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INCOME INEQUALITY-HEALTH OUTCOMES DEBATE MODEL OF SUB-SAHARAN AFRICAN COUNTRIES: HOW IMPORTANT IS RESOURCE ABUNDANCE?

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Abstract: This study assessed effect of income inequality on health outcomes in 29 Sub-Saharan African (SSA) countries, and exploring analysis further to determine if being endowed with abundance natural resources matters in either enhancing or mitigating effect of income inequality on health outcomes using data for the period 1996 – 2019. The study employed the system GMM estimation technique, "GINI" coefficient and life expectancy are utilised as measures of inequality, and health respectively, while controlling for health system investment, level of educational awareness, health shock, CO2 emissions as a measure of condition of place, and global factors proxied by influenza. Country dummy variable was used to categorise countries as either 'resource-rich', or 'non-resource-rich'. Results show that rather than income inequality, environmental quality, education awareness, and health system development serve as pathways for transmitting effect of income inequality to determine health outcomes significantly. Secondly, being richly endowed with natural resource does not consolidate nor mitigate the effect of income inequality on health, therefore is not of utmost important so does not matter in inequality-health outcomes model.

JEL Codes: C23, C51, I14,

Keywords: Income inequality; Life expectancy; System GMM estimator; Sub-Saharan Africa

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1. INTRODUCTION

Link between income inequality and health is well documented in literature to the extent that a number of studies made projections associating adverse health consequences to income inequality (Kondo *et al* 2009; Kezer and Nunnenkamp 2015; Deurzen *et al* 2014; Leitner 2015; Kragten and Rozer 2016; Fonta *et al* 2017; Curran and Mahutga 2018). This tends to suggest that as a macroeconomic aggregate, adverse income distribution could hinder developmental efforts at country and regional levels. Differences in spread and deepening of this macroeconomic aggregate across countries could explain global differences in the degree and spread of its associated impacts on health outcomes. Sub-Saharan Africa (SSA) experiences higher degrees of income inequality over the decades than any other region of the world (IMF 2015). This could possibly explain the reason why SSA has worse health outcomes than any other geographical region or country as widely supported by empirical and statistical evidence (Ruger 2009; UNICEF 2014; IMF 2015; Global Finance 2019). Findings from previous empirical investigation of the relationship between inequality and health remained inconsistent and contradictory. Leigh *et al* (2009) suggest use of better data and estimation method as ways of dealing with observed inconsistency in previous findings.

Adesina (2016) reports that despite declining average rate in SSA over 1960 to 1980s, income inequality rose again in 1990s and declined in 2000s. However, recent study suggests that overall; it has remained broadly unchanged amidst variations across countries in the region (IMF, 2016). For instance, in a study of 29 SSA countries, Cornia and Martorano (2015) found four income inequality trends between 1991-1993 and 2011; 75% of countries for which data were available showed significant increase in income inequality. Among these, income inequality is highest in Botswana and South Africa, and lowest in Ethiopia. Figure 1 shows income share of bottom 20 percent relative to top 20 percent of the population for selected SSA countries.

The figure clearly demonstrates evidence of income inequality in SSA which is highest in Botswana, Namibia, South Africa, and lowest in Ethiopia. The dynamics of this indicates that inequality increased in 50% of countries included in the study sample.

Though a number of studies had in the past attributed poor health incidence at the aggregate level to inadequacy in income level (Pritchet and

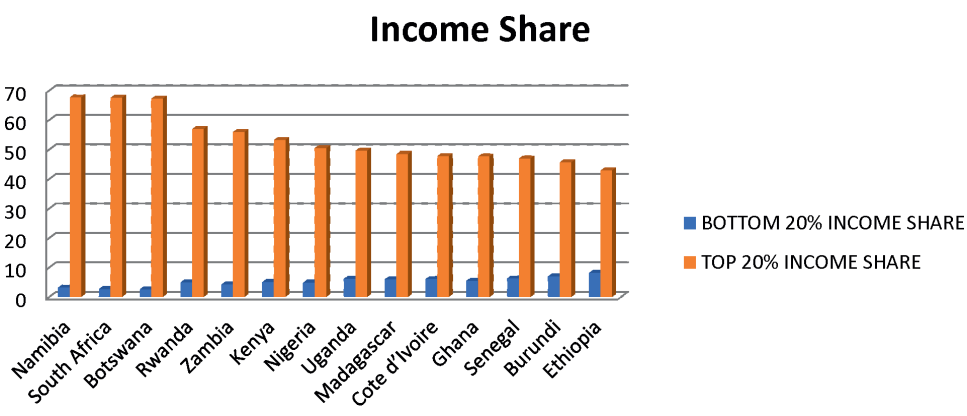


Figure 1: Income Share of bottom 20 percent and top 20 percent in Selected SSA countries

