Human Capital Impacts of Income Inequality: An Extensive Empirical Analysis From The African Continent

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Abstract

This paper evaluates the impacts of income inequality on life expectancy in the African countries. The empirical analysis has been performed on a panel dataset of 52 African nations covering the period of 1995-2018. For estimating the relationship, I have employed Two-Stage Least Squares (2SLS) technique and a Panel Error Correction Model (PECM). The long-run cointegrating relationship was estimated using a Panel Dynamic Ordinary Least Square (PDOLS) estimator. The outputs of both static and dynamic estimation models suggest that income inequality has negatively affected life expectancy at birth in the African continent overall. Though a positive short-run causal relationship was established, in the long-run, income inequality had deleterious effects. A series of steps had been followed to check the soundness of the result of the main empirical examination and it was confirmed that the results are robust.

1. Introduction

"A nation will not survive morally or economically when so few have so much and so many have so little"

-Bernie Sanders

(US Senator)

In 2011, the World Economic Forum established that the income inequality and corruption are the two most serious challenges in front of the world (World Economic Forum, 2011). The World Social Report 2020, published by UNDESA asserts that the inequality is rising for more than 70 percent of the global population, thwarting socio-economic development. It has been well over four decades since Rodgers (1979) reported the associations of health outcomes and income inequality, in his seminal work. His work, along with Wilkinson's (1992, 1996), gained traction and inspired further research on the subject matter in the following decades (for eg., Pickett & Wilkinson, 2015; Truesdale & Jencks, 2016). Apparently, one of the several channels via which income inequality proves to be detrimental to the economy is via the health facet of human capital. As mentioned by Wilkinson (1996), the distribution of income is "one of the most powerful influences on the health of whole population in the developed world to have come to light". Two primary hypotheses prevail to illustrate the ecological association between population health and income inequality: the absolute income hypothesis and the contextual inequality hypothesis, also known as the "Wilkinson Hypothesis". The absolute income hypothesis maintains that the uneven income distribution does not directly affect individual health. Instead, the association between income inequality and population health is purely an outcome of a curvilinear relation between income and individual health, i.e., a diminishing return of health to income (Deaton, 2003; Gravelle, 1998). The argument is depicted in Figure 1. Assume that health is nonlinear concave function of income, such that an increase in income causes diminishing returns of health and, that a hypothetical economy consists of only two equal-sized cohorts, the rich with income x_4 and the poor with income x_1 . The average population health is y_1 . If an amount of money ($x_4 - x_1$) is taken away from the rich and given to the poor, the poor's health will improve and the rich's health will deteriorate. Due to diminishing health return to income, the poor will have gained more health than the rich would have lost. Therefore, the population health increases from y_1 to y_2 , as income inequality decreases, though the average income in the society remains unchanged.

On the other side, the Wilkinson hypothesis advances a direct, contextual and causal income inequality impacts on the health of individuals, over and above underlying individual-level socio-economic determinants of health, inclusive of individual's income (Wilkinson, 1992, 1996, 2001). Income inequality stands as a hindrance in the path of nutrition consumption and accessing healthcare services due to disproportionate income emanating in poor households (Birdsall et al., 1995). Health conditions become aggravated in the case of income inequality even beyond the absolute poverty (or, read income) due to the psychological consequences of social and status comparisons, rise in violent

crimes and murders (Pickett, Mookherjee, et al., 2005), increased levels of obesity (Pickett, Kelly, et al., 2005), higher levels of infant mortality (Spencer, 2004) and bad self-reported health after adjusting for poverty levels and societal wealth, which in turn, reduces life expectancy in both developed and developing economies (Babones, 2008; Hales et al., 1999; Pei & Rodriguez, 2006; Rasella et al., 2013; S. V. Subramanian et al., 2003). It is posited that disparities in income distribution deleteriously impacts health outcomes of both the poor and rich via the psychosocial, structural, social capital or neo-material pathways (Aida et al., 2011; Elgar, 2010; Kawachi & Kennedy, 1997; Layte, 2012; Lynch et al., 2000; Mellor & Milyo, 2002; Pickett & Wilkinson, 2015; Ribeiro et al., 2017; Rözer & Volker, 2015; S. V. Subramanian & Kawachi, 2004; Torre & Myrskylä, 2011; Wilkinson, 1996, 1999). Psychosocial factors can be explained as the feeling of relative deprivation due to broadened gaps in financial conditions which results in frustration, stress, shame, and anxiety, which in turn, induces self-sabotaging behaviours like smoking and alcohol consumption (De Botton, 2004; Eibner & Evans, 2005; Wilkinson, 2001). Disproportionate income distribution might reduce social capital as well. Elgar (2010) discovered that income inequality was strongly associated to interpersonal trust, and that reduced interpersonal trust was linked to higher adult mortality, as well as diminished life expectancy. It has also been found that societies that condone higher levels of income inequality, tend to underinvest in wide array of physical, human, health and social infrastructures that improves population health (Detollenaere et al., 2018; Kaplan et al., 1996; Pearce & Smith, 2003; Rostila et al., 2012; G. D. Smith, 1996). Krugman (1996) and Deaton (2003) shed light on why higher income inequality causes lower social spending. They explained that uneven income distribution intensifies the divergence in interests between cohorts of different financial conditions.

