Forum for Economic and Financial Studies 2024, 2(3), 458.
https://doi.org/10.59400/fefs458

Article

Do medical spending and income reduce the prevalence of human immunodeficiency virus and tuberculosis? A study on Sub-Saharan Africa

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CITATION

Bein MA, Erdil GE. Do medical spending and income reduce the prevalence of human immunodeficiency virus and tuberculosis? A study on Sub-Saharan Africa. Forum for Economic and Financial Studies. 2024; 2(3): 458.
https://doi.org/10.59400/fefs458

ARTICLE INFO

Received: 5 April 2024
Accepted: 23 June 2024
Available online: 20 July 2024

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Abstract: Several countries in sub-Saharan Africa (SSA) suffer from economic hardship and high unemployment rates; furthermore, this region has higher rates of human immunodeficiency virus (HIV) and tuberculosis (TB). This study examined the relationships between HIV and TB, income, and total medical spending and its components, private and public healthcare expenditure, for 41 SSA countries. Random and fixed-effects models were utilized in this study to explore relationships by studying time series and cross-sectional panel data obtained from the World Bank. Results demonstrated that there is a positive relationship between HIV and unemployment and a negative relationship with income and medical spending. We also observed that, when private and public medical expenditures are compared, private medical expenditures alleviate the HIV epidemic. Considering the association with TB, income, total, and its components, private and public medical expenditures are negatively related. Since prevention of such life-threatening diseases as HIV and TB becomes vital to find remedies for, there is a need for more government initiatives, including job creation, increased productivity, and increased income levels, which can be seen as preconditions in fighting and controlling HIV and TB.

Keywords: HIV; TB; medical spending; income; unemployment

1.Introduction

Multiple countries in sub-Saharan Africa (SSA) not only suffer from high unemployment, stagnating economic growth, and poverty but also from the burden of a high prevalence of human immunodeficiency virus (HIV) and tuberculosis (TB) [1]. More than 70% of people with HIV live in Africa; although the number of HIV deaths has substantially decreased compared to previous years, in 2014 alone, the number of HIV-related deaths in Africa was estimated to be 790,000 [1]. TB also poses a substantial burden on the African population, as there are 281 cases for every 100,000 people [1]. There has been considerable progress in reducing mortality and controlling the spread of HIV and TB. As a result, the number of HIV-related deaths declined by 5.4 million in Africa between 2000–2014, and the number of HIV infections has also decreased drastically, from 2.3 million in 2000 to 1.4 million in 2014 [1,2]. Furthermore, the incidence of TB decreased by an average of 1.5% per year globally in 2000–2014 [1,2]. Over the same period, total medical spending (including public and private healthcare expenditure) in Africa has increased. For example, the average total healthcare expenditure per capita increased from US$35 in 2000 to US$82 in 2009 [3]. Research has shown that considerable healthcare expenditure is allocated to HIV. In line with this, researchers observed total public spending on HIV was calculated at 19.4% in SSA countries, while in other low- and middle-income

countries, it was 1.6% [4]. Another study on SSA showed that about 20% of total health spending is directed to HIV services [5].

Arán-Matero et al. [6] showed that the level of spending on HIV in Latin America and the Caribbean reached US$1.59 billion; out of this, 75.1% was allocated to treatment and care and 15% to prevention. Izazola-Licea et al. [7] also investigated the spending on HIV among low and middle-income countries and revealed that on average, the domestic health spending on AIDS is 50%. Other researchers, such as Ávila et al. [8], used the random-effects model to investigate government financing of HIV for 125 countries and argued that a 10% increase in GDP per capita is associated with an 11.49% increase in public spending on HIV. Zeng et al. [9] argued that developing economies with lower per capita gross national products (GNPs) will benefit from improved AIDS programs if they manage to increase their per capita GNPs.

Yogo and Mallaye [10] investigated the relationship between health aid and health outcomes for 34 SSA countries; they emphasised that each additional unit increase in health aid leads to reductions in the prevalence of HIV and child mortality of 8.6% and 64%, respectively. In line with this study, Peiffer and Boussalis [11] also argued that aid is effective in reducing HIV/AIDS. Farag et al. [12] considered whether aid leads to a change in the public healthcare expenditure for developing economies and showed that an increase in foreign aid results in a reduction in public health spending. Several authors have explored the relationship between health spending and health outcomes [13,14]. Some researchers have reported that health spending reduces the mortality rate and increases life expectancy [15,16]. Others question whether an increase in health spending reduces mortality, and some believe that there is limited or no relationship between the two [17,18].

