (1)}$$

where *k* is growth of capital per labor and S is saving. Mankiw, Romer and Weil (1992) however posited that human capital which the Solow model failed to give empirical justification for is one reason for differences in income across countries. It therefore implied a notion that increase in savings among other variables will lead to increase in capital including human capital whose major component is health. It should be recalled that because saving is not enough, foreign aid is needed to augment saving in order to build up capital. Therefore, equation (1) can be rewritten as:

$$H = f(HAD) \text{……………………………. (2)}$$

where H is health (a major component of human capital which is a part of general capital needed in the production process) and HAD represents foreign aid for the health sector which is required because saving is not enough. This study moved forward to proxy health (H) with life expectancy at birth (LEB) and expressed it as a function of health sector aid as:

$$LEB = f(HAD) \text{ ………………………….... (3)}$$

In addition, the study augment equation (3) with variables suggested in literature such as those of Toseef et al. (2019), Ssozi and Amlani (2015) and Welander (2012) as:

$$LEB = f(HAD, SSE, HEXP, POP, TOP, CORR, GOV, AIW, GDPC, PHY) \text{ … … … (4)}$$

LEB is life expectancy at birth which is defined statistically as the mean number of years remaining for an individual or a group of people at a given age. When taken at birth, it becomes life expectancy at birth (LEB) measured in years. HAD is health aid share of GDP. SSER is secondary school enrolment rate, and it is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. HEXP is health expenditure (domestic) and measured in constant 2010 US Dollar but entered the estimation as share of GDP. POP is population defined as the number of all residents regardless of legal status or citizenship and values used were midyear estimates. TOP is trade openness, and it measures the degree of openness to trade as captured by the addition of import and export as a percentage of the GDP. CORR is corruption index which measures the perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption. It is measured using annual control of corruption index which ranks countries on a scale from –2.5 (high corruption) to 2.5 (low corruption). This index was rescaled following Ackay (2006) by subtracting country scores from 2.5 so that higher values correspond with higher corruption levels. GOV is government effectiveness index which measured the quality of public services, the civil service and the extent to which these are free from political pressures and the quality of policy formulation among others. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e., ranging from approximately -2.5 to 2.5 (Worldwide Governance Indicator- WGI, 2021). AIW is access to improve water measured as % of total population with access to clean water. GDPC is GDP per capita which is a metric that breaks down a country's economic output per person and is calculated by dividing the GDP by the total population and measured in constant 2010 US Dollar. PHY is physicians per 1000 (physician density) which is measured as the number of medical doctors per 1000 people.

3.2 Sources of Data and Scope

Data on life expectancy at birth (LEB), population (POP), trade openness (TOP), secondary school enrolment rate (SSER), domestic health expenditure (HEXP), GDP per capita (GDPC) and physician density (PHY) were obtained from the World Development Indicators (World Bank, 2021). Health aid data were extracted from the OECD Creditors Reporting System (OECD, 2021) while access to improved drinking water (AIW) were obtained from UNICEF (UNICEF, 2021) and governance indicator variable data were sourced from the World Governance Indicator (WGI, 2021). Data collected covered 2000 to 2019 on all the study variables in the following 46 countries in SSA: Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Democratic Republic of Congo, Congo, Cote d'Ivoire, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, The Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe.

3.3 Estimation Techniques

Pre-Estimation

Descriptive statistical analyses were carried out to give a general picture of the data used for the substantive analysis. These included measures of central tendency which are mean, mode, median and measure of dispersion (standard deviation). It also included skewness which has to do with the degree of asymmetry, and kurtosis. In addition, correlation analyses were carried out in order to avoid the problem of multicollinearity by indicating pairs of explanatory variables with high correlation coefficients because such problem can lead to a situation where estimates of the model are indeterminate and standard errors may be infinitely large which may cause wrong conclusion about the parameter estimates.