However, the causal effects of income inequality on health are not unanimously agreed on. The proponents of the “Income Inequality Hypothesis” proclaimed that it was the income distribution rather than the absolute income that governed the health consequences (Runciman, 1966; Wilkinson, 1996). In fact, a lot of studies support the claim (for e.g., Le Grand, 1987; Rasella et al., 2013; Rodgers, 1979). On the opposing end, doubts have been cast on the robustness of this relationship. The reason cited was that if the individual health is a non-linear function of income, then income inequality might be spuriously correlated with aggregate health measures (Gravelle et al., 2002; Judge et al., 1998). Mellor and Milyo (2002) too made their scepticism clear by arguing that it is necessary to use individual-level data and individual income in the regression models to have a clear picture of the causal effect of income inequality on health. Many researchers did not find any link between the two variables as well (for e.g., Grönqvist et al., 2012; Judge, 1995; Wen et al., 2003).

Not losing sight of all these facts, Africa continues to be afflicted by overwhelmingly uneven income and wealth distributions, in spite of the impressive economic progress in the recent decades. In fact, a new UNDP report found a staggering figure that 10 of the world’s 19 most unequal countries are in sub-Saharan Africa. However, very little to no attention has been given on examining the impacts of income inequality on the health aspect of the human capital. This paper aims to empirically analyse the health impacts of income inequality in the entirety of the African continent, extensively. The empirical analysis has been performed on a panel dataset of 52 African nations covering the period of 1995-2018, inclusive. Life expectancy at birth has been used as the proxy for health conditions. For estimating the relationship, IV-2SLS technique and a Panel Error Correction Model (PECM) have been employed. The instrument used for inequality in the IV-2SLS estimation is agricultural land per capita and the long-run cointegrating relationship is estimated using a Panel Dynamic Ordinary Least Square (PDOLS) estimator. This study contributes to the existing literature in the following ways: i) it covered the entire African continent, ii) used a large dataset covering a longer period, iii) introduced a new instrument for inequality, iv) employed never used estimation techniques for this particular subject matter in the concerned location, and v) provided a detailed and up-to-date literature review.

The rest of the paper is structured as follows: Section 2 reviews the existing literature; Section 3 presents the empirical analysis to shed light on the theory, and Section 4 draws the conclusion of the study.

^[1] The hypothesis has been explained with reference to (Luo & Xie, 2020)

2. Literature Review

A multitude of empirical researches have been conducted since forever, to understand the income inequality-health hypothesis and consequently, shed light on how income distributions impact the human capital from health perspective, across countries. It can be safely asserted that, just like the takes on the subject matter by different economists are not unanimous, the empirical findings are not uniform as well. A broad spectrum of findings exists, with most conforming to the negative impacts of income inequality on health, some find no relationships and some has conclusions exactly on the opposite end. For convenience in analysing the existing studies, the review has been presented in the tabular format below:

Table 1
Empirical Studies on Health Impacts of Income Inequality

S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
1.	Rodgers (1979)	56 countries (DCs & LDCs)	Multiple Regression	GC and others	LE and IMR	Higher income inequality strongly associated to lower life expectancy
2.	Flegg (1979)	60 non-industrialised countries	OLS	Atkinson Index	Fertility Rate	10% reduction in Atkinson index leads to reduced birth rates by 2.2%
3.	Flegg (1982)	46 LDCs and 13 DCs	OLS; 2SLS	Gini Index	IMR	Inequality increases IMR
4.	Pampel and Pillai (1986)	18 industrialised countries	OLS	Gini Index	IMR	No association between higher income inequality and IMR
5.	Wilkinson (1992)	9 industrialised countries	Multiple Regression	Proportion of income to those below 7th decile	LE	Higher income inequality strongly correlated to reduced life expectancy
6.	Wennemo (1993)	11 industrialised countries	Multiple Regression	Gini Index	IMR	Higher income inequality associated to higher infant mortality rate
7.	Judge (1995)	13 industrialised countries	Multiple Regression	Gini Index; income shares	LE	No relation between income inequality and LE
8.	Kawachi et al. (1997)	39 US States	OLS	Robin Hood Index; Income decile	AAMR	Higher income inequality correlated with higher AAMR
S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
9.	Judge et al. (1998)	16 industrialised countries	OLS	Income Shares, GI	LE, IMR	No relation between inequality and LE; no relation between change in inequality and change in LE and IMR