Research exploring the relationship between HIV and TB with medical spending and income and between unemployment and HIV is rare; among the few authors, Maruthappu et al. [18] considered the relationships between public healthcare spending, unemployment, and HIV for 74 countries. These researchers argued that public healthcare spending is negatively correlated to HIV, while unemployment has a positive relationship with HIV. In addition, Adedigba et al. [19] investigated the effect of HIV/AIDS on households' income in Nigeria; the results revealed a significantly lower income among those affected by HIV. Indeed, researchers have investigated the link between HIV and poverty. For example, Steinert et al. [20] explored the relationship between poverty and AIDS in South Africa; their empirical results revealed an association between the two and showed that receipt of a disability grant in AIDS-affected households lowered the correlation with poverty in comparison to AIDS-affected households that did not receive a grant.

To the best of our knowledge, there are no studies that examine the relationship between unemployment and income and the epidemic of HIV and TB in SSA. The aim of this article is to study whether income and medical spending are related to HIV and TB in 41 SSA countries using yearly data from 1995 to 2014 (the complete list of countries is given in the Appendix). Earlier studies above have focused on the effects of health care spending and health outcomes and/or aid effects of HIV and the poverty effect on HIV. Our study differentiates from the others in the following ways: First, we have concentrated on SSA counties, which are the most affected by HIV as well as

TB. Second, SSA suffers from high unemployment and is seen as having an effect on HIV as well as TB. Results will provide insight to policymakers to take necessary precautions and help to design a framework on how to cope with unemployment, HIV, and TB. Also, strengthen understanding of the of the association between health spending and income with HIV and TB.

2. Method

To explore the effects of medical expenditure (both private and public) and income on HIV and TB, this study used the fixed and random effects models. These models are widely employed in exploring panel time-series data [21,22]. Using these techniques allowed individuality among 41 SSA countries, since each of these countries differs in its healthcare allocation and HIV and TB rates [23]. The following equations from Models 1–2, we used to investigate the relationships between healthcare allocation, income, and HIV/TB rates.

Model 1:

$$HIV = \propto_i + \beta_1 HEP_{it} + \beta_2 HEPP_{it} + \beta_3 GDP_{it} + \beta_3 UN + \mu_{it},$$

Model 2:

$$LTU = \propto_i + \beta_1 HEP_{it} + \beta_2 HEPP_{it} + \beta_3 GDP_{it} + \mu_{it}.$$

In the fixed-effects model, uit is an error term for each observation, and it is normally distributed. In contrast, in the random effects model, the error terms have two components. For ∝, the intercept $i = 1\ldots n$ (n—the number of countries) and $t = 1 \ldots T$ (T—the number of periods). The dependent variables are HIV (prevalence of HIV) in model 1 and LTU (logarithm of TB) in model 2, while the independent variables are private and public medical expenditures, GDP growth (GDPG), and unemployment. In addition, unemployment was included in the HIV equation to investigate whether they are related. Each of the models above was also investigated by dropping one or more variables to observe whether the results are sensitive when variables are included in the model.

3. Data

The data were all obtained from the World Bank, which gathers data from governmental and non-governmental organizations. Yearly data for the period of 1995–2014 were used. **Table 1** presents the pairwise correlation between HIV and TB.

Table 1. Correlation of healthcare expenditure, income unemployment with HIV and TB in sub-Saharan Africa.

	HEP	HE	HEPP	GDPG	UN
TB	−0.0234	0.2233	0.4056	−0.1154	0.5816
HIV	−0.0258	0.2731	0.4925	−0.0957	0.5322

Note: Healthcare expenditure (HE), private healthcare expenditure (HEP), public healthcare expenditure (HEPP), annual gross domestic product growth, (GDPG), unemployment (UN), human immunodeficiency virus (HIV), tuberculosis (TB).

4. Results

As can be observed, private healthcare expenditure and GDPG were correlated

negatively with HIV and TB, whereas unemployment correlated positively with HIV and TB. Total healthcare expenditure and public healthcare expenditure showed a positive relationship (**Table 1**).