Estimation

Equation 5 was estimated using the system Generalized Method of Moment (system GMM). The procedure was most preferred because literature has established that simultaneous relationship usually exists between foreign aid and human development (which include health indicators) causing endogeneity problem. The system GMM methodology combines in a system the differenced independent variable and its level forms and addresses endogeneity problem. According to Arellano and Bover (1995) and Blundell and Bond (1998), the chosen estimation procedure is capable of correcting for measurement error, unobserved country heterogeneity, potential endogeneity and omitted variable bias. These are in addition to its ability to control for persistence in life expectancy since it has behavioral effects which persist, the fact that the number of time series in each section (20) is lower than the number of countries (46), and ability to control for cross-country variations. According to Blundell and Bond (1998), the system GMM estimator can also correct for biases associated with differenced estimator.

The GMM approach is specifically desirable in estimating panel data in situations where time covered by the study is small and the number of cross section (countries in SSA in this instance) is large, the independent variables are not strictly exogenous (endogenous regressors), there is tendency for fixed effect, and when there are heteroskedasticity and autocorrelation within each country's data but not across the countries (Roodman, 2009). Rodman (2009) also suggested that the number of instruments should not exceed the number of cross-sections to guard against instrument proliferation or over identification which introduces bias into the GMM estimator, weakening of Sargan test and Hansen test and over fitting of endogenous variables.

The equation estimated using system GMM is stated explicitly as:

$$LEB_t = \alpha_0 + \alpha_1 LEB_{it-1} + \alpha_2 HAD_{it} + \alpha_3 SSER_{it} + \alpha_4 HEXP_{it} + \alpha_5 POP_{it} + \alpha_6 TOP_{it} + \alpha_7 CORR_{it} + \alpha_8 GOV_{it} + \alpha_9 AIW_{it} + \alpha_{10} GDPC_{it} + \alpha_{11} PHY_{it} + \eta_i + \mu_t + \varepsilon_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (5)$$

Variables are as earlier defined while η = Country specific effect; μ = Time specific effect; ε = Error term; α = Slope coefficient; *i* = Cross section of countries, and t = Time period

A priori Expectations: $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_6, \alpha_8, \alpha_9, \alpha_{10}, \alpha_{11} > 0; while\ \alpha_5 \& \ \alpha_7 < 0$

Post-Estimation Assessments

It is necessary to test for autocorrelation in the differenced residuals as part of the post-estimation diagnosis in GMM analyses. The test is expedient to establish the validity of the estimated GMM model. Arellano and Bond (1991) had earlier developed a test for autocorrelation in the idiosyncratic disturbance term v_{it} that may render some of the lags invalid as instruments. Because Δv_{it} (the differenced idiosyncratic error term) is mathematically related to $\Delta v_{i,,t-1}$ (lag of the differenced idiosyncratic error term) via $v_{i,t-1}$ term, negative first-order autocorrelation is much expected. This is called the AR(1) test and the null hypothesis of "no first order autocorrelation" is expected to be rejected. The null hypothesis of "no second order autocorrelation" called AR(2) is expected to be accepted. The validity of the instruments was examined with Sargan test and Hansen test to ensure the consistency of the GMM estimates. GMM estimator is consistent if the instruments are valid. The null hypothesis of both Sargan test and Hansen test is that all instruments as a group are exogenous. Finally, according to Bond (2002), the good estimate of the lagged dependent regressor is expected to have a value which should be between its OLS and fixed effect estimates. Thus, these estimates provide a useful robustness check on result. Hence, OLS and within group model were estimated in a bid to assessing the GMM results.

4 RESULTS AND DISCUSSION

4.1 Preliminary Analyses: Descriptive Statistics

These are presented in Table 1 and statistics contained therein include minimum, maximum, median, mean, standard deviations, kurtosis, skewness, and the Jarque-Bera statistics for the assessment of normality of distributions. Results showed that the mean of life expectancy at birth (LEB) in sub-Sahara Africa (SSA) from 2000 to 2019 was 57.87 years with a moderate dispersion around the mean i.e., a standard deviation value of 7.02. The LEB series was revealed to be normally distributed given the Jarque-Bera test probability which was more than 5% level. The number of physicians per 1000 of the population otherwise called physician density (PHY) value of 0.24 was far below the WHO recommended ratio of 1: 1,000. Although, Kumar and Pal (2018) posited that 44% of the WHO member countries have not been able to achieve the recommended ratio. Access to improved water (AIW) in SSA averaged 72.64% of the population during the period of the study. This was better than 46% in Central and Southern Asia but lesser compared to 97% in Finland and 96% in the United States (UNICEF, 2021). The average health expenditure share of GDP (HEXP) was 5.14. This was a bit lower than 6.35 for EAP, 7.22 for LAC and the world average value of 9.47 in the periods covered by the study (World Bank, 2021).

