ASECU South-Eastern Europe Journal of Economics, vol. 20, 2(2022), 141-158 SEEJE

EFFECTIVENESS OF FOREIGN AID FOR HEALTH IN REDUCING HIV PREVALENCE IN SUB-SAHARAN AFRICA

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Abstract
The study examined the effect of health aid on HIV prevalence in sub-Saharan Africa (SSA) using data on 46 countries from 2000-2019 analysed with system-GMM due to its appropriateness. Results confirmed persistence in HIV prevalence and showed that health aid significantly reduced HIV prevalence in SSA. Furthermore, domestic health expenditure, education and government effectiveness significantly reduced the scourge in SSA. All post-estimation diagnoses indicated that the estimated model was valid and robust. Increased domestic health expenditure to complement health aid, determination to encourage school enrolment and efforts to improve government service delivery, especially in the health sector, are recommended.

JEL Classification: C23, H53
Keywords: HIV Prevalence, Health Aid, Sub-Saharan Africa

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1. Introduction

HIV/AIDS was clinically observed for the first time worldwide in the United States in 1981. Because the early incidence of the virus was noticed among men who were gay and injection drug users, it was first referred to as GRID (Gay-Related Immune Deficiency) but with time and the realization, as more facts emerged, that it was not limited to these groups of the population, the United States Centre for Disease Control (CDC) introduced the term Acquired Immune Deficiency Syndrome (AIDS). According to Keele (2006) and Gao (1999), scientific tracing suggests that HIV came from Chimpanzees in southern Cameroon, southern Senegal, and in the west of the Ivory Coast, as early as the beginning of the 20th century. It is believed that the spread of HIV/AIDS got accelerated due to the influence of colonialism and the subsequent growth of large colonial African cities; this resulted in significant social changes entailing diverse patterns of sexual contacts, among which the most prominent ones were having more than one sexual partner at the same time, and prostitution (Worobey, 2008).

Overtime, HIV has spread to all countries of the world, due to increased mobility and globalization, at varying levels of prevalence. In 1995, HIV prevalence rate in SSA was 2.22%, 0.24% in the Latin America and the Caribbean (LAC), 0.4% in the United States; the world average was 0.3% (World Bank Data, 2021). Five years after, i.e., by 2000, average prevalence rate in SSA had increased to 4.68%, 0.47% in LAC, while the U.S. rate remained at 0.4% and the world average moved up to 0.6%. By 2019, the SSA prevalence rate was 3.72%, 0.5% in LAC, the U.S remained at 0.4%, while world average increased to 0.7%. The SSA average is usually pushed up by the high prevalence rate in Eastern and Southern African sub-regions. For instance, in 2019, the prevalence rate was 27% in Eswatini (Swaziland), 22.8% in Lesotho, 20.7% in Central Africa Republic, 19% in South Africa and 12.4% in Mozambique. Figure 1 shows that HIV prevalence in SSA has remained unacceptably high, especially when compared with other developing regions, such as LAC, and the world average. This situation has multiple implications concerning co-morbidity, livelihood, and labour productivity, among several others.

The HIV infection concentration always skews towards SSA. The region is responsible for 70% of the global HIV/AIDS load (UNAIDS, 2020). In 2019, over 38 million individuals (including 1.8 million children) were HIV positive, with a global HIV prevalence of 0.7% among adults. AIDS-related illnesses claimed the lives of approximately 690,000 persons in the same year. Compared to 2004, when the number peaked at 1.7 million, it dropped by almost 60%. Meanwhile, 59% of the 4,500 persons in the world who are infected with the virus everyday reside in SSA (UNAIDS, 2020).

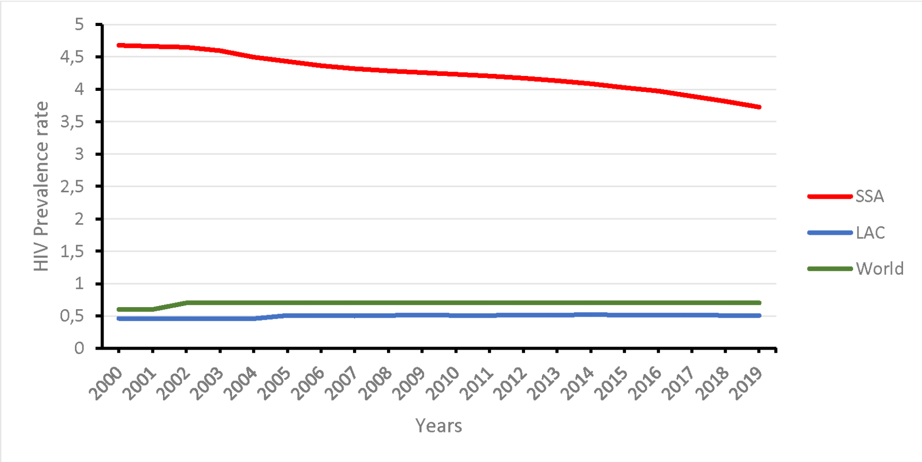

Figure 1. HIV prevalence rate in SSA, in LAC and the world average

HIV destroys the host's immune system cells, increasing the risk of infection and sickness as the immune system becomes weaker. If not treated, a person's CD4 cell count can drop to dangerously low levels, leading to AIDS, which is accompanied by a variety of opportunistic illnesses, such as malaria, TB, and so on (MHHS, 2021).