Summers 1996; Hammer *et al.*, 2003; Isa and Quattara, 2005). This happens to be the case given that income empowers one with much needed financial security with which to access existing health services, and at the level of the state permits the funding of needed health infrastructures for good health – an idea held by the absolute income hypothesis (AIH). However, relative income hypothesis (RIH), the deprivative hypothesis (DH), the relative position hypothesis (RPH) and the income inequality hypothesis (IIH) – all agree with the fact that income distribution has its own health effects. So not only absolute income that matters, but also some relative measures. Evidence from a number of studies has shown on average that, income inequality worsens health (Hezer and Nunnenkamp, 2011, 2015; Deurzen *et al.*, 2014). In the on-going war against COVID-19 pandemic, study has provided evidence to buttress the fact that inequality could exacerbate the spread of the pandemic. This as a matter of fact could give rise to disproportionality in healthy life expectancy and mortality rates between the richest and poorest population (Ahmed *et al* 2020). This shows that countries with same aggregate per capita income may not necessarily have same aggregate health condition but, will instead depend on the pattern of income distribution across income groups within countries/regions. However, the absolute income hypothesis (AIH) emphasises the importance of subjecting health effect of income to empirical examination because, what might be assumed to be the effect of unequal distribution of income might rather be an effect of the non-linear correlation between health and income. Given this lack of consensus among scholars, Heden (2015)

emphasized that none of the theories is independent of the others. Therefore, each might all have a unique contribution - if absolute income matters, relative income matters too.

From the perspective of empirical evidence, several prominent studies support the view that income distribution exerts amongst the most significant effects on the health of a whole population (Rodgers, 1979; Lynch *et al*, 1998; Wilkinson, 1996). It is a health hazard; it is only at low level of income that health of the population is determined by aggregate income, beyond a certain income-threshold, it is no longer income but income inequality that matters for health (Wilkinson 1996). This tends to suggest that, the role of income inequality on health is more relevant in developed countries but, may be secondary among low-income countries. Under such condition, low income is more likely to matter most for health than income inequality (Herzer and Nunnenkamp 2015). Subramanian and Kawachi (2004) concludes that at best, income inequality is one dimension that could be of importance for aggregate health. So, the question is not whether income inequality affects health rather, how it might affect health and vice-vasa.

Leigh *et al* (2009) identified three channels through which income inequality can affect health: first, it can affect health through implications of diminishing marginal health benefits from increases in individual income, second, through relative deprivation, and through its society-wide effects. It is also of note that some empirical evidence associates unequal distribution of income to better health (Mellor and Milyo, 2001; Deaton, 2003; Leigh and Jenk, 2007; Leigh *et al*, 2009). Surprisingly, this is against the general reasoning that income inequality impairs health conditions by eroding social trust and exerting different effect on the political process leading to the delivery of public goods. In another perspective, a brand of the literature argue strongly that income inequality affects health through environmental quality (Magnani 2000; Drabo 2011), and this effect can be examined both in the presence and absence of the environmental variable. This introduced an important categorization to the income inequality-health models. In one category are those that examined the relationship in the absence of the environmental variable (Herzer and Nunnenkamp 2015; Ray and Linden 2018; Curran and Mahutga 2018; Odusanya and Akinlo 2021), and studies that examined the effect in the presence of environmental variable (Drabo 2011). While literature

is scarce for studies that controlled for environmental variable particularly in SSA context, a vast number of studies excluded this in their models amidst different findings.

Past studies that examined the link between relative income and health produced findings that are inconsistent and contradictory (see Ram, 2006; Deurzen, *et al*, 2014; Herzer and Nunnenkamp, 2015; Pop van Ingen *et al* 2013; McGuire, 2005). On this issue, Leigh *et al* (2009) suggests the use of better data and estimation method as means of resolving contending issue of lack of consensus amongst studies. More so, studies with SSA content either did so by including SSA countries amongst group of developing countries (Herzer and Nunennkamp 2011, 2015), or group of countries defined by their level of income (Deurzen *et al* 2014). Therefore, to the best of the knowledge of this study, an exclusively SSA investigation of the relationship between income inequality and health outcomes is currently lacking in the literature.

Secondly, lumping countries of heterogenous groupings in a single analysis most likely increases the possibility of unobserved heterogeneity in the link between inequality and health. In the literature, a popular approach in dealing with this has been to model heterogeneity as unit-specific, time-invariant fixed-effects. But studies argue that this exposes the model to the commonly known "Nickel (1981)" bias, where the association between the lagged regressand and the fixed effects biases coefficient of the lagged regressand towards zero especially in short panel studies (Bonhomme and Manresa 2015; Ikpe *et al* 2025). However, Herzer and Nunennkamp argue that this bias minimizes when 'T' is about 20 or more. In comparing performances of different estimators with regard to "Nickel bias" in dynamic panel studies with moderate or small 'T' and 'N', Bun and Kiviet (2006) recommends both Least Square Dummy Variables (LSDV) and GMM estimators. The study further concludes that neither the LSDV or GMM dominates the other with respect to bias as well as mean square error.

