Healthcare Expenditure and Life Expectancy in Africa: A Panel Study

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Authors' contributions

This work was carried out in collaboration between both authors. Author SA conceived the idea, wrote the methodology, presentation of results, discussion of study and proof-read the manuscript. Author MT wrote the introduction, managed the literature searches, wrote the conclusion and proof-read the manuscript. Both authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Objective of the Study: The study examined the nature of relationship between healthcare expenditure and life expectancy in a panel of 45 African Countries, disaggregated into different sub-regions in the continent.
Methodology: The study used fixed effect method and two-stage least square technique to investigate the relationship between life expectancy and life expectancy in the selected African countries, from 2000 to 2015. Aside from the major variables of interest, GDP per capita, basic sanitation and urban population were used as control variables. The choice of countries and time frame were based on availability of data. The data used was sourced from World Bank website, and analyzed using STATA software.
Main Findings: The fixed effect method found that healthcare spending is an important predictor of life expectancy in Africa. It was found to positively and significantly influence life expectancy in West Africa, but significantly and negatively influences life expectancy in Central and Southern regions of Africa. Contrariwise, the two-stage least square shows that healthcare spending is a negative predictor of life expectancy in Central Africa, but not a significant predictor in Eastern, Northern, Southern and Western Africa.

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Conclusion: Conclusions from the study are two-fold. It can be concluded that fixed effect method is not a suitable estimation technique for models with endogeneity and reversed causation issues, and that healthcare expenditure is significant negative predictor of life expectancy in Central Africa; but not a significant predictor of life expectancy in Eastern, Northern, Southern and Western regions of Africa.

1. INTRODUCTION

Given the recent technological development in vaccines, antibiotics and medical equipment, humans today live much longer and disease-free lives than they did in the past. While several factors account for the increase in life expectancy, data suggests an association between healthcare spending and longevity of life. It is expected that a country with a stable healthcare system would have high life expectancy, but it is unknown how much healthcare contributes to a longer life [1]. Given the nexus between healthcare spending and quality of life, there is a herculean need for huge investment in health to improve the standard of living, national productivity and overall economic buoyance [2]. Investment in the health sector provides an avenue for improvement in individuals' health status, and requires mobilization of financial and non-financial resources. The amount of expenditures incurred in the preparation of and improvements in population's health are regarded as health expenditures [3,4].

To ascertain the actual relationship between healthcare expenditure and different health outcomes, a number of studies like McCarthy and Wolf [5], Anyanwu and Erhijakpor [6]; Heijink, Koolman and Westert [7]; Kim and Lane [8]; Makuta and O'Hare [9]; Sirag, Norashidah, Siong, Nik and Miloud [10]; Compah-Keyeke, Frank and Marcella [11]; Yaqub, Ojapinwa and Yussuff [12]; Sede and Ohemeng [13]; Richards and Vining [14] have been conducted and found mixed results. Also, it was found that most of the existing studies have investigated of healthcare expenditure and health outcomes relationship along different dimensions of variables. Studies like Zaman, Hossain, Mehta, Sharmin and Mahmood [15], and Boachi, Ramu and Põlajeva [16] have used times series in their investigation, while others like Obrizan and Wehby [17], Sango-Coker and Bein [18] used panel data and considered gender effect of healthcare spending and health outcome nexus.

In the time series studies, Zaman, Hossain, Mehta, Sharmin and Mahmood [15] found that healthcare expenditure did not significantly influence life expectancy, but found that GDP and total health expenditure are positively related. Boachi, Ramu and Põlajeva [16] found that increasing public health expenditure by 10% averts 0.102–4.4 infant and under-five deaths in every 1000 live births but increases life expectancy at birth by 0.77–47 days' in a year. Their cost effectiveness analysis found that cost per childhood mortality of US$0.20 to US$16 was averted, and that the cost per extra life year of US$7 to US$593.33 (2005 US$) was gained during the period. In the panel studies with gender difference, Duba, Berry, Fang and Baughn [1] found that there is a statistically significant link between life expectancies of both men and women and health care expenditures. Sango-Coker and Bein [18] found that female population lived longer than the male population and that there is a positive relationship between healthcare spending and life expectancy for the public sector. For the private sector, negative relationship was found between healthcare expenditure and life expectancy. Obrizan and Wehby [17] found that the largest returns from increased spending are for countries at the left margin of the life expectancy distribution for which a $100 increase in per capita spending leads to 11.5 and 11 months of life for males and females, respectively. In Jaba, Balan and Robu [19], the difference of effect between developed and developing nations was considered. They found a significant relationship between health expenditures and life expectancy. The study found that there is higher variation of health expenditures per capita among the developed countries than among developing and less developed countries.

