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Research Article

Health Status and its Determinants in East African Countries: Implications for Public Health Intervention

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Abstract: This study aims to investigate and examine the influence of health related variables, socioeconomic factors and environmental indicators on the health status of East African countries which is proxied by life expectancy and assesses the link between public health intervention and health outcomes. Panel dataset from 2000 to 2016 for 11 East African countries was used to estimate the results. Nine variables related to health, socioeconomic and environmental factors that are predicted to potentially influence life expectancy are selected based on the available literature. To ensure the robustness of the result of the study, two estimation methods, which are widely used with panel data analysis namely; Pooled OLS and Fixed and Random Effects models are used. The estimation results suggest that under five mortality rates, HIV prevalence, the practice of open defecation, and carbon dioxide emissions have a negative and statistically significant effect on life expectancy. On the other hand, access to basic drinking water, immunization against measles, net official development assistance and foreign aid as well as urbanization has statistically significant positive effects on life expectancy. Furthermore, assessment of the linkage between the regression results and public health intervention confirms the need for a concerted and coordinated public health intervention strategy to address population health problems and strengthen and maintain the achievements in healthcare outcomes, observed in the study period, in the East Africa region.

Keywords: Health status, life expectancy, health related variables, socioeconomic factors, environmental indicators, panel data, public health intervention, East African countries.

INTRODUCTION

Human beings have continuously been endeavoring to improve their health status and to reach a life which is more and more dignified. As healthy people are trusted to be more vibrant, energetic, and to have a positive outlook on life, improvement in health has always been one of the most important social objectives [1, 2]. Health is one of the most important assets a human being has. It permits us to fully develop our capacities. The underdevelopment or erosion of this asset can cause physical and emotional weakening, causing obstacles in the lives of people. Mwabu [3] and Permanyer and Scholl [4] assume that good health is an end in itself through improving human welfare and a means to creating wealth via its critical contribution as a factor of production. For these reasons, improvement in health status has been considered as a summary indicator of human development and the most valued and universal human goal.

Life expectancy at birth has been widely used as an indicator of overall development of health status and the quality of life in a country. It is defined as the average number of years an individual is expected to have an extended life span [5]. Life expectancy, as a measure of health status, is the most reliable metric to compare the health status of countries internationally and explains individual and aggregate human behaviour [6, 7]. Information on life expectancy and its determinants has significant implication to developing countries in their efforts for socioeconomic progress. It conveys an important message in terms of their investment in social sectors including health, education, sanitation, environmental management and sustainability [8].

Although marked differences remain between the developed and developing countries, over the past 170 years, life expectancy has been continuously increasing throughout the world [5]. The UNDP, Human Development Report [9] indicates that whereas life expectancy for countries with very high Human Development Index (HDI) increased from 73.3 years in 1980 to 80.2 years in 2013, it increased from 49.6 to 59.4 years for countries with low HDI, for the same time period. Africa's health outcomes have been

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showing steady increase over recent decades. According to the AfDB [10], 59 percent of gains in life expectancy over the last 60 years are due to declines in mortality among under-five years children and additional 12 percent is due to better survival rates for children between 5 and 14 years of age. However, pervasive poverty, epidemic diseases and food insecurity remains the major challenges of the continent. Communicable diseases such HIV/AID, malaria, and tuberculosis on the one hand and non-communicable diseases such as cardiovascular diseases, diabetes and cancer are posing a double diseases burden (AfDB, 2013). The health status of most of SSA countries is still considerably low as measured in terms of health indicators such as: life expectancy, infant and maternal mortality rates, malaria and tuberculosis, and HIV/AIDS [11].

Despite the fact that the East Africa region has registered better economic performance in terms of GDP growth in comparative terms, number of challenges remains in terms of securing citizens' good health and wellbeing. Therefore, investigating the underlying variables that determine life expectancy in the region and their implications for public health intervention justifies the conduct of this study. Thus, this study is motivated to investigate and examine the relevant variables that potentially influence the health status in East African countries and expected to have important contribution to efficient policy making, resource allocation and implementation as well as to enhance the understanding of the link between public health intervention and health outcomes. Therefore, this study intends to achieve two major objectives. Firstly, it attempts to identify and analyze the socioeconomic, environmental, and health related factors that determine the health status measured in terms of life expectancy in East African countries. Secondly, it strives to explain the implications of these relationships to public health intervention and public health policy of the region. Even though a number of empirical studies have been conducted on the determinants of health status in SSA, significant sub-regional variations persist at sub-regional level. To the best of our knowledge, no study has been conducted on the determinants of life expectancy in the East Africa region. Therefore, our study is expected to contribute to the existing literature of what determines health status from the perspective of East African countries.