The economic consequences of HIV are many and including, but not limited to, loss of productive time for those infected, high cost of time for family members who stay away from work to care for sick relatives, high financial cost for drugs where sponsored treatments are not available, etc. All these affect the overall economic position of society.

At the turn of the millennium, developed countries discussed and agreed on the need to help developing countries achieve improvements in all spheres of human development including HIV/AIDS reduction and treatment. Before then, there have been isolated efforts aimed at reducing HIV/AIDS and the consequent societal burden, due to other diseases, in developing countries. According to Joseph *et al.* (2017), it was indeed imperative to halt and reverse the global rise of infection, because of its negative impact on productivity, particularly among sick people and their family members. Global health initiatives (GHIs), such as the US President's Emergency Plan for AIDS Relief (PEPFAR) and the Global Fund to Fight AIDS, Tuberculosis, and Malaria (GFTAM), among others, have become critical tools for ensuring that everyone in need can receive antiretroviral drugs and other healthcare issues. All these are coming to complement other forms of bilateral and multilateral foreign development assistance through the Development Assistance Committee (DAC) of the Organization for Economic Cooperation and Development (OECD).

To this end, there has been an influx of foreign aid into the health sector in recent decades in developing countries, especially those in sub-Sahara Africa. For instance, OECD data series show that total aid to the health sector in the region came to approximately $742.47 million in 2001 at 2010-constant price and increased to approximately $1.873 billion in 2019. Correspondingly, HIV prevalence rate in the region was 4.67% in 2001and 3.72% in 2019. However, existing knowledge concerning the effect of health aid on HIV prevalence in SSA is limited and contradicting, and the need to carry out an objective assessment of the relationship between the two variables becomes imperative. The results of most relevant previous studies carried out in the region are outdated, not to mention few deficiencies in the methodologies used. For instance, Younde (2010) used Pearson correlation and data from 2004-2008, while Yogo and Mallaye (2012) utilised data from 2000-2010. The present study, therefore, assessed the effect of health aid on HIV prevalence in SSA using available up-to-date data analysed following the system GMM procedure, which can address some of the problems identified in certain available studies. Study findings are expected to be useful for governments and donors of foreign aid to the health sector in the region. The second part of the paper reviews relevant literature, while the third presents the methodology adopted. The fourth part presents and discusses the results, while the last (fifth) one summarises and concludes accordingly.

2. Empirical Literature Review

There have been attempts to assess the effect of foreign aid for the health sector and other related variables on HIV prevalence in developing countries, quite divergent in their findings. For instance, Peiffer and Boussalis (2010) looked at how foreign funding affects a country's reaction to an epidemic. While HIV/AIDS-focused aid enhanced treatment coverage rates, it was shown that a country's predisposition to implementing preventative measures focused on HIV/AIDS education is more likely to be influenced by its level of traditionalism.

Using Pearson correlation analysis, Youde (2010) examined the association between health aid, HIV prevalence, and government spending in 15 PEPFAR (the President's Emergency Plan for HIV/AIDS Relief)-targeted countries from 2004 to 2008. The study, which was to pave the way for future research into the link between health aid and HIV prevalence, revealed a statistically significant negative link between adult HIV prevalence and health aid. The study showed that the relationship between foreign aid and domestic government spending had a cumulative effect, implying that the government may rely on foreign resources to fund AIDS-related activities rather than its own money.

Nunnenkame and Ohler (2010) used the Difference-in-Difference estimation method to investigate whether or not there was a noticeable difference in HIV/AIDS outcomes between a group receiving treatment and another group not receiving treatment. The paper used the number of people who were HIV positive and AIDS-related deaths as regressands. It was found that foreign aid had a significantly negative impact on AIDS-related deaths but no statistically significant influence on the number of people living with the virus. Bendavid and Bhattacharya (2009) also employed the foregoing procedure to evaluate the impact of PEPFAR on Sub-Saharan Africa. It was revealed that a statistically significant difference existed between the treatment group, which received PEPFAR programme assistance, and the control, namely people who did not benefit from such assistance.