Thirdly, despite plethora of studies that examined the income inequality-health relationship, it is rare to find studies that controlled for environmental variable as a channel through which inequality in income affects health particularly in the context of SSA. Fourthly, past cross-country panel studies failed to recognise possible differences in degree of income inequality between resource-rich and non-resource-rich countries occasioned by uneven

distribution of income receipts from natural resources which most times are not adequately accounted for. Such is expected to create disparity in impact of income inequality between resource-rich and non-resource-rich countries and the degree of its associated effects.

Given the foregoing, this study contributed to existing literature along the following lines: First, it exclusively examined the relationship between income inequality and health in the context of SSA. The novelty of an exclusive SSA study is to provide empirical evidence that truly explains events in the region of SSA such that can be relied upon for policy. Second, the study utilised data from the World Bank Development Indicators (WDI Database), while estimation was conducted using Blundell and Bond (1998) two-step-dynamic panel system General Method of Moment (GMM) estimator known to be asymptotically efficient and robust to all kinds of heteroscedasticity to deal with problem of inconsistency in finding. GMM estimator was chosen over LSDV due to the study time period of 24 years which makes it a short panel in which GMM estimator is most suitable. Third, the study examined income inequality-health relation controlling for level of carbon dioxide emission (CO2) as proxy for environmental quality as channel through which inequality affects health in line with Mangnani-Drabo's health-environmental quality-income inequality model. Lastly, the study determined whether any possible difference in the impact of inequality on health outcomes exist between resource-rich and non-resource-rich countries.

In addition to the introduction, the rest of the paper is organised as follows: section 2 presents a review of the literature, methodological framework is the focus in section 3. Section 4 presents results, policy implication and recommendation are the focus in 5.

2. REVIEW OF RELATED LITERATURE

Two episodes exist in the literature on attempts at providing empirical evidence to explain the association between income inequality and health. While earlier attempt focused on examining whether there exist association between the two, thus employing correlation analysis, later studies were more about examination of possible causal relationship between the two (income inequality and health). A good number of the correlation analysts agree that there exists association between income inequality and health. However, debate about why income

inequality is linked to aggregate health according to Rowlingson (2011) dates back to Preston (1975) who first suggested that there might instead be a link between income inequality in a society and life expectancy. This issue was explored further in a cross-sectional study of 50 countries using aggregate data by Rodgers (1979), in which the study analysed the link between income inequality, and infant mortality and life expectancy. The study having controlled for average income in the cross-sectional regression model provided support for a significant relation between income inequality and LE across countries, with 5 to 10-year difference LE between relatively equal and unequal countries. A good number of other studies equally provided evidence of the existence of the association (Le Grand 1987; Lynch *et al* 2001).

Fundamental to the analysis of the causal impact of income inequality on health is Magnani (2000)-Drabo (2011) health – environmental quality-income distribution model. The model expresses a positive relationship between health and environmental quality which exerts equal health effects on every individual. On the other hand, in the absence of constraining income, individual exhibits preference for more quality environment as a health promoting behaviour. Specifically, by applying Magnani (2000) theoretical model, Drabo (2011) in a cross-country analysis provided evidence that environmental degradation is a channel through which income inequality affects health of the population. Results of the investigation shows that income inequality affects health through level of population abatement expenditure. In other words, relative income negatively affects environmental quality, and environmental degradation worsens population health. It was also observed from the analysis that accounting for environmental variables vanish coefficient of income inequality in both magnitude and its statistical significance; result is robust for rich and developing countries. According to Magnani-Drabo theoretical model, the effect of income inequality on health can be examined in the presence or absence of the environmental variable. However, it is worthy of note that accounting for environmental variable in income inequality – health model vanishes coefficient of income inequality in both magnitude and statistical significance (see Drabo 2011). In the literature (particularly in SSA) it is rare to find studies that accounted for environmental variable (except Drabo 2011); quite a plethora of studies examined the income – health relationship in the absence of environmental variable.

Amongst studies that examined income inequality-health relationship excluding environmental variable include Herzer and Nunnenkamp (2015). By carrying out separate estimations for developed and developing countries, Hezer and Nunnenkamp challenged the widely held view that income inequality is of more importance for high income countries than poorer countries. The outcome of panel cointegration estimation method and conventional panel regressions as employed in the analysis, the study found that income inequality increases LE in developed countries, as against a significant reducing effect in developing countries. In a comparative analysis of results of different estimation techniques in assessing the association between income inequality hypothesis using data for the period 1981-2014, Kragten and Rozer (2016) provided evidence that OLS and multilevel models estimates associate income inequality with health improvement. Result of the pseudo panel shows that income inequality worsens health instead.