The paper is organized as follows. Following the introduction, section 2 explains the determinants of life expectancy, and reviews the existing literature. In section 3 we explain the model, the data and the methodology used in the empirical analysis. The results obtained from the estimation approach are presented and discussed in section 4. The last section summarizes the main findings suggesting some policy implications.

CONCEPTUAL NOTE AND LITERATURE REVIEW

Understanding the Determinants of Life Expectancy: A conceptual note

Health is a primary public good. People's welfare and their potential for employment, productivity, social relationships, public participation etc. depends on having a good health. In view of the value of health to society in general, creating the conditions for people to enjoy a healthy life should also be a shared goal. Beauchamp [12] asserts that a certain level of health is necessary for people to fully participate in activities that promote good life including family and community life, gainful employment, and participation in political process. In the promotion of public health, collective action is more important than individual endeavors. Communal effort is a prerequisite for meaningful protection and assurance of the population's health as the community has a stake in environmental protection, hygiene and sanitation, clean air, uncontaminated food and water, safe blood and pharmaceutical products, and the control of infectious diseases. These are public goods that can only be secured through organised and collective actions [13].

Improvement of a nation's health status has been one of the major social objectives in public policy making. Building a healthy society has been at the center of development priorities as development itself is defined in terms of improving the quality of life including health [5]. However, improved health and increase in life expectancy are outcomes of the interaction of number of factors. Therefore, identifying and analyzing the factors that determine the health conditions of a certain population is essential to maximising the returns from the resources devoted to the provision of health services. Although measuring a country's health status is a difficult task, life expectancy has been used as a proxy measure, as it represents a broad summary indicator of a country's health status [14].

The status of one's health is the outcome of a complex interplay of individual, behavioural, environmental, and socioeconomic factors. Although health issues begin at an individual level, the promotion of public health goes beyond individual health factors requiring population health approach [15]. In addition to personal health care, there are several factors which include genetic, behavioral, socioeconomic and environmental factors that determine the health outcomes of a society [16, 17].

Most models of health determinants assume that there are macro and micro level factors interacting along a complex and dynamic pathways to produce health outcomes at a population level. For example, macro-level conditions and policies such as social, economic, cultural, and environmental and micro-level

factors which operate at individual level such as sex, and the ecology of the diseases agent greatly influence health outcomes.

The connections between health status and environmental factors is well documented. Developments in the provision of improved water, food, sanitation, reduced physical crowding, improved nutrition, cleaner fuel technologies are major health advances responsible for increased life expectancy. On the other hand as pointed by NRC [18] global warming, population growth, habitat destruction, loss of green space, and resource depletion have been causing massive environmental health problems. Salami, Shaaban, and Martins [19] also note that congestion related to urbanization and slum settlements, carbon dioxide emissions stemming from burning of fossil fuels, and the consumption of other solid, liquid and gas fuel as well as exposure to pollution and harmful contaminants still poses substantial health threats and risks that affect life expectancy negatively. These environmental problems are long-term in nature and could not be addressed through technical fixes. Their solution requires community and social engagements.

The historical experience in epidemiological transition in the developed countries could shed light on the potential driving forces in the improvements of life expectancy observed in developing countries. According to Preston [20], the mortality reductions in developing countries between 1900 and 1970 for infectious diseases were mainly due to preventive measures related to large-scale immunization, improvements in water supply and sewage disposal systems. The epidemiological transition assumes the shift of diseases from infectious to non-communicable diseases. This was thought to have been unidirectional where infectious and deficiency diseases were dominant causes of death at the beginning and as development and modernization proceeds, non-communicable diseases dominates [21]. However, this unidirectional transition does not always hold. According to Wahdan [21], the epidemiological transition is more complex and dynamic. The patterns of diseases and health of society changes in response to demographic, socioeconomic, technological, cultural, environmental and biological changes. It exhibits continuous and transformative process whereby some infectious diseases disappear and others appear or reappear. The emergence of new disease such as COVID-19 pandemic, HIV/AIDS and the reemergence of tuberculosis and dengue fever, which were previously controlled are some examples.