Yogo and Mallaye (2012) looked at the influence of health aid on health outcomes in 28 Sub-Saharan African countries between 2000 and 2010. Results show that, for each additional unit of health aid, the prevalence of HIV dropped by 0.05% after accounting for endogeneity; the technique used was the instrumental variable one. Using data from 120 low- and middle- income countries, Hsiao and Emdin (2015) investigated whether health aid, directed explicitly at malaria, HIV, and tuberculosis (TB), was connected with changes in mortality associated with these diseases. Country and time-period fixed effects and control variables were used in the regression analysis carried out in the study. Health aid was linked to lower HIV mortality rates, according to the findings. Various sensitivity assessments, including GMM estimation, yielded consistent results. Findings revealed that targeted health aid had a strong link with reduction in HIV mortality at the national level.

Atun *et al.* (2016) carried out an extensive review of how Innovative Financing (IF) has been used to co–finance HIV/AIDS responses in some SSA countries. The review identified IF instruments that could be adopted in HIV responses based on analysis of non–health sectors. The instruments identified included tax/levy, such as the AID Trust Fund used in Zimbabwe, a debt conversion instrument, such as the one used in Botswana, and the debt Buy–Down, as adopted in the Debt2Health Debt Swap Agreement in Ivory Coast. Hence, the study concluded that a small number of innovative finance tools allocated just a small portion of funds to domestic HIV/AIDS initiatives.

Developed countries, who are donors of foreign development assistance to fight HIV/AIDS in developing countries, have come to recognise the need to curb corruption and develop strong management and audit systems. This became imperative because utilisation of foreign aid is more important throughout the process. All of these are part of the effort to enhance the effectiveness of foreign aid. Therefore, Tun (2017) utilised data from 2005-2014, covering 17 countries selected across Africa, Asia, Latin America, and Europe, and adopted the panel-fixed effect procedure. The study reported that receipt of foreign aid for battling anti-corruption reduced HIV prevalence by 8.6%, while AIDS-related death rate was not affected. In addition, it was revealed that foreign aid for battling anti-corruption worsened the level of corruption instead of improving it, but the coefficient was not significant. It was, therefore, recommended that attention should be focused on AIDS treatment programmes that are susceptible to corruption because of the high cost of treatment pharmaceuticals, the goal to lower AIDS-related mortality by increasing the effectiveness of foreign aid flows into treatment programmes.

The impact of foreign aid on the fight against HIV/AIDS in Nigeria was investigated by Joseph *et al.* (2017). Their findings show that foreign aid from a variety of sources was responsible for significant improvements in HIV/AIDS care as well as lower mortality and morbidity rates. Official development assistance was stated to have aided in the reversal of HIV prevalence and incidence rates. The study also revealed that donor-funded initiatives have overstretched the workforce and health systems, resulting in a shift in healthcare priorities toward disease intervention programmes. It was stated that the HIV/AIDS programme is still reliant on donors and it is sometimes misunderstood as "donor-agency things."

Olakunde *et al.* (2019) examined the structure and correlated domestic HIV expenditure in 30 countries in SSA between 2012 and 2017. The study looked at the relationship between domestic proportion of the overall HIV expenditure, HIV prevalence, antiretroviral coverage, gross national income (GNI) per capita, total domestic government health expenditure (GGHED), and GGHED per capita. It was concluded that some SSA countries are still reliant on outside assistance to combat HIV. However, boosting domestic HIV spending in the countries sampled may necessitate economic growth; governments might improve their countries' fiscal status by seeking creative and long-term funding options within the country.

It is evidently clear from some of the previous studies reviewed so far that some of the findings are outdated, while some others neglected the factor of endogeneity, which may arise in a model such as the present one involving HIV prevalence and health aid. There is, therefore, a need for new investigation using current, up-to-date data and appropriate methodology, which is what the present study attempted to do.

3. Methodology

Model Specification

The study adapted the model of Tun (2017) and stated the modified empirical model implicitly as:

$$HIV = f(HDN, SSER, HEXP, POP, TOP, CORR, GOV, GDPC, PHY) \dots\dots\dots\dots\dots\dots \quad (1)$$

Equation 1 can be explicitly stated thus:

$$HIV_{it} = \alpha_0 + \alpha_1 HIV_{it-1} + \alpha_2 HDN_{it} + \alpha_3 SSER_{it} + \alpha_4 HEXP_{it} + \alpha_5 POP_{it} + \alpha_6 TOP_{it} + \alpha_7 CORR_{it} + \alpha_8 GOV_{it} + \alpha_9 GDPC_{it} + \alpha_{10} PHY_{it} + \eta_i + \mu_t + \varepsilon_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.. \quad (2)$$