Examining this relationship from the perspective of health expenditure, Lopez *et al* (2016) undertook a cross-sectional study of the US counties over the period 1998 – 2011, provided support that relative income accounts for higher health care expenses and more health care use. On the other hand, Curran and Mahutga (2018) examined the income inequality-health relation and provided further evidence that income inequality is a proximate cause of lower population health. More specifically, the study provided evidence that harmful effect of income inequality on population health in poorer countries is 139.7% to 374.3% higher than in richer countries; an outcome of the fixed-effects model estimation employed in the study using different measures of inequality and health.

Further evidence of a negative relationship between income inequality and health came from the study by Ray and Linden (2018). Result of GMM-2SLS estimation shows that infant mortality rate worsens with increasing disparity in income between the better-offs and worse-offs. Recently, an interesting dimension to the discuss was introduced by Gugushvili *et al* (2020). In a study of 31 EU and Eurasian economies the study showed that the impact of income inequality on health could also be a function of how people form opinions about the level of inequality in their domain. Result show that through experiences of relative income increases, people form perceptions of increasing relative income therefore more likely to report ill health.

While revisiting the income inequality debate in the context of SSA using data for the period 1995-2015, and GMM technique of estimation, Odusanya and Akinlo (2021) provided further evidence of harmful effect of inequality on health; this suggests that the IIHH hypothesis is valid for SSA. However, the study neglected the need to control for the concave aspect of income despite haven controlled for GDP per capita. Leigh and Jenk (2007) earlier emphasised the need to control for the concave aspect of income in the income inequality – health model. The necessity of this lies in separating any possible association that may be observed between inequality and health from the ante factual context.

3. METHODOLOGY

3.1. Theoretical Framework, Model Specification, and Estimation Procedure

3.1.1. Theoretical Framework

The theoretical basis for analysis of impact of income inequality on health is Magnani-Drabo's health – environmental quality – income distribution model. Magnani-Drabo's model considers environmental degradation as a channel through which income inequality affects population health. Its analysis shows that income inequality affects population health through environmental quality and degradation, therefore assesses effect of income inequality on health through level of population abatement expenditures. Derivable from the individuals' utility function, income inequality is assumed to affect health outcomes through environmental public expenditure. It examines the impact of income inequality on health through environmental quality. This can be done both in the presence and absence of environmental variable hence, relationship between income inequality and health takes the form:

$$\text{Health} = f(\text{inequality}) \tag{1}$$

In estimating the relationship in equation 1, the study adopted a dynamic panel (DPD) model method of estimation. The choice of this method of estimation is based on its ability to capture dynamic behaviour in a given relationship. Estimates arising from this method of estimation has been said to be consistent with population parameters therefore better explains reality than any other panel estimation model (Olubusoye *et al* 2016; Afolabi 2019; Ikpe *et al* 2025). The general form of the model is specified thus:

$$X_{it} = X_{it-1} + Y_{it} + \lambda_i + \omega_{it} . \quad (2)$$

where

X_{it} represents the dependent variable for the cross-sectional units "i" , Y_{it} denotes matrix of exogenous variables for countries in the sample for the study, λ_i is country-specific effects, while ω_{it} is the disturbance term.

It is of note that a typical dynamic model is known to be characterised by two persistency across time. One amongst these is autocorrelation; this arises due to inclusion of lagged value of the regressand as an explanatory variable which might be correlated with the disturbance term. On that event, expected value of the disturbance term is no longer equal to zero (ie.$E(\alpha X_{it-1}, \omega_{it} \neq 0)$. The other is the unobserved panel-level effect which introduces inconsistency in standard estimators (Baltagi 2008).

One amongst known DPD models useful and usually employed in estimating panel models with many cross-sectional units but short time (T) features is the two-step dynamic panel system General Method of Moments (GMM) estimator proposed by Blundell and Bond (1998). This technique of estimation has been found to be asymptotically efficient and robust to all kinds of hetroscedasticity. Secondly, the independent variables are treated strictly as exogenous, and the regression utilises only internal instruments. Reliance on internal instruments helps in solving problems associated with choosing suitable external instruments. The Arellano and Bond (1991) difference GMM estimator which also produces estimates that has been found to be consistent was not considered because of its feature of having to difference the data first, before using previous values of the endogenous variables as instruments. Empirical evidence establishes that lagged levels are often poor instruments for first differences in dealing with endogeneity concerns (Arellano and Bover, 1995).

In applying the Blundell and Bond GMM estimator, the study is aware that the procedure assumes there are no second order autocorrelation in the idiosyncratic errors. To take care of these, Arellano and Bond (1991) proposed two test as way of validating estimates: (i) test of expected first-order serial correlation (AR1) in the first DPD model; in this the null hypothesis of no autocorrelation is rejected, (ii) test for absence of second-order serial correlation (AR2) for remaining disturbances of the differentiated equation in which the null hypothesis of no autocorrelation is accepted, Again, in dealing

with endogeneity concerns, validity of the instruments was tested in line with Roodman (2009).