Different from the existing studies, the current study is meant to contribute to the debate by investigating the nature of relationship between healthcare expenditure and life expectancy in different regions of Africa. Currently, no study was found in this regard. In addition to the

current section of the work, literature review appears in the second section. Research methodology appears section three, presentation of results appears in section four, while conclusion and recommendation appears in the final section of the work.

2. METHODOLOGY

2.1 Nature and Source of Data

This study used a balance panel data of 45 African countries, disaggregated into different sub-regions in the continent, for the period of 2000 to 2015. The choice of the countries is based on availability of data. The dependent variable is life expectancy at birth, while healthcare expenditure is the main independent Variable. GDP per capita, basic sanitation and urban population are used as control variables. The data for all the variables are sourced from World Development Indicators (WDI).

2.2 Model Specification

The econometric approach will be based on panel data regressions, showing the relationship between current healthcare expenditure and life expectancy in Africa. Consistent with the reviewed studies, the model will be specified as below:

$$LEXPTANCY_{it} = \alpha_{it} + \beta_1 HCEPCD_{it} + \beta_2 GDPPCD_{it} + \beta_3 BASICSANIT_{it} + \beta_4 LURBANPOP_{it} + u_{it}$$

Where

$LEXPTANCY_{it}$ = Life expectancy at birth (measured in years);

α_{it} = Country-specific effect;

$HCEPCD_{it}$ = Health expenditure per capita (measured in US dollars);

$GDPPCD_{it}$ = GDP per capita (Measured in US dollars);

$LURBANPOP_{it}$ = Log of Urban population, as a measure of urbanization;

$BASICSANIT_{it}$ = People using at least basic sanitation services (% of population); and

u_{it} = Error term.

The study used two approaches in investigating the relationship between healthcare and life expectancy in the selected countries. The first approach is fixed effects estimation method. The method accounts for unobserved heterogeneity across different observations of a panel data. Secondly, the study used two-stage least square estimation technique. This is necessary to correct the likely endogeneity that may be associated with healthcare expenditure, income (GDP per capital) and life expectancy at birth. Apart from taken care of the endogeneity problem, it is also argued that 2-stage least square accounts for measurement error [20], simultaneity issues [21] and other estimation bias that are associated with linear estimation techniques.

2.3 Identification Strategy for Two-Stage Least Square

In using Two-stage least square, also called instrumental variable regression, there is a need to identify instrumental variable that will account for the endogeneity and reversed causation that may be associated with healthcare expenditure and life expectancy. Following the approach used in Boachi, Ramu and Põlajeva [16], this study used one year lagged values of healthcare expenditure and GDP per capital as the instrumental variables. It is assumed that the lagged healthcare expenditure and GDP per capital could explain current life expectancy, but the currently observed life expectancy at birth would not explain past levels healthcare expenditure and GDP per capital. As stated in Green [21] and Gujarati [20], the second condition of instrumental variable approach is that the error term of the model and the instrument should be uncorrelated. The validity of the estimation is confirmed by conducting Hansen J Statistics, an over-identification test, to confirm that the instruments adequately capture the endogeneity and reversed causation suspected in the model.

3. RESULTS AND ANALYSIS

3.1 Descriptive Statistics

Table 1 shows that the average life expectancy at birth in Africa is approximately 58 years. Generally, the data of the selected 45 African countries show maximum of 76 years' life expectancy and minimum of 39 years. The average public health spending in Africa was about US$ 86.41 million while the minimum and

maximum of US$4.69 and US$597.36 million were respectively spent on healthcare within the period. This shows that some African countries spend huge amount of money on health sector and resultantly have high life expectancy at birth. Others spend a pantry amount of about US$4.69 million and consequently have low life expectancy of about 39 years.

3.2 Graphical Representation

Fig. 1 shows the difference in the relationship between healthcare expenditure and life expectancy at birth across the regions of Africa. The graph shows that North Africa has the highest life expectancy of about 71 years at healthcare expenditure of about $148 million. At two opposing extreme ends are Southern and Western regions of Africa. Southern Africa has the highest healthcare expenditure of about $235 million but with life expectancy of about 55 years. Opposite-wise, West Africa with the lowest

healthcare expenditure less than $10 million dollars, and has a higher life expectancy of 56 years. Eastern and Central African countries respectively have a higher her expenditure and life expectancy than Western African region.