Where: HIV= HIV prevalence Rate; HDN= Health aid share of GDP; SSER = Secondary School Enrolment Rate (education proxy); HEXP = Health expenditure as a percentage of GDP; POP = Population; TOP = Trade Openness; CORR = Corruption Index; GOV = Government Effectiveness Index, GDPC = GDP per capita; PHY = Physicians per 1000 (physician density); η = Country specific effect; μ = Time specific effect; ε = Error term; α = slope co-efficient; i = Cross-section of countries; t = time period

A priori Expectations

Health Aid (HDN) is expected to have negative effects on HIV prevalence. Health aid is supposed to improve access to and quality of health care including the special care needed for HIV patients as it provides the necessary resources to bridge existing shortages. This expectation is in line with empirical work, such as that by Azuine *et al.* (2014) in a study that covered countries in Africa and Asia, and that of Hsiao and Emdin (2015) in a study that utilised data across 120 developing countries from 1990-2010. Health Expenditure share of GDP (HEXP) is expected to reduce HIV prevalence (negative effect). Health expenditure is expected to improve health infrastructure and availability of quality manpower in the health sector, thereby, improving the quality of healthcare, which trickles down to positive health outcomes, such as reduction in HIV prevalence. The expectation aligns with the report by Osemwengie and Shaibu (2020), which assessed the impact of public health spending on HIV prevalence rate in Nigeria.

Population (POP) is expected to worsen HIV prevalence rate (positive effect) due to increased pressure on available health facilities, manpower and budgets. The expected sign is in line with some health studies outcome, such as those by Hsiao and Emdin (2015), David (2017), etc. Corruption (CORR) is expected to worsen HIV prevalence rate (positive effect). Corruption is most likely to reduce the efforts aimed at reducing HIV prevalence rate due to outright embezzlement and misappropriation. This is in line with the model estimated by Doucouliagos *et al.* (2019). The effectiveness of government institutions (GOV) is expected to decrease (negative effect) HIV prevalence rates. Improvement in government effectiveness enhances service delivery and efficient use of resources. This expectation aligns with reports by Hwa-Young *et al.* (2016) in a study of developing countries from 2000-2010.

Secondary School Enrolment Rate (SSER) was used as a proxy for education, and it is expected to reduce (negative effect) HIV prevalence rate. Education is likely to improve health awareness and the expected negative sign aligns with the study of Vandemoortele and Delamonica (2000), which reported that HIV spreads twice as fast among uneducated girls in Zambia. GDP per capita (GDPC) stands as a proxy for income and the expected negative sign is in line with reality, as high-income countries tend to have a lower HIV prevalence rate. The expectation is in line with findings by

Asiedu *et al.* (2015) and Toseef *et al.* (2019). Trade Openness (TOP) is expected to reduce HIV prevalence rate if the country concerned engages in beneficial trade, such as making available hitherto unavailable pharmaceutical products through several other routes. This thought aligns with that of Manavgat (2020). Fertility Rate (FET) is expected to increase or have a positive effect on HIV prevalence rate, as giving birth frequently may expose women to the risk of direct and indirect contraction of HIV. This was included in the health outcome model in the study of Jain (2011). Availability of well-trained medical doctors relative to the population (physician density – PHY) is expected to reduce HIV prevalence due to availability of personnel needed for the care of HIV patients and raising the awareness of other ailments among patients. The expectation aligns with that of Welander (2012).

Summary of *a priori* Expectations: $a_1>0$, $a_2<0$, $a_3<0$, $a_4<0$, $a_5>0$, $a_6<$ or >0, $a_7>0$, $a_8<0$, $a_9<0$, $a_{10}<0$.

Definition and Measurement of variables

*HIV Prevalence (HIV)***:** This is the estimated number of adults aged 15 to 49 who have HIV infection, regardless of having AIDS symptoms, expressed as a percentage of the total population of the same age range (WHO, 2018).

Health Aid: This is foreign aid to be channelled into the health sector measured in Dollars (2010=100).

Population: At mid-year estimates, this is the total number of individuals living in a country, regardless of their legal status or citizenship.

*Control of Corruption index***:** This is a measure of how much public power is used for private benefit, including both petty and grand forms of corruption, as well as "state capture" by elites and private interests (WGI, 2017). It was calculated using an annual corruption control index that scores countries on a scale of –2.5 (high corruption) to 2.5 (low corruption). The indicator was rescaled, for ease of interpretation, by deducting nations' scores from 2.5, as implemented by Ackay (2006). In this approach, higher values correspond to higher levels of corruption.

Government Effectiveness: The quality of public and civil service and its degree of independence from political influences, the quality of policy formulation and implementation, and the genuineness of the government's commitment to such policies are all factors that constitute government effectiveness. Estimate is the country's overall score on the aggregate indicator, expressed in standard normal distribution units range from -2.5 to 2.5 (WGI, 2017).