There is consistent link between socioeconomic factors and risky health related behaviour such as smoking, physical inactivity, poor dietary habits, heavy alcohol consumption, etc. This is tantamount to saying as labeled by Lynch *et al*., [22] that "poor people behave poorly''. In this regard, Berkman and Kwachi [23] focus on the role of the social environment in shaping societal norms which defines the rules of the game and enforces through social control patterns of behaviour which can be health promoting or health damaging as well as providing or denying opportunities to engage in a particular behaviour. Accordingly, those with more economic and social resources tend to adopt health-promoting behaviour and reduce risky lifestyles.

EMPIRICAL LITERATURE REVIEW

Differences in individuals' health status are not only attributed to differences in biological factors and health service availability. There are, however, non-medical factors related to socioeconomic and environmental factors that have important impacts on health outcomes [24, 25].

Traditionally, growth in income has been associated as an important determinant for improved health. Throughout the 20th century, life expectancy was found to be highly related with per capita income. Particularly, for people at low income levels, life expectancy rises rapidly with income [26]. The transmission mechanism is that an increase in income leads to the consumption of nutritious food and increases the demand for health services. Although there appears to be a positive correlation between income and improved health, as measured by longer life expectancy, studies have shown that there is a gradual dissociation between income and life expectancy. A study by Preston [27] notices that since the 1930s, life expectancy has been observed to increase for a constant level of income, which reflects the presence of other factors that affect health, and this was particularly so for poor countries. Starting from the late 19th century, measures related to public health such as the provision of clean water, sanitation, and food regulation continues to significantly reduce child mortality. Moreover, the development of medical technology such as anti-bacterial drugs, penicillin, as well as new antibiotics and new vaccines were instrumental in controlling infectious diseases. This observation was reaffirmed by Soares [28] who claims that increases in life expectancy seems to be unrelated with income and general improvements in material conditions in developing countries in the post-war period. However, Soares reiterates that the shift in the income-life expectancy relationship observed does not imply a complete absence of a relationship between income and mortality.

Other socioeconomic and environmental factors that affect health status available in the literature include education, expenditure on health, prevalence of infectious diseases such as HIV/AIDS, unemployment, urbanization, inflation, exchange rate, etc. Education is one of the critical factors that continue to contribute to the improvement of health. Better educated individuals can easily acquire and implement health related new information and this results to an increase in life

expectancy [26]. This increase in life expectancy makes investment in education more attractive for individuals and countries, as the rate of return from this investment is expected to flow for a longer period of time.

In a time-series study conducted in Nigeria using VAR and VEC models, Sede and Ohemeng [8] have found that, while secondary school enrolment is found to have a positive effect on current life expectancy; unemployment and exchange rate negatively affect the life expectancy of Nigerians. In their study to explore the determinants of life expectancy in 28 European countries from 2001 to 2011, Bilas *et al*. [5] have found that GDP per capita and educational attainment explain 72.6% and 82.6% differences in life expectancy at birth, respectively.

Delavari, *et al*. [29] have examined the effects of GDP per capita, number of doctors per 10,000 population, degree of urbanization, food availability, CO_2 emissions, total fertility rate, inflation rate and literacy rate on life expectancy at birth in Iran using time series data from 1985 to 2013. Their study has proved that GDP per capita, number of doctors per 10,000 populations, literacy rate and food availability have positive effect on life expectancy; while total fertility rate has negative effect on life expectancy.

Expenditure on health has implications for health outcomes. For example OECD countries with less than 20 percent of world's population accounted for over 80 percent of world's spending on health. On the other hand, health expenditure of the majority of the poorest countries account for 7 percent of the world's total. Moreover, Africa that represents 10 percent of the world's population accounted for 3 percent of the world's health expenditure [30; 31; 32]. These inequalities in health spending result in differences in health status. Countries that spend low on health are found to face poorer health conditions. With particular focus on the relationship between health expenditure, longevity, and child mortality, Ray and Linden [33] have applied dynamic panel data approach with global data from 195 countries during 1995-2014 and found that public health expenditures had generally more health-promoting effects than private expenditures.

Applying Autoregressive Distributive Lag (ARDL) model to data from Nigeria during 1980-2018, Muhammad and Sabo [34] have reported that whereas health expenditure, material wellbeing, access to safe drinking water, primary school enrollment, infant mortality rate and energy consumption were found to be significant determinants of life expectancy in Nigeria, both in the short-run and the long-run; the prevalence of HIV/AIDS and household consumption were found to have affected life expectancy only in the short-run. Similarly, using panel dataset for 45 SSA countries, and employing multiple estimation methods, Keita [35] has found that GDP per capita, adult literacy, access to improved sanitation and safe water are positively associated with life expectancy gains.