3.3 Regression Results

As shown in Table 2, the F-test of the regressions are greater than 5% level of statistical significance, indicating that the models are well fitted and that all the independent variables are statistically different from zero. Also, the adjusted R^2 of the models are above 80%, indicating that significant variations in the dependent variable (life expectancy at birth) are explained by the independent variables. The models were estimated using robust standard error, implying that the models are free from linear regression estimation errors.

Table 1. Descriptive statistics of the variables used in the model

Variable	Observations	Mean	Minimum	Maximum
LEXPCNYBT	720	57.8	38.7	75.9
HCEPCD	720	86.41	4.69	597.36
GDPPCD	720	1833.70	111.36	22742.38
URBANPOP	720	152294	152294	86700000
BASICSANIT	720	34.52	3.15	93.17

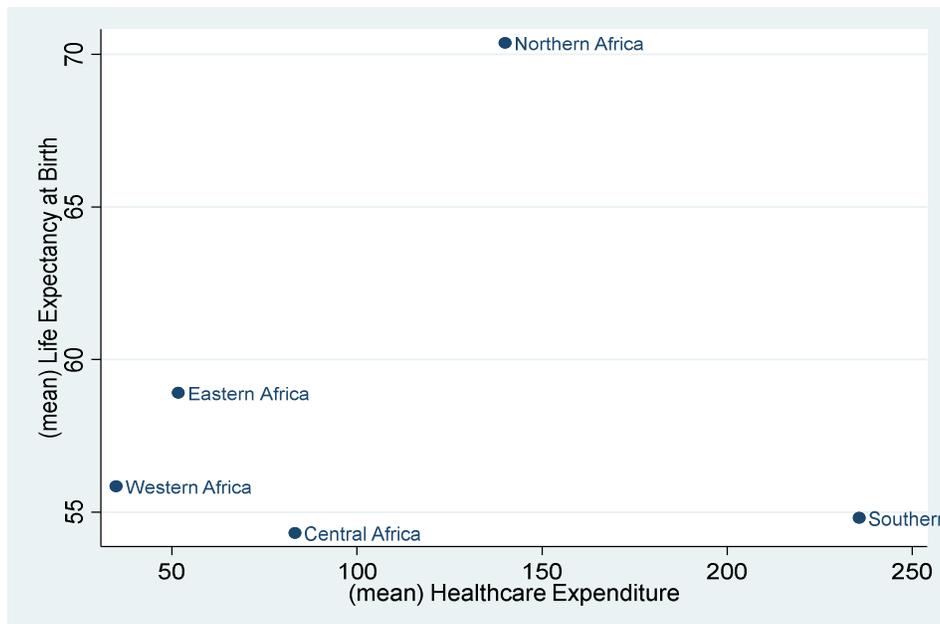*Source: Authors' Computation*

Fig. 1. Health expenditure and life expectancy nexus across regions

Table 2. Fixed effect regression results across regions

Variables/ Regions	Central Africa	Eastern Africa	Northern Africa	Southern Africa	Western Africa
Intercept	-173.6444	-56.0545	-135.2882	-293.8803	-109.8823
	(-17.29)***	(-5.62)***	(6.09)***	(-8.88)***	(-13.84) ***
HCEPCD	-0.0129	0.0191	-0.0032	-0.0138	0.0505
	(-2.30)**	(1.53)	(-1.38)	(-2.05)**	(7.48)***
GDPPCD	-0.00001	-0.0007	0.0002	0.0005	-0.0021
	(-2.30)**	(-0.85)	(1.10)***	(0.81)	(-6.37) ***
LURBANPOP	14.4509	6.3662	11.8697	23.3098	10.9910
	(20.72)***	(8.46)***	(8.38)***	(9.67)***	(19.67) ***
BASICSANIT	0.3846	0.6747	0.1191	0.2505	0.0435
	(10.47)***	(10.11)***	(4.91)***	(4.39)***	(1.77)*
Observation	128	192	80	96	224
R^2	90%	84%	93%	83%	89%
F-statistics	(265.82)***	(12.80)***	(51.36)***	(104.60)***	(417.83)***

*T-statistics are reported in brackets. *** denotes statistical significance at the 1 percent level, ** at the 5 percent level*