The average GDP per capita (GDPC) for the period was $2,290.37. This was far below the world average value of $9,557.36 and the average in some other regions in the world. For instance, GDP per capita was $8,771.75 in LAC and $7,701.95 in EAP (World Bank, 2021). The low GDP per capita may affect health demand and health outcome of the people negatively. Trade openness (TOP) reflects the depth of international trade relative to the concerned country's GDP. The average value in SSA during the study period was 72.05%. This reveals a high level of international trade in the region and far above those of some other comparable developing regions. For instance, trade openness was 43.62% in LAC and 59.86% in EAP during the same period while it was 79.7% in the European Union (World Bank, 2021). The low level of economic development in SSA compared with EU despite having close levels of trade openness may be a pointer to the fact that the bulk of international trade in SSA have not been much beneficial in general terms. Secondary school enrolment rate (SSER) may reflect the level of education/enlightenment of the people in a country and the average enrolment rate in the region was 42.06%. This suggests a very wide gap to cover in terms of secondary school education in the region. All the study variables, except corruption (CORR), skewed positively while in terms of kurtosis, life expectancy at birth, corruption, access to improved drinking water and secondary school enrolment rate were mesokurtic in distribution i.e., they had moderate peaks. The Jarque-Bera statistic combines the properties of measures of skewness and kurtosis to access the normality of the distribution of series and the statistic confirmed that life expectancy was normally distributed.

The mean of health aid share of GDP (HAD) among countries in the region during the study period was 0.3484%. The corruption index (CORR) average value was 3.11 which suggested high level of corruption in the region. Recall that the final measurement of the index ranged from 0 (no corruption) to 5 (high corruption). Government effectiveness (GOV) average value among countries in SSA was -0.71 for the period of the study. It will be recalled that the GOV index ranged from -2.5 (not effective) to 2.5 (highly effective). The average reported in this study therefore suggested very low level of government effectiveness. The discouraging levels of the two forgoing governance variables may impact government policy implementations negatively and policy targets including health outcomes such as life expectancy.

Table 1: Summary of Descriptive Analyses of the Study Variables Examining the Impact of Health Aid on Life Expectancy in SSA

	LEB (years)	**HAD**	**GDPC ($)**	**HEXP**	**CORR**	**GOV**	**AIW (%)**	**PHY**	**POP**	**SSER (%)**	**TOP (%)**
Mean	57.87	0.3484	2290.37	1.83	3.11	-0.71	72.64	0.24	17820385	42.06	72.05
Median	58.07	0.18	989.57	1.58	3.21	-0.74	72.42	0.10	10409229	38.56	62.04
Maximum	74.51	5.39	20532.95	7.12	4.33	1.05	99.87	2.53	1.91E+08	99.90	311.35
Minimum	38.70	2.33E-07	194.87	0.04	1.28	-1.88	24.58	0.008	81131.00	6.11	16.67
Std. Dev.	7.02	0.0516	93.26	0.17	0.62	0.61	4.90	0.38	27421484	21.20	7.44
Skewness	0.14	3.59	2.57	1.37	-0.69	0.53	-0.29	3.25	3.56	0.66	1.80
Kurtosis	2.80	23.48	10.12	5.12	2.91	2.79	2.77	15.21	18.19	2.80	8.60
Jarque-Bera	4.53	17998.22	2952.65	455.72	70.22	42.76	15.12	2919.14	10783.17	49.58	1617.51
Probability	0.1037	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005	0.0000	0.0000	0.000000	0.0000
Observations	920	917	919	910	874	874	915	866	920	678	877

Source: Author's Computation, 2021
LEB = life expectancy at birth, HAD = health aid share of GDP, GDPC = GDP per capita, HEXP = health expenditure, CORR = corruption index, GOV = government effectiveness, AIW = access to improved water, PHY= physician density, POP = population, SSER = secondary school enrolment, TOP = trade openness

Table 2 presents the results of product moment correlation analyses conducted on all the study variables. The results showed that there was no such high correlation between any pair of proposed independent variable to portend possibility of serious multicollinearity in the model estimated.