Table 2 presents four models, each using two techniques. In Model 1, a simple regression was run with HIV as a dependent variable and total healthcare expenditure as a percentage of the GDP. As can be observed, there was a negative relationship between HIV and total healthcare expenditure. For Model 2, multiple regressions were used to examine the effects of private and public healthcare expenditures on HIV rates instead of total healthcare expenditures; as a result, a negative and statistically significant relationship was observed between private healthcare expenditure and HIV and a statistically insignificant and positive relationship between public healthcare expenditure and HIV. In Model 3, income (GDPG) was introduced into Model 2, and the result revealed that increased income leads to a reduction in HIV. Finally, in Model 4, the unemployment rate was added to Model 3 and found that an increase in unemployment will lead to an increase in HIV prevalence.

Table 2. Empirical results for healthcare expenditure, income and unemployment in relation to HIV in sub-Saharan Africa.

	Model 1		**Model 2**		**Model 3**		**Model 4**	
	RE	**FE**	**RE**	**FE**	**RE**	**FE**	**RE**	**FE**
	Coef.							
HE	−0.100	−0.110						
	(0.047)	(0.047)						
	[−2.13]	[−2.33]						
HEP			−0.302	−0.301	−0.300	−0.299	−0.318	−0.316
			(0.080)	(0.079)	(0.080)	(0.079)	(0.079)	(0.079)
			[−3.77]	[−3.79]	[−3.76]	[−3.78]	[−4.02]	[−4.01]
HEPP			0.061	0.033	0.063	0.034	0.124	0.082
			(0.068)	(0.067)	(0.068)	(0.067)	(0.068)	(0.679)
			[0.89]	[0.50]	[0.92]	[0.51]	[1.82]	[1.21]
GDP					−0.0187	−0.0183	−0.017	−0.171
					(0.007)	(0.007)	(0.007)	(0.007)
					[−2.72]	[−2.72]	[−2.48]	[−2.54]
UN							0.189	0.138
							(0.039)	0.042)
							[4.86]	[3.31]
Cons	6.644	6.696	6.862	6.927	6.952	7.019	4.976	5.580
	(1.065)	(0.264)	(0.888)	(0.274)	(0.866)	(0.275)	(0.929)	(0.514)
	[6.24]	[25.32]	[7.73]	[25.26]	[8.03]	[25.51]	[5.36]	[10.86]
R^2	0.120	0.007	0.010	0.048	0.017	0.027	0.286	0.260
Wald χ^2 (2)	4.540		14.310		21.770		45.96	
F-statistics		5.41		39.06		7.29		8.27
p. value	0.034	0.020	0.001	0.000	0.000	0.017	0.000	0.000
Hausman test							$\chi^2 = 3.06$; prob. > $\chi^2 = 0.5479$	

Note: Random effects (RE), fixed effects (FE), number given in [ ], () are *t*-values and standard errors respectively, *F*-statistics (for FE model) and Wald χ^2 (2) (for RE model).

Results from a Hausman test are reported at the bottom to determine the most appropriate model from the two models' random effects and fixed effects. The results showed that the random-effects model is suitable ($\chi^2 = 3.06$; prob. > $\chi^2 = 0.5479$). For the rest of the equations, the Hausman test was not reported because for the two models, they were the same. The R^2 value for each technique was also reported at the bottom of the table, and it can be observed that when we included income level, unemployment (as in Model 4) the R^2 drastically increased which means that 26%–28% of the variation in HIV is explained by private and public healthcare expenditure, income and unemployment. In addition, *F*-statistics for the fixed-effects model and the Wald χ^2 for the random-effects model are reported, and the results reveal that all the models are appropriate.

Table 3. Empirical results for healthcare expenditure and income in relation to TB in sub-Saharan Africa.