The Table 2 shows that healthcare expenditure statistically influences life expectancy only in Central, Northern and Western regions of Africa. In Eastern and Southern regions of Africa, the relationship between healthcare expenditure and life expectancy is not statistically significant. In Central Africa, a one percent increase in healthcare expenditure leads to 0.0129 decrease in life expectancy at birth, all other factors remain constant. In Northern Africa, a one percent increase in healthcare expenditure leads to 0.0138 decrease in life expectancy at birth, all other factors remain constant. In Western Africa, a one percent increase in healthcare expenditure leads to 0.0505 decrease in life expectancy at birth, all other factors remain constant. Moreover, urban population and basic sanitation were found to statistically influence life expectancy at birth all the regions of Africa. GDP per capita only statistically and negatively influence life expectancy in West Africa.

As shown in the Table 3, the F-test of the models shows that the models are well fitted and the variables are statistically different from zero. Also, the adjusted R^2 of the models show that significant variations in the dependent variable are explained by variations in the independent variables. The models were estimated using robust standard error, implying that the models are free from estimation errors. The Hansen J Statistics shows that the instrumental variables are well-behaved, and adequately addressed the endogeneity in the model.

The Table 3 shows that healthcare expenditure statistically influences life expectancy only in

Central Africa. A one percent increase in healthcare expenditure leads to 0.0493 decrease in life expectancy at birth, all other factors remain constant. In the remaining regions, (Eastern, Northern, Southern and Western regions of Africa), the relationship between healthcare expenditure and life expectancy is not statistically significant. Moreover, urban population positively and statistically influence life expectancy in all the regions, basic amenities positively and statically influence life expectancy in all but one region (West Africa), GDP per capita positively and statistically influence life expectancy only in Central Africa.

4. DISCUSSION

The study used two estimation approaches to investigate the effect of healthcare expenditure on life expectancy at birth in 45 African countries, disaggregated into different sub-regions in the continent (Central, Eastern, Northern, Southern and Western Africa). The result of the fixed effect method shows that it is only in West Africa that the relationship between the two variables tallies with appriori expectation. It was found that healthcare expenditure positively influences life expectancy at birth in the region. It implies that increase in healthcare expenditure was found to lead to increase in life expectancy in the region. The finding is similar to that of Obrizan and Wehby [17]; Boachi, Ramu and Põlajeva [16].

In Central Africa and Southern regions of Africa, healthcare expenditure negatively influences life expectancy at birth. This means that, in the two regions, life expectancy at birth decreases, when

the healthcare expenditure is increased. Also, in Sango-Coker and Bein [18], two opposite results were found between healthcare expenditure and life expectancy in West Africa. They found that positive relationship for public sector, but negative for the private sector.

In eastern and northern regions of Africa, the study found no effect of healthcare expenditure on life expectancy. This is similar to the findings of Zaman, Hossain, Mehta, Sharmin and Mahmood [15], who found that healthcare expenditure does not statistically influence life expectancy in Bangladesh. Similar result was also found in Compah-Keyeke, Frank and Marcella [11]. Several factors could account for such insignificant relationship. It is likely that the effect of other macroeconomic factors supersedes that of healthcare expenditure. As such, healthcare expenditure cannot individually determine the level of life expectancy at birth.

Contrariwise, the results of the two-stage least square differ from those obtained from the fixed method. Unlike the fixed effect method, the least-square method shows that healthcare expenditure is statistically influences life expectancy only in Central Africa. A one percent increase in healthcare expenditure leads to 0.0493 decrease in life expectancy at birth, all other factors remain constant. In the remaining regions, (Eastern, Northern, Southern and Western regions of Africa), the relationship between healthcare expenditure and life expectancy is not statistically significant. Similar to the findings, Obrizan and Wehby [17]; Boachi, Ramu & Põlajeva [16], the healthcare expenditure-life expectancy nexus in the linear model is -0.0129 while that of 2-satge least square is -0.0493, this confirms the argument that estimation are usually under or overestimated in the linear models. The non-significance effect of healthcare expenditure on life expectancy in Eastern, Northern, Southern and Western regions of Africa is similar the findings in Berger and Messer [22]; and Compah-Keyeke, Frank and Marcella [11]. In many developing countries, governments place less emphasis on provision of social services as they expect economic growth to improve social sector outcomes and explore new avenues to lower expenditures and at the same time aim at improving equitable access to healthcare to achieve better health (Plümper and Neumayer, [23]). The non-significance effect of government spending on life expectancy in the five regions and counter-appriori sign obtained from the Central African region could be attributed to the meager resource allocation to health sector by most developing nations, including most African countries.