Trade Openness: This metric captures the degree of trade openness by combining import and export rates as a percentage of GDP.

Secondary School Enrolment Rate: The gross enrolment ratio is the proportion of total enrolment, regardless of age, in the population age group that officially corresponds to the level of education shown. Secondary education completes the basic education provided at the elementary level, the goal being to lay the foundations for lifetime learning and human development by providing more subjects or skill-oriented teaching taught by more specialised teachers.

Domestic Health expenditure: This is measured in constant 2010 US Dollars but enters the estimation as a share of the GDP.

GDP per Capita: This is a metric that breaks down a country's economic output per person and it is determined by dividing GDP (2010=100) by the entire population.

Physician Density: This is measured as the number of medical doctors per 1000 people.

Sources of Data

There are different descriptions of the number of countries that make up the SSA region. The present study, however, covered the entire 48 sub-Saharan African countries, as listed by the World Bank, using data from 2000 to 2019. Meanwhile, two countries (Somalia and South Sudan) were dropped because of the large number of missing data points. Therefore, 46 countries were finally used for the study. Data on HIV/AIDS prevalence, population, trade openness, secondary school enrolment rate, domestic health expenditure, GDP per capita and physician density were obtained from the World Bank's World Development Indicator (WDI) website. Health aid data were obtained from the OECD Creditors' Reporting System (CRS), while data on control of corruption and government effectiveness were obtained from the World Governance Indicator (WGI).

4. Estimation Techniques

Pre-Estimation

Descriptive Statistics: These provide a detailed description of the data used in the econometric analyses. Some of the descriptive statistics reported in the study concern mean, median, mode, standard deviation, skewness, kurtosis, and the Jaque-Berra test for normality of distributions.

Correlation Analysis: This was used to assess the joint movement of variables. The test was imperative as a pre-estimation analysis because it gives an insight into the possibility of relationships among variables. Correlation estimation helps guard against the problem of multicollinearity, which may arise when two or more highly correlated variables exist as regressors in an econometric model. Such occurrence may lead to a situation where estimates of the model become indeterminate and standard errors become infinitely large leading to wrong conclusions about parameter estimates.

Estimation

The most appropriate analytical procedure for the study is the system Generalized Method of Moment (System GMM) regression technique. It has been established in literature that a simultaneous relationship usually exists between foreign aid and human development, which includes health outcomes, such as HIV/AIDS prevalence; this may lead to the problem of endogeneity in the said models. The GMM estimation procedure has the desirable properties capable of taking care of such endogeneity issues. It combines the relevant regressors in a system expressed as first differences and levels. The Differenced GMM and System GMM procedures are contained in the GMM procedure. The System GMM is mostly suited for the present study because it corrects unobserved country heterogeneity, omitted variable bias, measurement error and potential endogeneity (Arellano and Bover, 1995; Blundell and Bond, 1998). The use of the GMM estimation approach is further justified as the procedure is not only dynamic in nature but also allows control for persistence in HIV/AIDS prevalence, which has behavioural effects that persist. The association between HIV/AIDS prevalence and its accompanying first lag can be used to assess persistence. In addition, the number of time series in each section is lower than the number of cross sections, i.e., N (46) > T (20). In regressions, cross-country variations are also taken into account. Finally, Blundell and Bond (1998) theorised that the system GMM estimator corrects for differenced estimator biases.

The study used the orthogonal deviation to transform equation 2. Arellano and Bover (1995) presented orthogonal deviations as an alternative to differencing, which was the original transformation employed in the typical GMM approach. This procedure subtracts the average of all future accessible observations of a variable from the variable's existing data. It can be calculated for all observations except the last one for each individual, regardless of the number of gaps, hence, minimising data loss (Roodman, 2009a). Time dummies, which capture time-specific effects, were also incorporated in all estimations. The assumption of no autocorrelation between countries is reflected in time dummies, which helps lower the degree of autocorrelation among countries and the error idiosyncratic term, thus resulting in a robust estimation (Roodman, 2009a).

Roodman (2009b) posited that the number of instruments should not exceed the number of groups to avoid proliferation and over-identification of instruments, which may lead to over-fitting of endogenous variables, bias in the GMM estimator and weakening of the Sargan-Hansen test (cross-section). With Windmeijer correction for finite samples, the two-step system GMM estimate is robust to panel-specific autocorrelation and heteroskedasticity, reducing standard error biases. Instruments were collapsed and set to a lag limit of 2 and longer lags for the transformed equation and a limit of 2 for the level equation to make results more robust. In addition, some instruments were removed until the set retained was found to be exogenous, as shown through the Sargan- Hansen test.