	Model 1		**Model 2**		**Model 3**	
	RE	**FE**	**RE**	**FE**	**RE**	**FE**
HE	−0.01838	−0.01956				
	(0.006641)	(0.006659)				
	[−2.77]	[−2.94]				
HEP			−0.01062	−0.01094	−0.01041	−0.01074
			(0.01122)	(0.011281)	(0.011193)	(0.011244)
			[−0.95]	[−0.97]	[−0.93]	[−0.96]
HEPP			−0.02369	−0.02562	−0.02352	−0.02554
			(0.00952)	(0.009511)	(0.0095)	(0.009479)
			[−2.49]	[−2.69]	[−2.48]	[−2.69]
GDP					−0.00244	−0.00239
					(0.000966)	(0.000962)
					[−2.53]	[−2.49]
Con	5.595238	5.601712	5.58471	5.590425	5.596717	5.602441
	(0.132992)	(0.037342)	(0.128822)	(0.038922)	(0.125925)	(0.039091)
	[42.07]	[150.01]	[43.35]	[143.63]	[44.44]	[143.32]
R^2	0.0661	0.0661	0.1262	0.0118	0.0684	0.0197
Wald χ^2 (3)	7.66		8.06		14.42	
F-statistics		8.62		4.65		5.19
p. value	0.0057	0.0034	0.0178	0.0098	0.0024	0.0015

Note: Random effects (RE), fixed effects (FE), number given in [ ], ( ) are t-values and standard errors respectively, F-statistics (for FE model) and Wald χ^2 (2) (for RE model).

Table 3 shows the empirical test results for the relationships between total healthcare expenditure, private and public healthcare expenditure, income, and TB. In Model 1, a simple regression was run, and the results revealed a strong negative relationship between TB and total healthcare spending. In the following (Model 2) separating total healthcare spending into private and public healthcare expenditure, the results revealed a negative association between health spending and TB. However, statistical significance was only obtained for public healthcare expenditure. In Model 3, income was added to the equation, and the results revealed that there was a negative

and statistically significant relationship between income and TB. R^2 values for each technique are provided at the bottom of the table. In addition, *F*-statistics for the fixed-effects model and the Wald χ^2 for the random-effects model are reported; in all models, the *p*-value is statistically significant, meaning that the model is appropriate.

5. Discussion

Three main points can be summarised from the empirical findings of this study. First, results obtained from all techniques employed in this study have shown a statistically negative relationship between total healthcare spending and HIV and TB diseases, akin to Yogo and Mallaye [10] and Maruthappu et al. [18]. When the total healthcare spending is categorized into private and public healthcare expenditure, the spending that comes from the private sector towards the payment for the prevention and control of the disease will bring a financial burden, reducing resources and quality of life. From the results, especially with the HIV epidemic, much more funding from the public needs to be encouraged to increase the gains that are expected to avoid more people being affected, since reliance on private expenditures towards fighting with the disease is not adequate.

Second, data analysis has indicated that there are negative relationships between income and TB and HIV. This result is consistent with earlier studies by Long and Deane [24], Adedigba et al. [19], and Steinert et al. [20], but in contrast with Agyei-Mensah [23]. Our findings demonstrate that raising people's incomes will contribute to a lower rate of disease infection because people will be more self-reliant, knowledgeable, and self-assured. So, they will not engage in socially unacceptable activities like prostitution, rape, and robbery.

When people have to pay for the upkeep of their diseases, not to mention the stigma associated with them, it becomes costly for them. Therefore, in areas where income levels are rising, it will be much easier for people to take care of their health, even if they are unlucky enough to be infected. We could also say that there is a need to find more strategies to avoid the effects of income levels, as it has greater effects on women at risk of being infected by the disease, as found by Long and Deane [24]. The results have shown that people are at risk when individual disposable income is not adequate to take care of themselves. This situation will put people in search of ways to increase their earnings, and in countries where there are low education levels, it might push people to engage in illegal behaviors, especially women. Females are at risk of getting infected by the disease in situations where they are poor and need financial assistance for survival and therefore will fall prey. De Wet [25] investigated the gender difference in AIDS among secondary school youth in South Africa and showed that the prevalence of HIV is higher among females than males; she further demonstrated that AIDS mortality is lower for females than males in secondary school, although it is still high for females.

Third, the unemployment variable showed that there is a strong positive relationship between unemployment and HIV consistent with Ávila et al. [8]; Zeng et al. [9]; Maruthappu et al. [18]. It is observed in our results that individuals who were affected by HIV and TB fell into a non-elderly group. It might be suggested that policymakers should find ways to improve job opportunities for non-elderly groups.