4.2 Results of System GMM Estimation of the Effect of Health Aid on Life Expectancy

To achieve the main objectives of the study, Equation 5 was estimated using the system GMM as stated under methodology and results are presented in Table 3. The system GMM results showed that the previous year's life expectancy had positive and significant effect ($P<0.01$) on the contemporaneous life expectancy in line with expectation. An increase in the previous year's life expectancy by 1% resulted in 0.9161% increase in the present year life expectancy at birth level revealing noticeable persistence of the variable. The positive relationship exhibited by lagged LEB may be because larger proportion of the population in SSA are in the productive age group that could possibly maximize health production. The positive value also corroborated the findings of Gutema and Mariam (2018) for Ethiopia.

Health aid (HAD) did not have any significant effect on LEB. This implied that health aid to SSA has not been able to increase life expectancy in the region, against expectation. Williamson (2008) concluded that foreign aid was not effective at improving overall health and was not

Table 2: Correlation Analyses of Variables Used in Examining the Impact of Health Aid on Life Expectancy in SSA

	LEB	HAD	GDPC	HEXP	CORR	GOV	AIW	PHY	POP	SSER	TOP
LEB	1										
HAD	-0.07	1									
GDPC	0.33	-0.42	1								
HEXP	0.07	-0.14	0.58	1							
CORR	-0.40	0.08	-0.61	-0.54	1						
GOV	0.23	0.28	0.24	0.08	-0.35	1					
AIW	0.49	-0.29	0.70	0.46	-0.57	0.41	1				
PHY	0.53	-0.32	0.86	0.29	-0.44	0.14	0.57	1			
POP	-0.19	-0.10	-0.14	-0.33	0.32	0.31	-0.24	-0.06	1		
SSER	0.58	-0.27	0.63	0.36	-0.54	0.39	0.68	0.62	-0.14	1	
TOP	0.18	-0.15	0.47	0.27	-0.40	0.26	0.30	0.37	-0.37	0.49	1

Source: Author's Computation, 2021
LEB = life expectancy at birth, HAD = health aid share of GDP, GDPC = GDP per capita, HEXP = health expenditure, CORR = corruption index, GOV = government effectiveness, AIW = access to improved water, PHY= physician density, POP = population, SSER = secondary school enrolment, TOP = trade openness

a successful tool for human development. This conclusion was as a result of the non-significance of foreign aid variable on all human development indicator models including life expectancy in a study that covered all countries which received foreign aid for the health sector from 1973 to 2004. Nwude et al. (2020) reported that official development assistance failed to increase life expectancy in recipient countries. In fact, a negative and significant effect of aid on life expectancy was reported based on data from 81 developing countries from 1999 to 2017. It is worthy of note that authors such as Easterly (2006) and Moyo (2009) have earlier posited that aids are not capable of improving health status of the people of recipient countries. Meanwhile, Yogo and Mallaye (2012) reported that health aid has positive and significant effect on life expectancy in SSA using data from 2000 to 2010. The difference in the results may be due to the difference in the analytical procedure and/or the periods covered. While the present study utilized the system GMM estimation procedure (which accounted for most econometric problems associated with such micro-panel data), Yogo and Mallaye (2012) adopted the OLS, fixed effect and instrumental variable regression.

Government health expenditure (HEXP) was not significant at any acceptable risk level. This implies that government spending on health has not been able to improve life expectancy at birth in the region. Ssozi and Amlani (2015) however reported positive but small effect of government health expenditure on life expectancy in the region.