Note: AAMR ⇒ Age Adjusted Mortality Rate; ADL ⇒ Activities of Daily Living; BMI ⇒ Body Mass Index; CHC ⇒ Chronic Health Conditions; CSMR ⇒ Cause-Specific Mortality Rate; DCs ⇒ Developed Countries; GI ⇒ Gini Index; HUI ⇒ Health Utility Index; IMR ⇒ Infant Mortality Rate; IRHI ⇒ Income-Related Health Inequality; LDCs ⇒ Less Developed Countries; LE ⇒ Life Expectancy; MAMC ⇒ Middle-upper Arm Muscle Circumference; SRH ⇒ Self-Rated Health; TB ⇒ Tuberculosis; UMR ⇒ Under-5 Mortality Rate; WHR ⇒ Waist-to-Hip Ratio; WHZ ⇒ Weight for Height-Z-score

S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
10.	Walberg et al. (1998)	Russia	Probit Regression	Robin Hood index	Change in LE	Higher income inequality leads to lower life expectancy
11.	Chiang (1999)	Taiwan	OLS	50% Income Shares, GI	AAMR, UMR	Weak association between income inequality and AAMR but UMR associated with higher income inequality
12.	Wolfson et al. (1999)	50 US States	Multiple regression	Gini Index	Risk of mortality	Weaker link between the level of income inequality and observed mortality in each state
13.	LeClere and Soobadar (2000)	US counties	Logistic Regression	Gini Index	SRH	Higher income inequality correlated with poorer SRH, for only whites with age 18 to 44 and not associated in other age groups
14.	Mellor and Milyo (2002)	50 US States	Probit Regression	Gini Index	SRH	No relation between income inequality and SRH
15.	Shibuya et al. (2002)	Japan	Probit Regression	Gini Index	SRH	Higher income inequality not associated with an increased likelihood of poor health
16.	Shi et al. (2003)	US States	Cross-sectional analysis	Gini Index	Stroke mortality	Income inequality has a reduced effect on stroke mortality
17.	Wen et al. (2003)	US States	Hierarchical ordinal logit model	Gini Index	SRH	Income inequality is not a structurally important determinant of SRH
S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
18.	Messias (2003)	Brazilian States	Simple and Multiple Linear Regression	Gini Index	LE	Income inequality negatively affects LE

Note: AAMR ⇒ Age Adjusted Mortality Rate; ADL ⇒ Activities of Daily Living; BMI ⇒ Body Mass Index; CHC ⇒ Chronic Health Conditions; CSMR ⇒ Cause-Specific Mortality Rate; DCs ⇒ Developed Countries; GI ⇒ Gini Index; HUI ⇒ Health Utility Index; IMR ⇒ Infant Mortality Rate; IRHI ⇒ Income-Related Health Inequality; LDCs ⇒ Less Developed Countries; LE ⇒ Life Expectancy; MAMC ⇒ Middle-upper Arm Muscle Circumference; SRH ⇒ Self-Rated Health; TB ⇒ Tuberculosis; UMR ⇒ Under-5 Mortality Rate; WHR ⇒ Waist-to-Hip Ratio; WHZ ⇒ Weight for Height-Z-score

S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
19.	McLeod et al. (2003)	Canada	Maximum likelihood ordered logit model	Income share of the poorest 50%	SRH	No association between income inequality and poor health
20.	Subramanian and Kawachi (2004)	50 US States	Logit model	Gini Index	SRH	For every 5% increase in income inequality, odds ratio of having poor health increased by 1.32%
21.	Vogli et al. (2005)	Italy and 25 DCs	Linear Regression	Gini Index	LE	Income inequality independently associated with life expectancy in Italy. Strong negative correlation in cross national analysis
22.	Ram (2005)	US States	OLS	Gini Index	Death crude rate	Income inequality exerted on mortality, significantly
23.	Ram (2006)	108 countries (cross-sectional)	OLS	GI, income share of top 10%	IMR	Cross-country association found negative between income inequality and health
24.	Li and Zhu (2006)	8 Chinese Provinces	Probit Regression	Gini Index	SRH, physical functions, ADL	Inverted U-association between income inequality and SRH, implying higher inequality poses health threats
25.	Wilkinson and Pickett (2006)	Countrywide studies	Meta-analysis of 155 studies	–	–	Negative effect of income inequality on health was found in 70 percent of the studies
S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
26.	Subramanian et al. (2007)	India (1998-1999 cross-sectional National Family Health Survey)	Multi-nominal logistic regression	Gini Index	BMI	Risk of under and over nutrition at the individual level significantly associated with income inequality

Note: AAMR ⇒ Age Adjusted Mortality Rate; ADL ⇒ Activities of Daily Living; BMI ⇒ Body Mass Index; CHC ⇒ Chronic Health Conditions; CSMR ⇒ Cause-Specific Mortality Rate; DCs ⇒ Developed Countries; GI ⇒ Gini Index; HUI ⇒ Health Utility Index; IMR ⇒ Infant Mortality Rate; IRHI ⇒ Income-Related Health Inequality; LDCs ⇒ Less Developed Countries; LE ⇒ Life Expectancy; MAMC ⇒ Middle-upper Arm Muscle Circumference; SRH ⇒ Self-Rated Health; TB ⇒ Tuberculosis; UMR ⇒ Under-5 Mortality Rate; WHR ⇒ Waist-to-Hip Ratio; WHZ ⇒ Weight for Height-Z-score