Using cointegration analysis, Ferda [36] has modeled life expectancy in Turkey on the basis of time series data from 1965 -2005 and reported that nutrition and food availability along with health expenditures are the main factors responsible for longevity; while smoking appears to be the main cause for mortality. Similarly, in their analysis of the determinants of life expectancy in SSA using one-way and two-way panel data analysis, Fayissa and Gutema [37] have identified that a decrease in illiteracy rate and an increase in food availability index as well as a decrease in alcohol consumption are positively associated with improvements in life expectancy. On the other hand, health expenditure has negative relationship with life expectancy. Contrary to the empirical findings mentioned above, Mahfuz [38] has examined the socioeconomic determinants of life expectancy for 91 developing countries using multiple regression and probit models. He has found that most of the explanatory variables such as per capita income, education, health expenditure, access to safe water, and urbanization have insignificant effect implying that such factors may not always be considered determinants of life expectancy in developing countries.

DATA AND ESTIMATION METHOD

The study is guided by the human capital model formulated by Grossman. Grossman defined health in terms of the longevity and illness-free days in a given year which in this study is represented by life expectancy [39]. Thus, longevity or a higher life expectancy is demanded for its own sake as it affects utility and is also a derived demand to produce marketable and nonmarketable commodities. Grossman also indicated that the health status of an individual is not only exogenously determined but also depends on the resources allocated to its production.

The Model

In most empirical studies, the determinants of health status as proxied by life expectancy have been aggregated in a health production function whereby socioeconomic factors, health related variables, lifestyle indicators and environmental exposures have been considered as the main explanatory variables. In this study, life expectancy (*LE*) is assumed to be a function of a vector of health related variables (*H*), a vector of socioeconomic factors (*I*), and a vector of environmental indicators (*E*). Variable selection is based on key determinants identified in the literature, and the relationship can be written as

$$LE = f(H, I, E) \quad \text{.....(1)}$$

Life expectancy at birth (*LE*), as a dependent variable, indicates the number of years a newborn infant would live if the existing conditions of mortality at the time of its birth remain to be the same throughout its life span [35]. The explanatory variables are grouped into three traditional blocs. First, the health related variables incorporate under 5 mortality rate (per 1000 live births) (*MOR*), measles immunization (% of children ages 12-23 months) (*IMU*), total prevalence of HIV (% of population ages 15-49) (*HIV*). On the other hand, the vector of socioeconomic variables are explained using current health expenditure as a percentage of GDP (*CHE*), net official development assistance and official aid received (constant 2015 USD) (*ODA*), and people using at least basic drinking water services (% of population) (*BDW*). Finally, the impact of environmental conditions on life expectancy is captured by CO_2 emissions (metric tons per capita) (CO_2), people practicing open defecation (% of population) (*DEF*), and urban population (% of total population) (*URB*).

To capture the non-linear and non-monotonic relationship between the independent variables and life expectancy, a Cobb-Douglas health production function is used, where all the variables are expressed in logarithmic forms. Moreover, the logarithmic transformation implies that the coefficients are elasticities and thus provide a basis for comparing the relative contribution of the independent variables as well as for comparing the findings of our study with other studies in the literature. The general econometric specification of the health production function, which takes a dynamic fixed effect (*FE*) form, is given by equation (2).

$$\ln LE_{i,t} = \beta_0 + \beta_1 \ln H_{i,t} + \beta_2 \ln I_{i,t} + \beta_3 \ln E_{i,t} + u_i + e_{i,t} \quad \text{.....(2)}$$

By expanding the vector variables in equation (2), we reach at equation (3)

$$\ln LE_{i,t} = \beta_0 + \beta_1 \ln MOR_{i,t} + \beta_2 \ln IMU_{i,t} + \beta_3 \ln HIV_{i,t} + \beta_4 \ln CHE_{i,t} + \beta_5 \ln ODA_{i,t} + \beta_6 \ln BDW_{i,t} + \beta_7 \ln DEF_{i,t} + \beta_8 \ln URB_{i,t} + \beta_9 \ln CO_{2i,t} + u_i + e_{i,t} \quad \text{.....(3)}$$

Where; the subscript *i* indicates the country and *t* represents the respective year observed in the sample. β_i's measure the elasticities of the dependent variable with respect to each of the explanatory variables, u_i denotes the country-specific effects capturing differences among countries which can be random or fixed, and $e_{i,t}$ refers to the idiosyncratic error term. The error terms are assumed to have the classical "white noise" properties, that is, they are identically and independently distributed with zero mean and constant variance.