Education proxied by secondary school enrolment rate (SSER) had a significant positive effect on life expectancy at 10% risk level in line with a priori expectation. The coefficient value of 0.0059 implied that an increase in school enrolment rate by 1% led to 0.0059% increase in life expectancy. It is expected that well educated people will be conscious of their health status and be proactive in taking precautionary and corrective actions against diseases, ailments, and lifestyle choices that may result in early death. Luy et al. (2019) reported that improvement in life expectancy in the

US, Italy and Denmark could be ascribed to the changes in the population structure by educational level.

GDP per capita had positive and significant (P<0.05) effect on LEB. The coefficient of GDPC value of 0.0503 implied that an increase in GDP per capita by 1% increased life expectancy by 0.0503%. This may be the reason for high levels of life expectancy in developed countries who have very high GDP per capita. For instance, while per capita income was about $1,657 in SSA in 2019 and average LEB was 62 years, per capita GDP in the United States and Luxemburg were $55,753 and $111,043 per annum while life expectancy at birth were about 79 and 83 years, respectively. The positive effect of per capita GDP on LEB reported in the present study is in line with the findings of Asiedu et al. (2015) who assessed the impact of per capita income on the health outcome of 128 developing countries from 1994 to 2014 using system GMM. The positive impact of per capita income on life expectancy is also in line with the findings of Manavgat (2020). In SSA, the share of out-of-pocket expenditure from current health expenditure as of 2019 was 30% (World Bank, 2021). Therefore, per capita income is still an important factor as affordability of healthcare consultation fees, drugs, and hospitalization depends on patients' income.

Much research and policy attention have been paid to the impact of trade openness (TOP) on economic growth. There have been arguments regarding health benefits of international trade to developing countries, hence, the inclusion of TOP in the model for the study. The coefficient of trade openness was positive and significant (P<0.1). The coefficient value of 0.015 implied that increase in trade openness by 1% increased life expectancy by 0.015% in SSA ceteris paribus. International trade enables countries to have access to goods such as pharmaceutical and other health products and services they cannot produce on their own and this could have a direct positive impact on health. Although, such inter-country trades also come with movement of people sometimes with the risk of spread of infectious diseases such as the recent spread of Ebola and COVID-19. The statistically significant and positive effect of trade openness on LEB found in the present study corroborates the findings of Novignon et al. (2018) for SSA using same analytical procedure but with data from 1995 to 2013. It was also in line with the findings of Manavgat (2020) who reported positive effect of trade openness on life expectancy among upper middle-income countries in the Middle East and Asia.

Transparency International (2006) and Vian (2008) asserted that corruption is a multifaceted phenomenon which impede the positive effect of public investments on access to health care, equity, services, and health outcomes. Moreover, there have been outcries about high level of corruption in most developing countries, the category that SSA countries belong. To this end, modified control of corruption index was introduced into the model. The results indicated that a unit increase in the corruption perception score decreased life expectancy by 0.17%. This confirms the views that corruption is an impediment to all facets of development which include health. The result of this study corroborates the findings of Achim et al. (2019) which emanated from a study covering 185 countries from 2005 to 2017. The significance of corruption found in the present study is a challenge to governments in SSA to rise to the occasion by putting in place viable mechanisms to reduce corruption in the region. Non-governmental organizations, civil society groups and the ordinary citizens should also get involved in fighting and exposing corrupt practices in all its forms with a view to eliminate it from the society.

The popular saying that "*water is life*" cannot be overemphasized as it suggests the importance of water to human life. In addition, unclean water could be a source of diseases which may reduce human longevity and life expectancy, hence, the importance of clean drinking water to the people. According to Mitchell (1945), up to 60% of adult body is water. Accordingly, access to improved drinking water was positive and it significantly ($P<0.01$) affected life expectancy. The results showed that 1% increase in the access to improved drinking water among the populace increased life expectancy by 0.42%. This is in line with the results reported by Kaur (2020) from a study which covered a total of 10 developed and 10 developing countries. Lu and Yuan (2017) also reported a positive relationship between quality of drinking water and human life longevity in Mayang, Hunan Province of China. The study reported positive and strong correlation between trace elements found in the drinking water in the study area and the quantity of trace elements in the hairs of selected respondents.