3.1.2. Model Specification.

To transform equation (1) into a DPD model as specified in (2), the study first considered the bivariate relationship between income inequality and health as is the common practice in panel studies (see Pedroni 2007; Moscone and Tosetti 2010; Herzer and Nunnenkamp 2015). Specification here follows that by Hezer and Nunnenkamp (2015).

$$\text{Health}_{it} = \lambda_i + \theta \textit{Inequality}_t + \omega_{it} \tag{3}$$

Where subscript "i" denotes one of the N cross-sectional units; i takes up value 1, 2, ….., N, subscript "t" defines one of the T time points, "t" takes up value 1, 2, …, T. Health refers to health outcomes which is proxied by life expectancy at birth, Inequality refers to income inequality in Gini format, θ is the coefficient of income inequality; it captures permanent change in health associated with a unit increase in income inequality. λ is country – specific fixed effects while ω is the error term.

Next, it became necessary to econometrically transform equation (3) to a linear dynamic panel data (DPD) model such that can capture effects of lagged values of health on current outcomes. The specification here follows that by Asiedu *et al* (2015). Thus,

$$\text{Health}_{it} = \alpha \text{health}_{it-j} + \theta \text{Inequality}_{it} + \lambda_i + \omega_{it} \tag{4}$$

To make the model more specific to the context of this particular investigation, equation (4) is transformed to (5) by including relevant control variables.

$$\text{Health}_{it} = \alpha \text{health}_{it-j} + \theta \text{Inequality}_{it} + \beta \text{RRICH} + \gamma \text{Inequality}_{it} \times \text{RRICH} + \Sigma \eta_j X_{jit} + \Sigma \varphi_t Z_t + \lambda_i + \omega_{it} \tag{5}$$

where health_{it-j} represents lagged value of health, RRICH is dummy variable for resource-rich countries, "$\text{Inequality}_{it} \times \text{RRICH}$" captures interaction between Inequality and RRICH dummy, X is a vector of control variables; these include CO2 (proxy for environmental quality), HIV/AIDS (proxy for health shocks), Z denotes vector of time-dummy variables; it takes on value 1 in period "t" and zero if otherwise, other variables are as previously defined.

3.1.3. Estimation Procedure

To determine whether income inequality affects health, Equation 5 was estimated without the interaction term (Inequality X RRICH). In it, key variables of interest are Inequality and LE; two time-dummy variables were included to capture the impact of global factors such as the spread of major influenza or diffusion of health technology. In the study, this is proxied by the Ebola Virus outbreak (influenza) that occurred across SSA in 1998 – 2008, and 2009 – 2019. These two outbreaks were documented to have the worst/highest death toll (733, and 13288), with fatality rates of 64% and 62% respectively (Rugarabamu, Mboera, Rweyemamu *et al*. 2020). In addition, two relevant control variables (CO2, and HIV) were included; introduction of RRICH (country dummy) was intended to capture any possible distinction in the impact of Inequality on health between countries classified as resource-rich and those classified as non-resource-rich countries. Secondly, to determine how observed difference in effect of Inequality between resource-rich and non-resource-rich countries influence degrees of income inequality to empirically create a distinction in impact of Inequality between these group of countries, Equation 5 was re-estimated with the inclusion of interaction term (Inequality X RRICH).

3.2. Robust Checks

To be sure that estimates of these model are reliable for policy, the study conducted robust checks by: (i) using alternative measure of health - under-five mortality rate (U5MR) was employed; this has been widely adopted as alternative measure of health to LE in previous studies (see Herzer and Nunnenkamp 2011; 2015; Asiedu 2015; Makuta and O'Hare 2015; Nketiah-Amponsan 2019). It is noteworthy that LE and U5MR are highly correlated. (ii) the model was re-estimated by averaging Gini data over a five-year period to eliminate possible effects of business cycle. Attanasio *et al* (2000) earlier raised the argument that the practice of averaging leads to lose of useful information in annual data. Moreover, there is doubt that averaging over a fixed interval of time may not be able to completely eliminate effects that are related to business cycle since their length of time could over time be different across countries. Besides, averaging the data could lead to reduction in the number of observations as well as statistical power. (iii) to be sure that the estimates in 5

is different from the 'ante factual' context in line with Leigh and Jenk (2007), the model is re-estimated controlling for GDPC, and $GDPC^2$, and estimates compared with estimates in 5. The novelty of controlling for absolute income in both linear and quadratic form is to be sure that results of our estimation is distinguished from health-effects of absolute income in its linear and quadratic form.