S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
27.	Safaei (2007)	10 Canadian Provinces	–	Income groups	HUI, CHC, SAIH	Income inequalities caused health inequality
28.	Chen and Meltzer (2008)	9 Chinese Provinces	Multi-level linear probability model	Coefficient of variation	Health risk factors, obesity & hypertension	Health risk factors positively associated with increasing community income inequality
29.	Babones (2008)	126 countries (1970 and 1995)	Polynomial Regression	Gini Index	LE, IMR and Murder rate	Income inequality significantly correlated with LE, IMR and inconsistently with murder rate
30.	Kondo et al. (2009)	11 countries	Meta regression	Gini Index	Premature mortality and SRH	Income inequality is linked with a modest excess risk of premature mortality and SRH
31.	Biggs et al. (2010)	22 Latin American countries (1960-2007)	Fixed Effects	Gini Index	LE, IMR and TB	Inequality has no significant direct effect on public health
32.	Torre and Myrskylä (2011)	21 rich countries (1975-2006)	Random Effects	Gini Index	ASMR and LE	Strong positive association between income inequality and mortality rate
33.	Esmaeili et al. (2011)	24 Islamic countries (1996-2004)	OLS	Gini Index, Income share	LE and IMR	Income inequality not a determinant of health
S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
34.	Karlsdotter et al. (2012)	Spanish life conditions survey for 2007	Multilevel logistic regression	Gini Index, Theil and Atkinson indices	SRH and Chronic illness	Income inequality measures had no significant connection with health outcomes
35.	Feng et al. (2012)	Longitudinal survey data for 23 Chinese Provinces (2008)	Multilevel logistic model	Gini Index	SRH	Province level income inequality affects health of elderly

Note: AAMR ⇒ Age Adjusted Mortality Rate; ADL ⇒ Activities of Daily Living; BMI ⇒ Body Mass Index; CHC ⇒ Chronic Health Conditions; CSMR ⇒ Cause-Specific Mortality Rate; DCs ⇒ Developed Countries; GI ⇒ Gini Index; HUI ⇒ Health Utility Index; IMR ⇒ Infant Mortality Rate; IRHI ⇒ Income-Related Health Inequality; LDCs ⇒ Less Developed Countries; LE ⇒ Life Expectancy; MAMC ⇒ Middle-upper Arm Muscle Circumference; SRH ⇒ Self-Rated Health; TB ⇒ Tuberculosis; UMR ⇒ Under-5 Mortality Rate; WHR ⇒ Waist-to-Hip Ratio; WHZ ⇒ Weight for Height-Z-score

S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
36.	Qi (2012)	57 OECD & non-OECD countries (2005)	Logistic regression	Gini Index	SRH	No independent adverse effect of country income inequality on SRH
37.	Lau et al. (2012)	Hon Kong (1976-2000)	Negative binomial regression	Gini Index	All- cause and cause-specific deaths	Positive association between income inequality and mortality
38.	Grönqvist et al. (2012)	Swedish population aged 16-65 / 16-74	OLS; Instrumental Variable	Gini Index and others	Risk of being hospitalised	Income inequality has no significant effect on health
39.	Sun et al. (2012)	12,449 middle and high schools' students from 7 Chinese cities (2002)	OLS	SPRII	SRH, depression, stress and cigarette smoking	Positive relationship between SPRII and SRH but no association between SPRII and stress
S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
40.	Rasella et al. (2013)	27 Brazilian states (2000-2009)	Fixed Effects Estimation	Gini Index/ Percentile dispersion ratio	LE	Income inequality negatively associated with life expectancy
41.	Baeten et al. (2013)	China (1991-2006)	Probit Model	IRHI	SRH	Rising income inequality related to poor health
42.	Pop et al. (2013)	140 countries (1987-2008)	Hybrid Fixed Effects Model	Net Gini	LE	Higher inequality associated with lower LE for low- and middle-income countries but insignificant for DCs
43.	Hamilton and Kawachi (2013)	35,620 US immigrants	Logistic regression	Gini Index	SRH	Less income inequality leads to better health

Note: AAMR ⇒ Age Adjusted Mortality Rate; ADL ⇒ Activities of Daily Living; BMI ⇒ Body Mass Index; CHC ⇒ Chronic Health Conditions; CSMR ⇒ Cause-Specific Mortality Rate; DCs ⇒ Developed Countries; GI ⇒ Gini Index; HUI ⇒ Health Utility Index; IMR ⇒ Infant Mortality Rate; IRHI ⇒ Income-Related Health Inequality; LDCs ⇒ Less Developed Countries; LE ⇒ Life Expectancy; MAMC ⇒ Middle-upper Arm Muscle Circumference; SRH ⇒ Self-Rated Health; TB ⇒ Tuberculosis; UMR ⇒ Under-5 Mortality Rate; WHR ⇒ Waist-to-Hip Ratio; WHZ ⇒ Weight for Height-Z-score