The distribution of physicians varies across time, countries and regions, and a decrease or increase in the number is an important issue for the healthcare system. In the present study, number of physicians per 1000 population (physician density) was found to be positive and significant ($P<0.05$). The value of the regression coefficient of 0.0921 implied that an increase in physician density by 1% increased life expectancy by 0.0921% point. This is in line with the a *priori* expectation of the study. Physicians are the backbone of medical services anywhere in the world as they render essential professional and highly technical services to ensure good health for the people. Nguyen et al. (2016) also reported positive effect of number of physicians and other categories of health workers such as pharmacists and nurses on life expectancy in a study conducted across eight regions of Vietnam from 2006 to 2013. The finding in the present study also corroborated that of Hosseini-Jebeli et al. (2019) who reported positive and significant effect of physician density on life expectancy in OECD countries. Interestingly, Nakamura et al. (2012) reported that increased number of physicians only significantly increased life expectancy among men in Japan. The lack of a relationship between an increase in the number of physicians and life expectancy in women was attributed to the possibility that the indices might be saturated (for women) in relation to the number of physicians given the assertion of Payne and Doyal (2009) that women consult doctors more often than men throughout the healthcare system and also take more prescribed medication in some countries. They already tend to receive medical care more frequently and may be less influenced by an increase in the number of physicians than men.

4.3 Post Estimation Assessments

Autocorrelation Tests: In the GMM framework, it is essential to examine the presence or absence of autocorrelation of the first order in the idiosyncratic error term popularly referred to as AR(1) test. The p-value of the test was less than 5% (specifically, 0.023), therefore, the null hypothesis of "no first order autocorrelation" was rejected. In the theory of the GMM analyses, the rejection of the null hypothesis is inconsequential as it conveys no special message. The rejection is expected due to the manner the differenced error term upon which the test was conducted was generated. However, the null hypothesis of the AR(2) test which was "no second order serial correlation" was accepted due to the higher p-value of 0.525. These aligned with expectation in order to establish the validity of the empirical model. Therefore, considering the results of AR(1) and AR(2) tests, the validity of the estimated model was confirmed (Table 3).

Table 3: Results of the Models Examining the Impact of Health Aid on Life Expectancy in SSA

	Main Results			Robustness Check Results					
	Two-Step System GMM			**Pooled OLS model**			**Fixed Effect Model**		
	Coeff.	S.E.	t-value	Coeff.	S. E.	t-value	Coeff.	S. Error	t-value
L1.LEB	0.9161***	0.2793	3.28	0.9625***	0.1725	5.58	0.8447***	0.0918	9.20
HAD	0.0015	0.0145	0.10	0.0011	0.0009	1.36	0.0070	0.0096	0.73
SSER	0.0059*	0.0035	1.68	0.0075**	0.0029	2.56	0.0019**	0.0008	2.45
HEXP	0.0027	0.0018	1.50	0.0112*	0.0058	1.94	0.0301*	0.0167	1.80
InPOP	0.0017	0.0036	0.48	0.0212	0.0098	1.14	0.0052	0.0082	0.63
TOP	0.0150*	0.0077	1.95	0.0031	0.0019	1.45	0.0056	0.0028	1.06
CORR	-0.1705**	0.0848	2.01	-0.0011	0.0009	-1.24	0.0034*	0.0020	1.68
AIW	0.4201***	0.1590	2.64	0.0015	0.0011	1.18	0.0001	0.0001	1.02
InGDPC	0.0503**	0.0255	1.97	-0.0014*	0.0007	-1.96	-0.0004	0.0041	-0.10
InPHY	0.0921**	0.0382	2.41	0.0615	0.0406	1.41	0.5314	0.4875	1.09
GOV	0.0181	0.0299	0.59	0.0413	0.0444	0.93	0.0037	0.0031	1.21
AR(1)	0.023	-	-	-	-	-	-	-	-
AR(2)	0.525	-	-	-	-	-	-	-	-
Hansen Test p-value	0.122	-	-	-	-	-	-	-	-
Sargan Test p-value	0.164	-	-	-	-	-	-	-	-
R-Squared	-	-	-	0.9946	-	-	-	-	-
Adj. R^2	-	-	-	0.9745	-	-	-	-	-
F-Stat (Prob)	394.99 (0.0000)	-	-	11422.41 (0.0000)	-	-	3443.74 (0.0000)	-	-