Different econometric estimation techniques have been employed in the literature to examine the relationship between socioeconomic, health, and environmental variables and life expectancy gains. Thus to ensure robustness of the results of the study, equation (3) is estimated using two estimation methods, and the results of these methods are compared. Frist, because of its simplicity and wide appeal, the model is estimated using Pooled OLS method. However, the results obtained from Pooled OLS estimations tend to be spurious, because of the problems of multicollinearity, heteroscedasticty and unit root associated with it. Secondly, Fixed Effects (FE) and Random effects (RE) models are estimated. Even though they might be inefficiently flexible, these models are widely used with panel data, because of the fact that they control for time invariant and omitted variables.

In the aggregate health production function, which is specified in equation (3), we expect that health related variable such as mortality rates and the prevalence of HIV will have negative effects on life expectancy. Efforts and investments to reduce child mortality and measures to halt prevalence of contagious disease like HIV are expected to increase life expectancy. On the other hand, the expansion of child immunization could serve as early signals for improved life expectancy. The rate of urbanization as measured by the percentage of urban population to total population is expected to have mixed effects on life expectancy. Kabir and Mahfuz, show that urban population who enjoy improved medical care and improved socioeconomic facilities are expected to have an improved health status. On the other hand, urbanization characterized by population concentration and slum expansion with poor socioeconomic services and facilities could adversely affect health outcomes. Furthermore, environmental pollution from carbon dioxide emissions, through its harmful effects on health, is expected to negatively influence life expectancy [40]. The practice of open defecation, which is a manifestation of lack of proper sanitation facilities, is an environmental risk factor which causes a multitude of diseases such as diarrhea that negatively affects life expectancy. The provision of basic drinking water, current health expenditure as percentage of GDP, and receipt of official development assistance and aid are grouped under socioeconomic factors and they are expected to have positive effect on life expectancy.

DATA

Macro-level panel data of 11 East African countries[1] over the period of 2000–2016, which is obtained from the World Bank, World Development Indicators (2020) was used. Data gaps in specific years were addressed using linear interpolation.

RESULTS AND DISCUSSION

Table 1 presents the descriptive analysis of the set of variables used in the empirical model. The result shows the overall descriptive statistics for the panel data of 11 East African countries and 17 years of time and a total of 187 observations. The mean value of life expectancy at birth for the region is about 58 years with the minimum (46 years) being registered in Uganda in 2000 and the maximum (67 years) recorded in Rwanda in 2016. The average under five mortality rates in the region is about 86 per 1000 live births which are far above the Sustainable Development Goals (SDG) target of 25 per 1000 live births to be achieved by 2030. Rwanda dominates the reduction in less than five mortality rates from 183.1 per 1000 live births in 2000 which was the maximum from the group to 38.8 in 2016 which is the minimum in the Eastern Africa region and also below the current global average of 39 per 1000 live birth. The mean value of immunization of measles among children aged 12-23 months for the region is found to be 76 percent where Eritrea is leading the region with 99 percent immunization coverage in 2016 and the lowest immunization (35 percent) being recorded in the Democratic Republic of Congo in 2001. With respect to HIV, the average prevalence rate among the population aged 15-49 is around 3 percent in the region with Kenya registering the maximum (9.8 percent) in 2000 and Comoros registering the minimum (0.1 percent) throughout the period under investigation. Comoros was leading the region in current health expenditure as a percentage of GDP, where 12 percent is recorded in 2000; while the Democratic Republic of Congo recording the lowest health spending (1.6 percent) in the same year, with the mean value of current health expenditure as a proportion of GDP being 6 percent in the region.