S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
44.	Rajan et al. (2013)	2001 Indian Census & 60th Round of Indian National Statistical Survey	Logistic regression	Gini Index; 90/10- & 80/20-income ratios	IMR, UMR and SRH	Income inequality is a strong determinant of health at the individual level but not at the state and district level
45.	Herzer and Nunnenkamp (2014)	19 DCs and 59 LDCs	Panel ARDL	Gini Index	LE	Income inequality increases life expectancy in DCs and significantly reduces life expectancy in LDCs
46.	Rözer and Volker (2015)	30 DCs	Multi-level regression	Net Gini	SRH	Income inequality had negative impacts on health, but the effect faded away after age 36
47.	Vincens and Stafström (2015)	Brazil (2002-2009)	Random Effects	Gini Index	Stroke Mortality Rate	Income inequality independently associated with stroke mortality rates despite controlling for GDP per capita
S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
48.	Siddiqi et al. (2015)	US States (1990-2007)	Fixed Effects and Random Effects	Gini	IMR	Income inequality inversely associated with IMR, but with time, it had increased positive association with IMR
49.	Bakkeli (2016)	China	Fixed Effects	Theil index & Gini Index	Blood pressure, WHR, MAMC and overweight	Income inequality does not have significant impact on individual health
50.	Undurraga et al. (2016)	Bolivian Amazon	Negative binomial model, ordered logit, OLS and logistic regression	Income shares of the poorest 20%	SRH, WHZ, blood pressure and body fat	Income transfers to rural households increased perceived stress of the better off and reduced the perceived health stress of the poorest

Note: AAMR ⇒ Age Adjusted Mortality Rate; ADL ⇒ Activities of Daily Living; BMI ⇒ Body Mass Index; CHC ⇒ Chronic Health Conditions; CSMR ⇒ Cause-Specific Mortality Rate; DCs ⇒ Developed Countries; GI ⇒ Gini Index; HUI ⇒ Health Utility Index; IMR ⇒ Infant Mortality Rate; IRHI ⇒ Income-Related Health Inequality; LDCs ⇒ Less Developed Countries; LE ⇒ Life Expectancy; MAMC ⇒ Middle-upper Arm Muscle Circumference; SRH ⇒ Self-Rated Health; TB ⇒ Tuberculosis; UMR ⇒ Under-5 Mortality Rate; WHR ⇒ Waist-to-Hip Ratio; WHZ ⇒ Weight for Height-Z-score

S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
51.	Elgar et al. (2016)	40 industrialised countries (1994-2014)	Hybrid FE model	Net Gini	Psychological and physical symptoms	Early life income inequality has adverse impacts on health and well-being of adolescent girls
52.	Ward & Viner (2017)	103 countries (2012)	Cross-Sectional Regression	National Gini Coefficient	IMR	Gini positively associated with increased all-cause and communicable disease mortality in both sexes across all age groups.
53.	Ribeiro et al. (2017)	Meta-analysis of 27 studies	Meta-regression	Gini, Theil & Atkinson Indices	Mental illness related morbidity	Income inequality linked with mental health issues, with a small overall effect
54.	Pasqualini et al. (2017)	12 European countries (1920-1956)	OLS	Gini Index	SRH, BMI, chronic diseases	Country income inequality are associated negatively with health conditions
55.	Moeller et al. (2017)	US	Chi-square tests	Gini Index	Oral health	Income inequality affects oral health
S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
56.	Odusanya and Agboola (2017)	Nigeria	ARDL	Gini Index	IMR	Inequality exerts negatively on health
57.	Hill and Jorgenson (2018)	50 US states and Columbia District (2000, 2005, 2010)	Two-way Fixed Effects	GI, income shares for top 10, 5 & 1 %	LE	State-level income inequality inversely associated with male and female life expectancy. Same general pattern across all the measures of income inequality.
58.	Matthew and Brodersen (2018)	50 US States	Probit regression	State-Level Gini index	Behavioural, physical and mental health	Income inequality has significant relationship with all health outcomes
59.	Vilda et al. (2019)	US Census American Community Survey	Poisson Regression	Gini Coeff.	Pregnancy related mortality	Income-inequality is related to pregnancy related mortality

Note: AAMR ⇒ Age Adjusted Mortality Rate; ADL ⇒ Activities of Daily Living; BMI ⇒ Body Mass Index; CHC ⇒ Chronic Health Conditions; CSMR ⇒ Cause-Specific Mortality Rate; DCs ⇒ Developed Countries; GI ⇒ Gini Index; HUI ⇒ Health Utility Index; IMR ⇒ Infant Mortality Rate; IRHI ⇒ Income-Related Health Inequality; LDCs ⇒ Less Developed Countries; LE ⇒ Life Expectancy; MAMC ⇒ Middle-upper Arm Muscle Circumference; SRH ⇒ Self-Rated Health; TB ⇒ Tuberculosis; UMR ⇒ Under-5 Mortality Rate; WHR ⇒ Waist-to-Hip Ratio; WHZ ⇒ Weight for Height-Z-score