Source: Authors' Computation, 2021
LEB = life expectancy at birth, HAD = health aid share of GDP, GDPC = GDP per capita, HEXP = health expenditure, CORR = corruption index, GOV = government effectiveness, AIW = access to improved water, PHY= physician density, POP = population, SSER = secondary school enrolment, TOP = trade openness

Validity of the Instrumental Variables: It is desirable to be sure that estimates of GMM model are consistent and in order to obtain consistent estimates the instrumental variables must be valid. The Sargan test and Hansen test are both tests of overidentifying restrictions, which test the validity of the instrumental variables with the null hypotheses that the instruments were valid or exogenous. The p-value of the Hansen test and Sargan test were greater than 5% acceptable risk level, necessitating the acceptance of the null hypotheses (Table 3). Therefore, the instruments were taken as valid.

Robustness Check (Pooled OLS and Fixed Effect Model Results): It is extremely important to ascertain the robustness of the estimated system GMM. This is done by estimating the pooled OLS and the fixed effect versions of the model and confirming if the coefficient of the lagged dependent variable in the system GMM lies within its value in the fixed effect and the pooled OLS, as theoretically required to establish robustness (Bond, 2002). Results in Table 3 revealed that the coefficient of lagged LEB (0.9161) in the system GMM was between the value in fixed effect (0.8447) and that of pooled OLS estimates (0.9625). Thus, the estimated GMM was considered robust.

5 CONCLUSION AND RECOMMENDATIONS

The study assessed the effects of health aid on life expectancy in SSA with data from 2000 to 2019 collected on 46 SSA countries. The system GMM model result showed that lagged life expectancy, school enrolment, per capita GDP, trade openness, access to improved drinking water, and physician density have significant positive effects on life expectancy at birth implying that increases in each of these factors increased life expectancy, while corruption significantly reduced life expectancy. The study revealed that health aid and government health expenditure did not have any significant effect on life expectancy in SSA. The AR(1) and AR(2) tests which respectively assessed first order and second order autocorrelation in the error term confirmed the validity of the system GMM model estimated, as the presence of the first order and the absence of second order autocorrelation were confirmed as theoretically expected. The Sargan test and Hansen test confirmed the validity of the instrumental variables used in the study as revealed by the p-values. The results of the pooled OLS and the fixed effect models estimated established the robustness of the system GMM model as the parameter estimate of the lagged dependent variable in the system GMM model fell between its value in the Pooled OLS and the fixed effect model.

The study concluded that health aid and government health expenditure did not impact life expectancy in SSA. Therefore, improved effectiveness in the utilization of official development assistance and government budgetary spending in the health sector is recommended. Donors should continue to monitor the utilization of resources given to countries in the region, while civil society groups and financial crime agencies are encouraged to monitor foreign aid utilization, and indeed government health spending. In addition, policies which can achieve noticeable growth and development in the economies of countries in the region should be put in place by various governments in order to achieve improved health outcome (because per capita income was an important determinant of life expectancy in the models estimated). Such policy may include diversification of the economies of the region into commercial agriculture, agricultural value addition, tourism, solid mineral development, knowledge promotion and innovation, information and communication technology, etc. Concerned government agencies in the region should encourage beneficial trades and discourage dumping for the countries to benefit maximally from international trade. There should be deliberate efforts to improve access of the people to clean drinking water by expansion and revitalization of hitherto moribund public water supply systems in most countries in the region. School enrollment should be encouraged among children of school age as education affects health awareness, knowledge, and familiarity with precautionary measures which can improve health outcomes such as life expectancy. Finally, attractive work environment alongside commensurate remuneration should be given to health workers especially the physicians to encourage them to stay back in the region to render the needed medical services to the people while deliberate efforts are made to train more physicians to meet future demand in the region.

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