The mean financial flows to the region in terms of net official development assistance and official aid amounts to 1.1 billion in constant 2015 USD. The Democratic Republic of Congo received the highest flows with 6.7 billion USD in 2003 and Comoros being the least recipient with 244 million USD registered in 2005. Regarding the provision of basic drinking water, on the average, 50 percent of the population of the region has access to at least basic drinking water. Ethiopia registered the minimum where 18 percent of the population uses at least basic drink water in 2000, while Comoros dominating the region with 90 percent its population accessing basic drinking water in 2000; although the trend declined to 80 percent in 2016. On the average 21 percent of the population of the East Africa region practices open defecation with significant variations among the countries. Whereas 82 percent of the population in Eritrea practiced open defecation in 2000 with a declining trend thereafter, only 0.6 percent of the population practices open defecation in Comoros. The majority of people in the region live in rural areas with only 29 percent of the population living in urban areas during the study period. Burundi was found to be the least urbanized country in the region with only 8 percent of the population living in urban areas in 2000 with a marginal increase thereafter and Djibouti dominating the region where 77 percent of the population is urbanized. The East Africa region is characterized by low level CO_2 emissions with Djibouti registering the maximum CO_2 emissions in 2014 and the Democratic Republic of Congo recording the minimum in 2000.

Table-1: Descriptive statistics

	LE	MOR	IMU	HIV	CHE	ODA	BDW	DEF	URB	CO2
Mean	58.28	86.29	76.54	2.79	6.05	1.15E+09	50.80	21.87	29.23	0.17
Median	58.92	81.00	77.00	1.70	5.31	7.26E+08	49.25	11.73	26.78	0.11
Maximum	66.88	183.10	99.00	9.80	12.25	6.71E+09	90.95	82.73	77.53	0.80
Minimum	46.23	42.10	35.00	0.10	1.57	24440001	18.70	0.59	8.25	0.02
Std. Dev.	4.59	29.56	15.91	2.51	2.30	1.13E+09	16.62	23.22	17.34	0.15
Obs.	187	187	187	187	187	187	187	187	187	187

[1]According to the UN-Economic Commission for Africa 2015, the East Africa Region include: Burundi, Comoros, Djibouti, Democratic Republic of Cong, Eritrea, Ethiopia, Kenya, Madagascar, Rwanda, Seychelles, Somalia, South Sudan, Uganda, and Tanzania. Seychelles, Somalia and South Sudan are dropped from the analysis for lack of data.

Table 2 reports the results estimated using Equation 3. Two estimation methods have been employed to ensure robustness of the results of the study. Thus, column 1- shows results of Pooled OLS estimation technique which assumes no heterogeneity among cross-sectional units (countries). The second column shows estimation results obtained using a Fixed Effects Model (FE). The FE model accounts for time invariant unobserved features of the cross-sectional units in order to obtain consistent estimates. The model controls for the time-invariant unobserved differences between the countries by including individual intercepts; Column 3- reports the result of a Random Effect (RE) model where individual country differences are assumed to be purely random and captured in the disturbance term rather than in their specific intercepts.

As can be seen from Table 2, all the estimated regression coefficients, in all the regression results, have their expected theoretical signs. Under-five years mortality rates, HIV prevalence, the practice of open defecation, and carbon dioxide emissions have a negative and statistically significant effect on life expectancy. On the other hand, access to basic drinking water, immunization against measles, net official development assistance and foreign aid and urbanization were found to have statistically significant positive effects on life expectancy. Current health expenditure as a proportion of GDP has positive but statistically insignificant impact on life expectancy.

All the coefficients show the elasticity of life expectancy with respect to the regressors. This is important to see the marginal influence of the regressors over life expectancy. Summary of the appropriate tests are presented at the bottom of table 2. The Hausman Test suggests that the random effect model is the appropriate model, since the null hypothesis that the random effect estimator is consistent is not rejected even at less than 1 percent level of significance. To check whether there exists significant differences across countries or not, we performed Breusch-Pagan Lagrange Multiplier (LM) Test. The result points the existence of hetroscedacity indicating that there is significant difference among East African countries and thus reject the null hypothesis and conclude that the Random Effects model is appropriate. Checking for cross-sectional independence across countries using Friedman Test leads to the acceptance of the null hypothesis at less than 1 percent level of significance, indicating that there is no serial correlation among the residuals.

The result obtained using the Random Effects model with robust standard errors (column 4) is the most efficient following the outcome of the post estimation tests conducted.