5. Results and Discussion

Preliminary Analyses

Descriptive Statistics

Table 1 presents the results of the descriptive statistics of the study variables. Those reported in the present study are mean, median, minimum, maximum, standard deviation, skewness, kurtosis, and the Jaque-Berra test for normality of distribution. Results showed that the average HIV prevalence rate was 4.25% during the period of the study. This is higher than 0.5% in LAC and the world average of 0.69% for the same period. SSA has long been labelled as the epicentre of the HIV scourge in the world and, indeed, a lot of efforts have been geared towards slowing down the prevalence of the virus in the region. The value of physicians per 1,000 population members of 0.24 was far below the WHO recommended ratio of 1: 1,000 and this may adversely affect the fight against HIV/AIDS in the region, as medical doctors are needed to attend to the health needs of HIV/AIDS patients. The average health expenditure share of the GDP was 5.14. This was a bit lower than 6.35 for East Asia and the Pacific (EAP), 7.22 for LAC and the world average value of 9.47 in the period covered by the study. Low investment in health may adversely affect health outcomes including the prevalence of HIV/AIDS since such funds are needed to raise awareness about its existence, prevention, and treatment. All the study variables except corruption skewed to the right (implying that majority of observations in each of the series fall below their various averages and the long tails lie to the right of the distribution), while kurtosis, corruption, and secondary school enrolment rate were mesokurtic in distribution. Jaque-Berra statistics combines the properties of measures of skewness and kurtosis to access the normality of the distribution of series and the statistics confirmed that none of the series was normally distributed.

Table 1. Results of Descriptive Analyses

	HIV	HDN	GDPC	HEXP	CORR	GOV	PHY	POP	SSER	TOP
Mean	4.25	0.3484	2290.37	5.14	3.11	-0.71	0.24	17820385	42.06	72.05
Median	1.16	0.18	989.57	1.58	3.21	-0.74	0.10	10409229	38.56	62.04
Maximum	21.24	5.39	20532.95	7.12	4.33	1.05	2.53	1.91E+08	99.90	311.35
Minimum	0.010	2.33E-07	194.87	0.04	1.28	-1.88	0.008	81131.00	6.11	16.67
Std. Dev.	3.61	0.5163	3193.26	1.17	0.62	0.61	0.38	27421484	21.20	37.44
Skewness	2.38	3.59	2.57	1.37	-0.69	0.53	3.25	3.56	0.66	1.80
Kurtosis	8.80	23.48	10.12	5.12	2.91	2.79	15.21	18.19	2.80	8.60
Jarque-Bera	2065.65	17998.22	2952.65	455.72	70.22	42.76	2919.14	10783.17	49.58	1617.51
Probability	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	880	917	919	910	874	874	366	920	678	877

Source: Author's Computation, 2021

Correlation Analyses

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

Table 2. Results of Correlation Analyses

	HIV	AID	GDPC	FERT	HEXP	CORR	GOV	PHY	POP	SSER	TOP
HIV	1										
AID	-0.03	1									
GDPC	0.41	-0.42	1								
FERT	-0.36	0.30	-0.80	1							
HEXP	0.57	-0.14	0.58	-0.53	1						
CORR	-0.34	0.08	-0.61	0.64	-0.54	1					
GOV	0.19	-0.28	0.24	0.17	0.18	-0.35	1				
AIW	0.17	-0.29	0.70	-0.73	0.46	-0.57	0.41				
PHY	0.06	-0.32	0.86	-0.72	0.29	-0.44	0.14	1			
POP	-0.16	-0.10	-0.14	0.22	-0.33	0.32	0.31	-0.06	1		
SSER	0.13	-0.27	0.63	-0.73	0.36	-0.54	0.39	0.62	-0.14	1	
TOP	0.38	-0.15	0.47	-0.50	0.27	-0.40	0.26	0.37	-0.37	0.49	1

*Source:*Author's Computation, 2021

Effect of health aid on HIV prevalence

The health outcome of the people is a product of many complex interacting factors. The issue of morbidity (disease occurrences and illnesses) is as important as the issue of mortality that terminates people's lives and stops their contributions to economic growth and development, more so, as the former leads to the latter. The occurrence of illnesses from diseases such as HIV/AIDS can be truly devastating, as sick people may not be able to work during the period of illness, while substantial time of family members who stay at home or at the health facilities to provide additional care is wasted and entails huge incidental costs. The multiple implications of illnesses suggests that morbidity is as important as mortality.