S/N	Author(s), Year	Sample	Estimation Method	Proxy(s) of Income Inequality	Proxy(s) of Health	Findings
60.	Odusanya & Akinlo (2021)	31 SSA countries (1995-2015)	GMM	Gini Index	LE, IMR, UMR	Income inequality significantly contributes to poor population health
Note: AAMR $\Rightarrow$ Age Adjusted Mortality Rate; ADL $\Rightarrow$ Activities of Daily Living; BMI $\Rightarrow$ Body Mass Index; CHC $\Rightarrow$ Chronic Health Conditions; CSMR $\Rightarrow$ Cause-Specific Mortality Rate; DCs $\Rightarrow$ Developed Countries; GI $\Rightarrow$ Gini Index; HUI $\Rightarrow$ Health Utility Index; IMR $\Rightarrow$ Infant Mortality Rate; IRHI $\Rightarrow$ Income-Related Health Inequality; LDCs $\Rightarrow$ Less Developed Countries; LE $\Rightarrow$ Life Expectancy; MAMC $\Rightarrow$ Middle-upper Arm Muscle Circumference; SRH $\Rightarrow$ Self-Rated Health; TB $\Rightarrow$ Tuberculosis; UMR $\Rightarrow$ Under-5 Mortality Rate; WHR $\Rightarrow$ Waist-to-Hip Ratio; WHZ $\Rightarrow$ Weight for Height-Z-score						

3. Methods Of Empirical Analysis

3.1. Model Specification and Variable Descriptions

The impact of income inequality on life expectancy has been studied empirically for the case of African economies. Both static and dynamic analysis using panel data, were done to capture the impacts extensively.

For static analysis, this article resorts to IV-2SLS estimation technique. The model used is specified as follows:

$$gini_{i,t} = \alpha_0 + \alpha_1 ag_{i,t} + \alpha X_{i,t} + m_{i,t}$$

1

$$liex_{i,t} = \beta_0 + \beta_1 gini_{i,t} + \beta X_{i,t} + n_{i,t}$$

2

For the dynamic counterpart, the long and short-run relations between public health expenditure and growth will be estimated using a Panel Error Correction Model (PECM) of the form as follows:

$$liex_{i,t} = \gamma_0 + \gamma_1 gini_{i,t} + \gamma X_{i,t} + \epsilon_{i,t}$$

3

$$\Delta liex_{i,t} = \delta_0 + \delta_1 \Delta gini_{i,t} + \delta \Delta X_{i,t} - \rho (liex_{i,t-1} - \gamma_0 - \gamma_1 gini_{i,t-1} - \gamma X_{i,t-1}) + \sum_{i=1}^N \lambda_i + \sum_{t=1}^T \theta_t + \mu_{i,t}$$

4

where *liex* is life expectancy at birth and the dependent variable; *gini* is income inequality index; *health* is government health expenditure and the independent variable of interest; *agis* agricultural land per capita and the instrument; λ_i and θ_t in the short-run equation (4) are the country fixed effects and time dummies to control for unobserved heterogeneity and cross sectional dependence (CSD); and the term in the parenthesis in equation (4) is the error correction term. A vector of control variables X , has been carefully selected following several articles (eg. Baten & Juif, 2014; Herzer & Nunnenkamp, 2014; Rasella et al., 2013). They are as follows: *af* is the adolescent fertility rate. Global health observatory, an initiative by the World Health Organisation, reports that the WHO African region has the highest adolescent fertility in the world (118 births per 1000 women). It has been hypothesized that with repeated

pregnancies, women become depleted of resources that would otherwise be available for maintenance and repair of the body, and hence, lead to higher mortality. When child birth occurs at adolescent age, the chance for health complications increases which decreases life expectancy even more. *edin* represents education index. Educational attainment is one of the crucial social factors of increased life expectancy. Educated individuals tend to make better overall lifestyle choices which positively impacts the life longevity. *heaexpen* is the total health expenditure which is a determinant of human life quality and expectancy. Better health facilities lead to a healthier population. *urb* is the urban population, used as a measure of urbanisation. Urbanisation leads to multidirectional development, enhancement of lifestyle and increase in facilities including the health sectors which might improve quality of life. However, urbanisation also leads to environmental pollution, increase in crime activities amongst others which might prove counterproductive. *regsc* is the regime score, with lower scores being autocratic and higher scores being democratic form of government. It is a prevailing theory that democracy improves population health. Wigley and Akkoyunlu (2011) shed light on this argument by explaining that the democratic regimes distribute health-promoting resources more widely than autocratic regimes. *saf* is access to basic drinking water services. This is used as a control for basic sanitation. The world health organisation reports that every year more than 3.4 million people die as a result of water related diseases, making it the leading cause of disease and death around the world. Most of the victims are young children, the vast majority of whom die of illnesses caused by organisms that thrive in water sources contaminated by raw sewage. Hence, access to basic water services is an important determinant of life expectancy. The final control variable, *gdppc* is the real GDP per capita which is employed to control for economic prosperity. Economic prosperity leads to higher standard of life and subsequently, a healthier population.