Table-2: Estimation results

Variable	**1**	**2**	**3**	**4**
	OLS	**FE**	**RE**	**RE_rob**
MOR	-0.2087807***	-0.1976502***	-0.2020395***	-0.2020395***
	[0.000]	[0.000]	[0.000]	[0.000]
IMU	0.0132734**	0.0193181**	0.0179136**	0.0179136
	[0.030]	[0.034]	[0.029]	[0.290]
HIV	-0.0255059***	-0.0275296***	-0.0246784***	-0.0246784***
	[0.000]	[0.003]	[0.000]	[0.003]
CHE	0.0042524	0.0030957	0.0027981	0.0027981
	[0.335]	[0.494]	[0.511]	[0.670]
ODA	0.0096533***	0.0066967***	0.0075893***	0.0075893*
	[0.000]	[0.004]	[0.000]	[0.067]
BDW	0.0429352***	0.0527027***	0.0514618***	0.0514618*
	[0.000]	[0.001]	[0.000]	[0.075]
DEF	-0.0007459***	-0.0004598**	-0.0005736***	-0.0005736
	[0.000]	[0.037]	[0.001]	[0.184]
URB	0.0347142***	0.0481759**	0.0359309***	0.0359309**
	[0.000]	[0.031]	[0.002]	[0.031]
CO_2	-0.0132652***	-0.0071783***	-0.007489***	-0.007489*
	[0.000]	[0.001]	[0.000]	[0.095]
Constant	4.441192	4.354489	4.407264	4.407264
Observation	187	187	187	187
No. of countries	11	11	11	11
F-test	609.50 [0.000]	967.07 [0.000]		
Wald test(X^2)			8928.54 [0.000]	
R^2	0.9672	0.9334	0.9572	0.9572
Hausman test		$\chi_9^2 = 3.45$ [0.9439]		
BP LM test for RE			$\chi_1^2 = 342.66$ [0.000]	
Friedman's test			$\chi_1^2 = 7.772$ [0.6511]	

***, **, * Coefficient significant at the 1%, 5% and 10% level, respectively, Numbers in square brackets are ρ values

The elasticity estimates show that reduction under-five years rate has the highest impact on life expectancy. For example a 100 percent reduction in under-five years mortality rate rate increases life expectancy by about 20 percent. Following under five mortality rate, accessing basic drinking water and urbanization have positive and statistically significant effect on life expectancy whereby a 100 percent increase in the percentage of the population accessing basic drinking water and living in urban areas increase life expectancy by 5 and 3 percent, respectively. Reduction in the prevalence of HIV has also positive and statistically significant effect on life expectancy with an elasticity of 0.025. Note that, although HIV prevalence, net official development assistance and foreign aid as well as CO_2 have statistically significant coefficients with correct theoretical expected signs, the practical significance of their impact on life expectancy is considerably low.

The regression results demonstrate that majority of the regressors incorporated in the two estimation methods appear to be statistically significant. Only one independent variable (current health expenditure as a proportion of GDP) has consistently been insignificant throughout the models estimated. This could be due to the fact that the level of GDP of these countries is small in size and thus the percentage of GDP earmarked to current health expenditure is too low to bring about significant impact on health status. Two regressors (the practice of open defecation and immunization against measles) have changed their level of significance from being statistically significant at one or five percent in Pooled OLS, FE and RE models to statistically insignificant when we conduct RE regression with robust standard errors.

The regression outcomes entail important implications for public health interventions. The variables selected in this study have crucial linkages with population health concerns. The belief that healthcare should be considered as a public good is a valid point as it addresses the socioeconomic concerns of people. The concern originates from the general principle that individual self-interest particularly in areas like health can be better served through collective action. Healthcare is, therefore, universally evolving as a public good or quasi-public well. This is becoming more valid in developing countries where their health market is characterized by imperfections. Compared to private goods, Karsten [41] have observed that, healthcare as a good cannot be easily packaged and marketed, the benefit from its consumption cannot be rival, and the principle of exclusion cannot be fully applicable to healthcare. The relationship of health to other factors including the environment, public infrastructure and other socioeconomic factors which brings about positive and negative externalities make healthcare more prone to market failure.

The regression results are linked with public health intervention in multi-dimensional ways. The improvement of socioeconomic status of the population which determines healthcare outcomes is mainly a public sector domain. Public health intervention to design and implement child survival strategy is fundamental to reduce under-five years mortality rate. In 2017, globally an estimated 5.4 million children under the age of five died and almost half of those deaths reported to be in SSA [42]. Thus the Sustainable Development Goal's target of reducing under-five mortality rate to 25 per 1000 live births by the end of 2030 in SSA requires a coordinated and concerted public health intervention efforts.