3.3. Data and Descriptive Statistics

3.3.1. Data

The chosen measure of health is life expectancy at birth. It is the most widely used indicator of aggregate health outcome measure, and was utilised in the study. However, another measure (under-five mortality rate) was utilized to examine the robustness of results obtained. On the other hand, the most common measure of income inequality is Gini-coefficient, and it is the measure of income inequality employed in the study. The issue of lack of continuous data for this variable was addressed using the conventional method of averaging the data over a five years' period (see de Haan and Sturm 2017; Schneider and Yasar 2014). Further information for these and other variables is summarised in Table 1.

Table 1: Variables' Description, Measurement, and Sources

Variables	*Description and Measurement*	*Sources*
LE	*The average number of years a newborn is projected to live at the time of birth; measured in years*	*WDI*
U5MR	*Number of new born that die before their 5th birthday, per 1000 live births*	WDI
GINI	Degree by which the distribution of income deviates from a perfectly equal distribution; ranges between 0 & 100	WDI
GDPC	Gross domestic product per head of the population; measured in current US dollars	WDI
HExp	Size of current health per capita expenditure; measured in US dollars	WDI
EDU	Number of pupils that enroll at primary level of education in both public and private schools	WDI
CO2	Level of carbon dioxide emission in production and consumption activities; measured in metric tons per capita	WDI
GlobFac	Health shocks/advancement in health technology that simultaneously affect countries; proxied as influenza	NA

WDI = World Development Indicators (World Bank, 2023). GINI was averaged over a five years period (see de Haan and Sturm 2017; Schneider and Yasar 2014).

3.3.2. Descriptive Statistics

Table 2 Presents summary of descriptive statistics for income inequality-health relation. This includes sample statistics of the key variables (Inequality and LE). Observation in it shows that income inequality has an average value of 3.8, with a minimum and maximum values of 3.4 and 4.2 respectively; a standard deviation of 1.2. The mean value of LE for the study sample is 4.0, while its minimum and maximum values are 3.6 and 4.2 respectively; the standard deviation is 0.1. Statistics for other variables are as presented in Table 2

Table 2: Descriptive Statistics

Variables	*Mean*	*SD*	*Min*	*Max*	*Observations*		
					N	*N*	*T*
LnLE	4.0	0.1	3.6	4.2	580	29	20
LnU5MR	4.7	0.4	3.7	5.8	580	29	20
LnGDPC	6.4	0.9	4.7	9.0	580	29	20
LnGDPC2	12.8	1.8	9.4	18.0	580	29	20
LnINEQU	3.8	1.2	3.4	4.2	580	29	20
LnCO2	7.8	1.6	4.6	13.2	580	29	20
LnHIV	9.5	1.6	5.3	13.1	580	29	20
LnEDU	14.3	1.2	11.6	17.1	580	29	20
LnHEXP	3.4	1.0	0.9	6.4	580	29	20

In addition to the above, Table 1 of appendix shows a list of countries included in the sample showing the average values of Inequality and LE for each country. In it, country with the highest average Gini coefficient is Botswana, while Ethiopia has the least Gini value. In terms of average value of LE, Senegal has the highest average LE, while Central African Republic has the lowest. Analysis of this shows that distribution of GINI coefficient cannot be said to have any relationship with resource endowment position of the countries. Though top three GINI values are found among countries classified as resource-rich (Botswana, South Africa, and Namibia), and the least among countries classified as non-resource-rich (Ethiopia) but, its however not enough justification to conclude that this reflects pattern of GINI distribution between resource-rich, and non-resource-rich countries. Observation from the table (Table 1 of the appendix) shows that closely following these top three GINI countries are Lesotho (56.6), and Malawi (54.2); these are non-resource-

rich countries. Countries with higher LE are found mostly amongst those classified as non-resource-rich countries.

4. RESULTS AND DISCUSSION

In this section, results of estimates of the relationship between Life Expectancy (LE) and Inequality – Model 1 is presented, as well as result of robust check conducted using alternative measure of health (U5MR) in Model 2. Estimates of these estimations are presented in Table 3.