The long-run relationship estimation implies that there exists a cointegrating relationship between the variables and that the series are non-stationarity. It is also to be taken into account that in longer panels, individual time series are probably affected by the same common factors, resulting in the presence of CSD. Hence, a couple of testing procedures are to be carried out preliminarily. I begin by testing for the presence of CSD following Pesaran (2015) and subsequently, test for the presence of unit roots. At first, the CIPS test developed by Pesaran (2007) is used for series with CSD. The CIPS test belongs to the second-generation panel unit root tests and is robust in presence of CSD. For testing the existence of cointegration, Kao cointegration test has been used and the lags were selected by AIC criterion.

The cointegration relation of equation (3) is estimated using Panel Dynamic OLS (PDOLS) estimator, the lags and leads of which were selected by AIC criterion and Fully Modified OLS estimator. By adding lags and leads to the variables in (3), these estimators control for potential simultaneity bias. The parametric DOLS is preferred to the non-parametric FMOLS in that the latter (unlike the former) imposes additional requirements that all variables should be integrated of the same order and that the regressors themselves should not be cointegrated. Hence, I will be mainly using PDOLS estimator. The FMOLS estimation outputs are provided just to observe whether there are any contradictory results. I, then estimate the PECM specification of equation (4) by using a standard fixed effects estimator.

3.2. Instrument Core Identification Strategy

Instrumenting inequality is called for because the outcome variable affects inequality in certain ways. It is an established fact that human capital is a necessary determinant of overall economic and individual well-being. Narrowing down on the health aspect of human capital, poor health can decline productivity by limiting one's ability to work, inhibiting educational attainment and hence, lead to medical debts and bankruptcy. This, in turn, thwarts income generation and aggravates income inequality situations. Evidences exist attesting to the direction of causality from health to income (for eg. Smith, 1999). Henceforth, I propose agricultural land per capita as an instrument for inequality.

The single most crucial activity in Africa by far is agriculture. The agricultural sector provides employment to about two-thirds of the continent's working population and for each country, contributes an average of 30 to 60 percent of the GDP. Provided the fact that agriculture is the main livelihood of the people, agricultural land is most likely to be the key factor behind income generation, or consequently, the income inequality. A high correlation coefficient (0.3959) between the instrument and income inequality confirmed the potential explanatory power of the instrument. However, contrary to the argument that more agricultural land available to people would generate more income and reduce income inequality, the correlation was found positive. This is entirely plausible and the explanations are; firstly, the poorer population might own too less land to generate sufficient income. The entire land produce is used up for consumption by the owners. That brings me to the second point. Even if larger land areas are available, the poor land owners might not have enough means to produce at a sustainable level. In such cases, large land areas might become a burden. Thirdly, the data on agricultural land per capita might not capture the actual proportion of land ownerships. There exist uneven distributions of land owing to poor land governance and land reform policies. Hence, a well-off section of the population generates more income from the land while the conditions of the poor remain unaltered. Lastly, increasing population, disguised unemployment, absence of well-defined labour and agricultural laws and criminal activities like land grabbing leads to available agricultural land becoming a counterproductive factor for income inequality. There also exists empirical evidence that agricultural land can actually increase inequality (Nguyen, 2013).

The suitability of an instrument crucially depends on whether the instrument satisfies the exclusion restriction. The exclusion restriction for my identification strategy is satisfied if the instrument only affects life expectancy via income inequality and not directly. In my view, the condition holds firstly because agricultural land per capita has never been used as an explanatory variable for human capital formation or life expectancy. Secondly, in the events where agricultural land might lead to closely knit protected communities and enough productions for sustenance of life, life expectancy is likely to increase, which implies results that are biased in the direction opposite to the findings. Lastly, small land possessions are most likely to yield enough to impact life expectancy in itself. Additionally, almost no correlation (corr coefficient: -0.042) was found between the instrument and outcome variable which entrenched the suitability of the instrument.

3.3. Data Type and Source

The study involves annual data from a panel of 52 African countries, ranging over the period from 1995 to 2018. All the data have been collected from World Bank World Development Indicators (2020 Q4 Edition), Polity5, UNFAO, UNDP HDR, SWIID and Penn World Table (version 9.1). The data for the regressions of historical context were collected from Clio Infra database.

3.4. Results and Discussion

The IV-2SLS estimation outputs are plotted in Table 2 along with the first stage regression and other necessary test results.