Meanwhile, UNAIDS (2021) reported that 67% of people living with HIV/AIDS worldwide are living in SSA. In order to rein the tide of HIV/AIDS in SSA, there has been an influx of foreign aid for health specifically to fight HIV/AIDS in the region. In order to achieve the objective of analysing the effect of health aid on HIV/AIDS in the region and to answer the question regarding how effective health aid is in reducing HIV prevalence, a system GMM model was analysed as stated in equation 2 and reported in Table 3. Results showed that lagged HIV prevalence rate, health aid, secondary school enrolment, health expenditure and government effectiveness significantly affected the HIV prevalence rate in SSA. The lag of HIV prevalence rate came up with a significantly (P<0.01) positive coefficient value of 0.9325 implying that a 1% increase in HIV prevalence in the last period leads to an increase in current HIV prevalence by 0.93%. Health aid returned a significantly (P<0.05) negative coefficient. A 1% increase in health aid share of GDP decreased HIV prevalence rate by 0.0878%. This result aligned with the finding of Azuine *et al.* (2014), which assessed the global health donor presence in relation to variations in HIV/AIDS prevalence in selected developing countries in Africa and Asia and reported that increased donor presence yields quantifiable reduction in HIV prevalence burden. The negative effect of health aid on HIV prevalence also agreed with the report of Hsiao and Emdin (2015), which also reported HIV prevalence reducing effect of health aid in a study that covered 120 developing countries from 1990-2010. It also agreed with that of Yogo and Mallaye. (2012), which reported a significantly negative effect of health aid on HIV prevalence rate in a study that used data from 28 SSA countries from 2000-2010. Nunnenkamp and Öhler (2010), on the other hand, in a study that examined the impact of foreign aid on HIV/AIDS-related deaths and the number of people living with HIV in developing countries from 1990 to 2007, found no evidence that foreign aid prevented new infections to the extent that it would reduce the number of people living with HIV. However, the study found that foreign aid made a significant contribution to the medical care of affected patients. Meanwhile, it was reported that only the biggest bilateral supplier of foreign aid, namely, the United States, has clear proof of significant treatment effects on AIDS-related fatalities. Targeted US assistance programmes, in particular, appeared to be more effective than multilateral organisation operations. The difference in the finding might be due to the fact that the total amount of foreign aid was used as the explanatory variable in the reference study rather than aid targeted at the health sector as operationalised in the present study. Besides, the period covered by the reference study marked the beginning of an aggressive fight against HIV/AID in SSA; therefore, the impact might not have been evident. Furthermore, Akinbode *et al.* (2019) also reported insignificant effect of health aid on HIV prevalence in Nigeria. Furthermore, the study used per capita health aid while the present study used the health aid share of GDP, in addition to the fact that the present study used data from 46 SSA countries rather than a single country.

Health expenditure was negative and significant at 10% risk level. A 1% increase in domestic health expenditure share of GDP significantly reduced HIV prevalence rate by 0.06% in SSA in line with *a priori* expectations. This is in line with result of Osemwengie and Shaibu (2020), who assessed the impact of public health spending on HIV prevalence rate in Nigeria from 1982-2016 using the Vector Autoregressive (VAR) procedure and reported a significantly negative relationship between public health expenditure and the HIV prevalence rate in the country.

Secondary School enrolment served as a proxy for the educational level of people in the estimated model. It is expected that well educated people will understand the problem posed to society by the HIV/AIDS pandemic and will be aware of it, and perhaps, take precautionary measures. The coefficient of school enrolment was negative and significant at the 10% risk level. A 1% increase in secondary school enrolment reduced HIV prevalence by about 0.15%. This implies that, if secondary school enrolment doubles, HIV prevalence will reduce by about 15%. Moreover, education is important as HIV/AIDS is known to be more prevalent among people aged 15-49 years, which is a range that consists of active individuals. A study carried out in Zambia found that the virus spreads twice as fast among uneducated girls (Vandemoortele and Delamonica, 2000). A study in Kenya also found that there is a fourfold higher likelihood that girls who are in school will be virgins and present low HIV prevalence than girls who drop out of school (World Bank, 2002).

Government effectiveness as an explanatory variable in the HIV model came up with a significantly ($P<0.1$) negative coefficient. A unit increase in the index score decreased HIV prevalence rate by 0.336%. Government effectiveness is part of the family of governance indicators, which includes accountability, regulatory quality, and rule of law/legal rules, among others. The significance implied that, as government improves service delivery, HIV prevalence decreases. This is plausible as ineffective service delivery may impede health services aimed at reducing HIV prevalence. This result aligned with that of Hwa-Young *et al.* (2016) in a study of developing countries from 2000-2010. The result is a call to action for governments in SSA to improve service delivery and increase their commitments in the conduct of government business in the region in order to reduce HIV/AIDS prevalence.

Post Estimation Assessments

Autocorrelation Tests

In an attempt to establish the validity of the system GMM model estimated, the autocorrelation test of the first order i.e., AR (1), and that of the second order, i.e., AR (2), were carried out on differenced idiosyncratic error terms. The AR (1) test result, which came up with a p-value of 0.048 implied the presence of first order serial correlation and this is expected in line with the theory. The AR (2) test, with a p-value of 0.154, implied the acceptance of the null hypothesis of "no second order serial correlation", thereby, confirming the validity of the estimated system GMM model (Table 3).