Table 3: Effect of Income Inequality on Life Expectancy

	Model 1	*Model 2*	*Model 3*	*Model 4*
Variables	*Impactof GDPC (LE)*	*RobustCheck (U5MR)*	*Diff b/w RRICH &NON-RRICH Countries (LE)*	*Robust Check (U5MR)*
lnLE_1	0.9456678**		0.9330724**	
	(0.000)		(0.000)	
lnU5MR_1		0.99946063**		0.9086929**
		(0.000)		(0.000)
LnINEQU	0.0221653	-0.0734606	0.0057644	-0.1155998
	(0.460)	(0.179)	(0.904)	(0.207)
lnCO2	-0.0303884**	0.0380206**	-0.0307302**	0.032044**
	(0.000)	(0.000)	(0.000)	(0.001)
LnHIV	-0.0036732	0.0185507	-0.0039602	0.0405798
	(0.619)	(0.097)	(0.600)	(0.126)
LnEDU	0.0314374**	-0.0561023**	0.0322177**	-0.0745839**
	(0.000)	(0.000)	(0.000)	(0.004)
LnHEXP	0.0272161**	-0.029961	0.027682**	-0.0503632
	(0.000)	(0.069)	(0.000)	(0.084)
RRICH	0.0076155	-0.0079599	-0.0850442	0.2236414
	(0.465)	(0.572)	(0.689)	(0.517)
LnINEQU* RRICH			0.0243523	-0.0561968
			(0.663)	(0.519)
TIME1	-0.0119181**	0.0007741	-0.012528**	0.011993
	(0.012)	(0.805)	(0.005)	(0.429)
TIME2	-0.0193379**	0.0170804**	-0.0196232**	0.0263618
	(0.007)	(0.020)	(0.005)	(0.057)
Arellano-Bond Test (AR1)	(0.033)	(0.308)	(0.032)	(0.310)
Arellano-Bond Test (AR2)	(0.078)	(0.193)	(0.096)	(0.346)

Sargan Test	(0.341)	(0.805)	(0.369)	(0.161)
Hansen Test	(0.509)	(0.453)	(0.553)	(0.160)
No of Observations	551	551	551	551
No of Countries	29	29	29	29
No of Instrument	13	22	14	14

Probability values in parentheses
** $p<0.05$

Evidence in column 1 of the Table 3 shows that, estimated marginal impact of Inequality on LE is given as 0.02. Implication of this is that 1% increase in Inequality in the average country in SSA increases life expectancy by 0.02%, though not significant. Further evidence in column 2 (Model 2) shows that U5MR insignificantly reduces by 0.1% given a similar increase in Inequality. This show tendency for LE and U5MR to insignificantly increase and decrease respectively given a percentage increase in Inequality. In quantitative terms, about 2.2% annual increase in life expectancy, and 7.4% reduction in under-five mortality in the average country in SSA are insignificantly accounted for by inequality in income. Furthermore, result of re-estimation of Model 1 controlling for GDPC and $GDPC^2$ done primarily to be sure that result in Table 3 is different from possible implicit effect of absolute income (Table 2 of appendix) produced result similar to result in column 1 of Table 3. This shows that result in column 1 of Table 3 is different from the ante factual context (Leigh and Jenk 2007). From the table, estimated values of GDPC, and $GDPC^2$ are 2.4, and -1.2 respectively, and they are insignificant. When other explanatory variables are considered, evidence in column 1 of Table 3 shows that five of these variables (CO2. EDU, HEXP, TIME1, and TIME2) have significant impact on life expectancy. Specifically, 1% increase in CO2 accounted for 0.03% reduction in life expectancy, but increased U5MR by 0.04%. A similar increase in the level of education (EDU) increased LE by 0.03% and reduced U5MR by 0.1%. On the other hand, 1% increase in HEXP increased LE by 0.03%, and equally reduced U5MR by same amount (0.03%). Equally observable from column 1 is the fact that both episodes of Ebola outbreak (1998 – 2008, and 2009 – 2019) significantly reduced LE by 0.01%, and 0.02% respectively. These outcomes when viewed from a different perspective indicate that income inequality improves health, but its

however not an important factor to be considered in directly altering levels of health in SSA. Instead, factors that serve as pathways for transmission of effect of income inequality to health like environmental quality, educational quality, government investment in health sector, as well as global factors are of importance in shaping health outcomes.

Secondly, the interaction effect of inequality and RRICH as captured by "Inequality x RRICH" in columns 3 and 4 (Model 3 and Model 4) has positive but insignificant impact on health in both LE and mortality regressions. This implies that positive impact of "Inequality" on LE is higher for resource-rich countries than non-resource-rich countries; similarly, this same effect (insignificant positive impact of "Inequality") on U5MR is less for resource-rich countries than non-resource-rich countries. Empirically, this means that "ceteris paribus" 1% increase in "Inequality" insignificantly increases LE by 0.02% more, and reduces U5MR by 0.1% less in resource-rich countries than in non-resource-rich countries. Implication of this is that, impact of income inequality on health is significantly not different between resource-rich and non-resource-rich countries. Again, lagged values of LE, and U5MR are found to be positively significant in all regressions. This suggests that improvement effect of previous health condition on current health outcomes is persistent.