The expansion of access to drinking water, improving sanitation and environmental hygiene are critical factors in reducing mortality. In the less developed countries, mortality rates related to poor water, sanitation and hygiene conditions represent 6 to 7 percent and contributes significantly to the environmental burden of diseases [43]. Public intervention to provide improved community water supplies, hygiene education, and hand-washing campaign and facilities could result in significant health and socioeconomic benefits at a lower cost.

The wide practice of open defecation, which is a major concern of sanitation, has been a cause of infectious diseases such diarrhea. According to Susmita *et al*., [44], East African countries stood the second in SSA with 79 percent of the population practicing open defecation. According to WHO/UNICEF JMP report [45], five of the ten SSA countries having the worst sanitation coverage were found in East Africa. Therefore, public intervention in the form of investment in improved water and sanitation and public health intervention with comprehensive strategy would capture the socioeconomic benefits and healthcare gains from reduced mortality.

The making and implementation of social policy, which anchors healthcare, is a public good domain which requires public intervention. Public policy in the social sector among others defines access to healthcare, promotes social justice by reducing inequality, ensures social protection, decides on the allocation of resources to the health sector, stimulates health promoting environments etc. The expansion of immunization, the control of infectious diseases, the promotion of clean energy sources, and the expansion of social services should constitute the main targets of public policy making and resource allocation to improve population health. Furthermore, continuous surveillance and monitoring the emergence of new infectious diseases underscores the need for public health intervention. Positive behavioural changes through awareness raising campaigns and formal as well as informal education has important links with healthcare outcomes such as life expectancy and their

promotion require public intervention. The control of HIV/AID requires changes in the sexual behaviour of people. Health risks related with obesity can be reduced by inducing people to change their life style in terms of food, physical activity, positive habit formation etc. At the macro level, political will and commitment, legal issues, institutional considerations and governance which in turn affect micro level determinants of health such as life expectancy and yet their improvement and sustainability require collective action.

Another important factor under the domain of public health intervention is the principle of Universal Health Coverage (UHC) which specifies three interrelated components: population coverage, service coverage and financial coverage. Most of the variable selected in this study are in fact major targets of UHC. They call for the majority of the population to receive a wider range of health services at a lower cost or subsidized payments. Access to improved sanitation facilities, drinking water, reduction in air pollution, child immunization, the provision of affordable healthcare services are core components of UHC. The OECD report 2016 [46), have proved that there exists a positive relationships between life expectancy and the core components of health coverage. For example, the report indicates that the introduction of universal health schemes in Thailand reduced infant death by 6.5 per 1000 live births among the poor from 2001 to 2005. Although the transition to UHC is a lengthy process and requires substantial fiscal space, it could be progressively achieved over time with strong political commitment. Flows of official development assistance and their effective and efficient use could also contribute towards relieving the resource constraints in the East Africa region.

SUMMARY AND CONCLUSIONS

The study attempted to identify and analyze the socioeconomic, environmental, and health related factors that determine the health status measured in terms of life expectancy and their implication for public health intervention in East African countries. A panel dataset of 11 East African Countries, covering from 2000-2016, was used and Pooled OLS, Fixed Effects and Random Effects estimation techniques were employed. Nine variables, which are widely used in the literature as determinants of life expectancy, has been selected as regressors to analyze the direction and magnitude of their relationships with life expectancy. The relevant post-estimation test was performed to check the robustness of the results obtained from the various models. Consequently, heteroskedasticity and non-normality of error terms were absent in the models. Goodness of fit tests also confirmed appropriateness of the regression frameworks. Since the model is developed in log-linear form, all the coefficients show the elasticity of life expectancy with respect to the regressors, which explain the marginal contribution of the regressors on life expectancy. Under-five years mortality rate, HIV prevalence, the practice of open defecation, and carbon dioxide emissions were found to have negative and statistically significant effect on life expectancy. Similarly, access to basic drinking water, immunization against measles, net official development assistance and foreign aid as well as urbanization have positive and statistically significant effect on life expectancy.

An effort was made to link and examine the implication of the regression results to public health intervention. The variables selected are linked with public healthcare intervention in many ways: including public investment in socioeconomic services to improve population health problems, the making and implementation of social and public policy that promote the provision of healthcare services, surveillances, monitoring and evaluation, coordination and governance. Above all, the achievement of UHC is to a greater extent the domain of the public sector. Such linkages culminates to the need for a concerted and coordinated public health intervention strategy to address population health problems and strengthen and maintain the achievements in healthcare outcomes proxied in terms of life expectancy observed in the study period in the East Africa region.

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