Fig. 1 confirms the meagerness of health sector allocation in the African countries. The figure shows the maximum average of $235 million allocated to health sector between 2000 to 2015 in Southern Africa and a paltry of less than $10 million dollars in West Africa. Given the insignificant health sector allocation in the sub-regions of the continent, within the time frame of this study, the non-significance relationship between healthcare expenditure and life expectancy is not a surprise. The graphical representation of the healthcare expenditure and the corresponding life expectancy also confirms

Table 3. Two-stage least square regression results

Variables/ Regions	Central Africa	Eastern Africa	Northern Africa	Southern Africa	Western Africa
HCEPCD	-0.0493	-0.0159	-0.0258	-0.0009	0.0108
	(0.0132)***	(0.0191)	(0.0037)	(0.0218)	(0.0009)
GDPPCD	0.0003	0.0015	0.0003	-0.0005	-0.0009
	(0.0002)**	(0.0012)	(0.0002)	(0.0017)	(0.0011)
LURBANPOP	16.9225	5.6850	12.2489	26.6813	12.3537
	(1.1562)***	(0.7759)***	(1.6399)***	(2.4150)***	(1.3433)***
BASICSANIT	0.4030	0.7111	0.1135	0.2356	0.0324
	(0.0455)***	(0.0707)***	(0.0246)***	(0.0713)***	(0.0291)
Observation	120	180	75	90	210
R^2	86%	81%	93%	88%	87%
F-statistics	(171.57)***	(105.92)***	(223.58)***	(139.93)***	(327.70)***
Hansen J Statistics	0.4235	0.4276	0.1080	0.6809	0.2582

*Robust standard errors in parenthesis; *** denotes statistical significance at the 1 percent level,*
*** at the 5 percent level. Values for Hansen J statistics are probabilities*

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and gives a clue to the conflicting results that were found in the fixed effect method regression.

Surprisingly, Southern Africa has the highest healthcare expenditure of about $235 million but has a low life expectancy at birth of about 55 years. This is dissimilar to Northern region that has a smaller healthcare expenditure of about $148 million but has the highest life expectancy at birth of about 71 years. Even the West Africa region with lowest healthcare expenditure of less than $10 million has life expectancy of about 56 years, which is slightly higher than that of Southern Africa. This goes to imply that other factors; aside from healthcare expenditure, determine the level of life expectancy at birth in each region. Other factors like the country's level of income, urbanization rate and sanitization rate and many other factors captured by the error term complement healthcare expenditure in explaining the nature, magnitude and direction of relationship between healthcare expenditure and life expectancy at birth in the sub-regions of the continent.

5. CONCLUSION

Two conclusions can be drawn from this study; the first from methodology point of view, and the second from policy angle. It can be concluded that fixed effect estimation method is not capable of estimating a model with endogeneity problem. It gives underestimated estimations and false statistical significance of some variables in the models, unlike an instrumental variable technique that gives a true relationship in the model. Using the result of the two-stage least square estimation method, it can be concluded that that healthcare expenditure is significant negative predictor of life expectancy in Central Africa; but not significant predictor of life expectancy in Eastern, Northern, Southern and Western regions of Africa.

6. LIMITATIONS AND FUTURE RECOMMENDATIONS

The data used in the study covers 45 African countries (disaggregated into five sub-regions in the continent) and time frame of fifteen years. To increase the robustness of the findings, future researchers are encouraged to use data with wider coverage and longer time frame. A different estimation technique might also be tried. Given the findings of this study, policy makers are advised to put more resources and efforts in improving the general health outcomes of people in Africa.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Selected African Countries

Western Africa	Eastern Africa	Central Africa	Southern Africa	Northern Africa
Benin	Burundi	Angola	Botswana	Algeria
Burkina Faso	Comoros	Cameroon	Lessotho	Egypt
Gambia	Eretria	Central African Republic	Namibia	Morocco
Ghana	Ethiopia	Chad	South Africa	Sudan
	Kenya	Democratic Republic of Congo		Tunisia
Guinea	Madagascar	Republic of Congo	Zambia	
Guinea Bissau	Malawi	Equatorial Guinea	Swaziland	
Liberia	Mauritius	Gabon		
Mali	Mozambique			
Mauritania	Rwanda			
Niger	Tanzania			
Nigeria	Uganda			
Senegal				
Sierra Leone				
Togo				

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