So, when the young are given a chance to participate in the workforce, they will be away from making money illegally, and women will be encouraged to participate in the workforce more willingly. This in turn will reduce the possibility of getting affected by infection, resulting in the in the prevalence of the disease among the young.

The majority of studies, like the one done by Karim et al. [26] on employment and HIV, reveal that women are more likely to contract the virus and have higher rates of unemployment. Without employment, one is prone to be poor, and this has a great impact on the individual's health status and can have ripple effects such as AIDS [20]. Policymakers in the region are advised to focus especially on measures that would promote the growth of industries, as this will raise the demand for human resources and lead to the creation of more jobs.

Nevertheless, research has documented that, apart from unemployment, income, and health spending, there are other reasons why HIV and TB have not decreased in Sub-Saharan Africa over time. According to Nyindo [27], major risk factors for HIV-1 infection and AIDS disease in Sub-Saharan Africa (SSA) were identified as follows: poverty, hunger, low women's status in society, corruption, resistance to changing sexual behavior, internal conflicts and refugee status, lack of recreational facilities, ignorance of one's own HIV status, adult and child prostitution, unreliability of blood intended for transfusion, widow inheritance, circumcision, and illiteracy.

6. Limitation

This research comes with several limitations. Data for the study was collected from World Bank sources. The authors could have been using more recent data, but it was not ready during the data collection and examination of the study variables. Female participation in the workforce would have been significant for our research outcome in acknowledging reducing infection if it is going to reduce the epidemic. Education, if included in our model, would have been an important variable to reveal its contribution to lessening the spread of such infections. Additionally, factors such as social, cultural, and effects of moving from rural to urban towns would have been worth examining; however, a lack of data about those variables has prevented researchers from testing their relation to HIV and TB.

7. Conclusion

It is difficult to determine the number of people with AIDS, and this is because sharing the disease with others has socially unacceptable consequences. As a result, the precise number of individuals who have been infected by HIV and TB is not possible. But the spread can be controlled. We believe minimizing spread is possible first by increasing job opportunities, which in turn foster employment, especially for adults; second, by enhancing public health care expenditures and at the same time subsidizing private health care expenditures; or strongly suggesting that African countries consider universal health care coverage, especially for minimum wage earners and individuals who are affected by HIV and TB.

Parallel to our suggestions, the Sustainable Development Goals (SDG) in 2015 argue countries to pay more attention to health quality, provide quality education, erase hunger, enforce gender inequality, and create decent work and economic growth.

Future studies should consider the roles of education, infrastructure, and other variables, such as female participation in the workforce, in reducing HIV and TB. In addition to this, future studies may consider social, cultural, and policy factors, which are the limitations of this research.

Author contributions: Conceptualization, MAB and GEE; methodology, MAB; software, MAB; validation, MAB; formal analysis, MAB; investigation, MAB; resources, MAB; data curation, MAB; writing—original draft preparation, MAB and GEE; writing—review and editing, MAB and GEE; visualization, MAB and GEE; supervision, GEE; project administration, MAB and GEE; funding acquisition, MAB and GEE. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no conflict of interest.

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Appendix

Table A1. List of 41 SSA nations whose data was examined for the study.

Angola	AGO	Madagascar	MDG
Benin	BEN	Malawi	MWI
Botswana	BWA	Mali	MLI
Burkina Faso	BFA	Mauritania	MRT
Burundi	BDI	Mauritius	MUS
Cabo Verde	CPV	Mozambique	MOZ
Cameroon	CMR	Namibia	NAM
Central African Republic	CAF	Niger	NER
Chad	TCD	Nigeria	NGA
Congo, Dem. Rep.	ZAR	Rwanda	RWA
Cote d'Ivoire	CIV	Senegal	SEN
Equatorial Guinea	GNQ	Sierra Leone	SLE
Eritrea	ERI	South Africa	ZAF
Ethiopia	ETH	Sudan	SDN
Gabon	GAB	Swaziland	SWZ
Gambia	GMB	Tanzania	TZA
Ghana	GHA	Togo	TGO
Guinea	GIN	Uganda	UGA
Kenya	KEN	Zambia	ZMB
Lesotho	LSO	Zimbabwe	ZWE
Liberia	LBR		