5. CONCLUSION, POLICY IMPLICATION OF FINDINGS AND RECOMMENDATION

5.1. Conclusion

By means of extensive review of the literature, presentation and evaluation of stylised facts and choice of quality data and estimation models, this study intensively and individually examined the empirical link between income inequality and heath in SSA. The analysis produced sets of findings that have implication that are of importance for policy: (i) the model showed tendency for health improvement given increases in 'Inequality". More specifically, the variable showed tendency to insignificantly increase life expectancy and reduce mortality. This finding happens to be consistent with finding by Herzer and Nununkamp (2011), but inconsistent with Drabo, 2011, Deurzen *et al* (2014), Leitner (2015), and Curran and Mathuga (2018). (ii) Rather than income inequality, environmental factors, educational quality, and health system development, are variables that individually exert direct significant

effects on health outcomes. While unhealthy environmental condition reduces life expectancy and worsens mortality, improvement in level of education, health system development increases life expectancy, and improves mortality respectively. Each of these factors serves as pathways for transmitting the effect of inequality to shape levels of aggregate health outcomes. (iii) Non country specific factors have negative impact on health; it reduces life expectancy and worsens mortality, and the magnitude increases across time.

5.2. Policy Implications of Findings and Recommendations

From the study findings and conclusions made in each case, four policy implications are arrived at and recommendations made thereof. First, since better health is associated with wider income gaps (though not significant) between the haves and have-nots, health improvement can be achieved through effective income redistribution policies. Experience has shown that tax policies are ineffective in achieving this objective due to massive tax evasion by the elites. Instead, the objective can be achieved through pro-poor education and health policies under regime of good governance. This as a matter of fact, need be complemented with concerted efforts at checking rent-seeking behaviour of economic agents. That will ensure that on average, people earn income only through productive means; with that, authorities will be able to effectively regulate income inequality to levels that will ensure good health. Second, the concept of "greenhouse effect" should be a major concern to economies in the region. To this end, the "Green, green" policy of the United Nations (UN) should be implemented with vigour. This will ensure improvement in quality of the environment for good health. Third, given that education and health system funding are notable channels of improving quality of human capital for development, there should be a standing legislative act that makes it mandatory for government at all levels to ensure strict adherence to minimum benchmark budgetary allocation to these sectors. In addition, economies should seriously consider a Public – Private – Partnership (PPP) management model for proper accountability. Fourth, observation of progressive time-increasing negative effect of non-country-specific factors on both life expectancy, and mortality shows that an average country in SSA is currently within the negative guardrant of influences of geographical factors. Policies that could raise influential impact of the positive-effect generating global factors (like increasing access to medical

technological advancement and immunisation practices) is needed to offset influences of negative factors and ensure health outcomes improvement.

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APPENDIX

Table 1: Countries in the Sample of 29 SSA Countries and Summary Statistics 1996 - 2019

Country	*Average Gini*	*Average LE*
South Africa*	62.38	58.05
Botswana*	62.98	51.72
Namibia*	60.46	59.50
Lesotho	56.6	48.24
Madagascar	42.44	54.20
Nigeria*	44.12	52.70
Ghana*	42.96	49.35
Cameroon*	43.66	60.57
Cote d'Ivoire*	41.78	57.07
Senegal	40.14	56.95
Benin Republic	39.58	50.94
Gambia	46.30	53.18
Mali*	41.66	55.71
Burkina Faso*	44.82	51.96
Togo	44.46	60.69
Niger*	44.60	53.70
Mauritania*	38.44	55.34
Guinea*	41.92	50.94
Tanzania*	40.42	55.39
Uganda	42.34	50.00
Ethiopia	34.26	46.42
Mozambique*	49.26	49.70
Central African Republic*	43.92	57.42
Zambia*	52.76	50.12
Kenya	47.30	52.24
Rwanda	47.32	53.09
Burundi	35.16	51.23
Guinea Bissau	37.50	51.01
Malawi	54.22	51.21

Note: (*) indicates Resource-rich Countries – countries that their income receipts from natural resources is in excess of 25% of national income

Tables 2: Effect of Income Inequality on Life Expectancy Controlling for GDPC and GDPC2

Variables	*Coefficients*	*Standard Errors*	*Z – values*	*P – values*
lnLE_1	0.9275524**	0.827509	11.21	(0.000)
LnINEQU	0.0131844	0.0240334	0.55	(0.583)
LnGDPC	2.346571	6.200284	0.38	(0.705)
LnGDPC2	-1.162882	3.102431	-0.37	(0.708)
lnCO2	-0.0232851**	0.0099574	-2.34	(0.019)
LnHIV	-0.004356	0.0053876	-0.81	(0.419)
LnEDU	0.0247441**	0.0091611	0.007	(0.007)
LnHEXP	0.0047098	0.0092393	0.51	(0.610)
RRICH	-0.0025857	0.0102966	-0.25	(0.802)
TIME1	-0.0012511	0.0015133	-0.83	(0.408)
TIME2	-0.007048**	0.0035229	-2.00	(0.045)
Arellano-Bond Test (AR1)				(0.027)
Arellano-Bond Test (AR2)				(0.048)
Sargan Test				(0.000)
Hansen Test				(0.298)
No of Observations				551
No of Countries				29
No of Instrument				27

Probability values in parentheses
** $p<0.05$