Validity of the instrumental variables

The Sargan-Hansen tests are over-identifying restriction tests that are used to determine the validity of instrumental variables. "All instruments as a group were exogenous or valid," was the null hypothesis. The Sargan and Hansen test had probability values of 0.117 and 0.239, respectively (Table 3). As a result, the GMM's instrumental variables were assumed to be valid. The consistency of parameter estimates generated from the system-GMM model depends on the validity of instrumental variables. In applied econometrics and policy making, estimates that are inconsistent are less valuable.

Check for Robustness

The analysed GMM model must be assessed for robustness. The criterion is that the estimated coefficient of the lagged dependent variable in the GMM model falls between its value in the fixed effect model and the pooled OLS model, as stated by Roodman (2009a). Table 3 displays the results of the Pooled OLS and fixed effect models. Results showed that parameter estimates of the lagged HIV prevalence rate obtained in the GMM model (0.9470) was between its values in the fixed effect (0.9315) and pooled OLS (0.9667) estimates. As a result, the robustness of the estimated GMM model was confirmed.

Table 3. Results of the HIV prevalence model

	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
Const.	-0.0978	1.3589	-0.07	0.2458	0.3052	0.81	2.9554***	1.0415	2.8407
L1.HIV	0.9470	0.0950	9.97	0.9667***	0.1736	5.57	0.9315***	0.2268	4.11
HDN	-0.0878**	0.0416	-2.11	-0.0588**	0.0297	-1.98	0.0211	0.0409	0.52
SSER	-0.1453*	0.0756	-1.92	-0.0014**	0.0007	-1.99	-0.0628**	0.0248	-2.53
HEXP	-0.0643*	0.0337	-1.91	-0.0353***	0.0128	-2.76	-0.0411*	0.0241	-1.70
InPOP	-0.0040	0.0161	-0.25	-0.0031	0.0115	-0.27	0.1663	0.1944	0.86
TOP	0.6710	0.7170	0.92	0.0013***	0.0005	2.51	0.05105	0.0912	0.56
CORR	-0.0120	0.0653	-0.18	-0.0284	0.0350	-0.81	-0.1190	0.0947	-1.26
GOVEFF	-0.3363**	0.1450	-2.31	-0.0231	0.0391	-0.59	-0.1750**	0.0774	-2.26
InGDPC	0.0530	0.1745	0.30	-0.0110	0.0278	-0.40	0.1346	0.1450	0.93
InPHY	-0.0048	0.0790	-0.06	0.2090	0.0181	1.15	0.0053	0.0334	0.16
AR (1) p-value	0.048	-	-	-	-	-	-	-	-
AR (2) p-value	0.154	-	-	-	-	-	-	-	-
Hansen test p-value	0.239	-	-	-	-	-	-	-	-
Sargan test p-value	0117	-	-	-	-	-	-	-	-
R-Squared	-	-	-	0.9983	-	-	-	-	-
Adj. R^2	-	-	-	0.9725	-	-	-	-	-
F-Stat (Prob)	1533.47 (0.0000)	-	-	13,297.57 (0.0000)	-	-	1149.33 (0.0000)	-	-
No. of instruments	18	-	-	-	-	-	-	-	-

No. of countries = 46; No. of years =20

S.E = Standard Error; *, ** and *** implies significant at 10%, 5% and 1% respectively

Source: Author's Computation, 2021

5. Summary and Conclusion

HIV prevalence rate model results revealed that lagged HIV prevalence rate significantly increased the present period rate, while health aid, education, domestic health expenditure and government effectiveness had significantly negative effects on HIV prevalence rate in SSA. The AR(1) and AR(2) tests, which examined the presence, or otherwise, of first and second order autocorrelation in the error terms of the two-step system GMM model, showed that the estimated model was valid given the rejection of the null hypothesis of "no autocorrelation" of AR (1) and the acceptance of the null hypothesis of "no autocorrelation" of AR (2) tests. The Sargan-Hansen tests results showed that the instrumental variables used for the estimation of the system GMM models were all exogenous, and, by extension, valid. The results of the Pooled OLS and fixed effect models verified the robustness of the system GMM model, with the coefficient of the lagged dependent variable in the GMM model falling between its value in the fixed effect and the pooled OLS model. It was concluded that health aid plays a crucial role in SSA's attempts to reduce HIV/AIDS prevalence. The study recommended that governments in SSA should increase their domestic health expenditure in order to complement the contribution of health sector aid. Efforts should be made to improve government service delivery, especially in the health sector, while improvement in formal and informal education is important for the fight against HIV/AIDS in the region.

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