Table 2
IV-2SLS Estimation

IV-2SLS Second Stage Regression (Dependent Variable: <i>liex</i>)		
		Coefficients
<i>gini</i>		-0.338*** [0.047]
<i>edin</i>		9.96*** [2.353]
<i>afr</i>		-0.058*** [0.005]
<i>heaexpen</i>		-0.399*** [0.082]
<i>gdppc</i>		0.104 [0.069]
<i>saf</i>		0.098*** [0.015]
<i>regsc</i>		0.84** [0.039]
<i>urb</i>		0.053*** [0.014]
R ²		0.6562
N		853
IV-2SLS First Stage Regression (Dependent Variable: <i>gini</i>)		
<i>ag</i>		0.818*** [0.047]
F-Statistic		294.84***
Under id test p-value		0.0000
Weak ID test statistic (Cragg-Donald Wald F statistic)		245.342
Stock Yogo weak ID test Critical Values:	10% maximal IV size	16.38
	15% maximal IV size	8.96
	20% maximal IV size	6.66
Note: ***, ** and * represent significance at 1%, 5% and 10% level respectively. Standard errors are shown in []		

IV-2SLS Second Stage Regression (Dependent Variable: <i>liex</i>)	
25% maximal IV size	5.53
Endog p-value	0.0103
Note: ***, ** and * represent significance at 1%, 5% and 10% level respectively. Standard errors are shown in []	

The IV 2SLS estimation outputs shows that, the coefficient of the gini variable is negative and significant at the 1% level which implies that increasing income inequality has a detrimental effect on life expectancy in the African population. All the outcomes are as par expectations except for health expenditure which has a significantly negative coefficient. Possible reasons could be inefficient spending, poor executions or non-optimal implementation of health schemes. The test results confirm the suitability of the instrument. The F tests in the first stage regressions remain highly significant. The under-identification test statistic was found to be significant at 1% level implying no under identification. The weak identification test statistic is larger than all the stock-yogo weak id critical values implying no weak identification. Lastly, a significant endogeneity test statistic represents there is endogeneity.

The dynamic estimation analysis is initiated by interpreting the test results of Pesaran (2015) test for CSD. From the first panel of Table 3, the outputs show that all the series display significant CSD.

Table 3
CSD and Unit Root Test

Pesaran (2015) Test for Cross Sectional Dependence									
	<i>liex</i>	<i>gini</i>	<i>edin</i>	<i>afr</i>	<i>heaexpen</i>	<i>gdppc</i>	<i>saf</i>	<i>regsc</i>	<i>urb</i>
	59.6***	64.8***	66.5***	60.8***	57.3***	54.2***	61.8***	10.8***	62.5***
lags	Pesaran (2007) Panel Unit Root Test (CIPS)								
	<i>liex</i>	<i>gini</i>	<i>edin</i>	<i>afr</i>	<i>heaexpen</i>	<i>gdppc</i>	<i>saf</i>	<i>regsc</i>	<i>urb</i>
0	4.66	5.05	1.07	8.41	0.27	1.87	1.82	-2.8***	13.73
1	-0.91	5.03	2.23	0.34	2.64	1.09	5.6	-3.9***	-2.3***
Note: ***, ** and * represent significance at 1%, 5% and 10% level respectively.									

Following the CSD test, the unit root tests are done. The lag specification is ranged from 0 to 1. The null hypothesis being existence of unit root, is accepted for all series with non-significant test statistics. Hence, the variables with significant test statistics (*urb* and *regsc*) are dropped out from the rest of the dynamic analysis.

The outcomes of the Kao cointegration tests (optimal lags selected by AIC criterion) are displayed in Table 4. Skimming through the test results, we see that three out of five test statistics are significant and hence, can confirm that there exists a long-run cointegration relationship in equation (3).

Table 4
Kao Cointegration Test

	Test Statistic
Modified Dickey-Fuller t	0.2694
Dickey-Fuller t	-1.422*
Augmented Dickey-Fuller t	-0.4739
Unadjusted Modified Dickey-Fuller t	4.051***
Unadjusted Dickey-Fuller t	1.6047*
Note: ***, ** and * represent significance at 1%, 5% and 10% level respectively.	

Table 5
Inequality and Life Expectancy: The Long-Run Relationship

Dependent Variable: <i>liex</i>		
	PDOLS	FMOLS
<i>gini</i>	-0.338*** [0.068]	-0.213*** [0.021]
<i>edin</i>	13.253*** [1.748]	19.773*** [0.028]
<i>afr</i>	-0.068*** [0.007]	0.037* [0.021]
<i>heaexpen</i>	-0.001 [0.035]	0.204*** [0.038]
<i>gdppc</i>	0.222*** [0.057]	0.328*** [0.035]
<i>saf</i>	0.318*** [0.011]	0.352*** [0.032]
Obs. (N)	703	813
R ²	0.9816	0.9743
Note: ***, ** and * represent significance at 1%, 5% and 10% level respectively. Standard errors are shown in []		

Estimation outcomes for (3) are shown in Table 5. The lags and leads for the PDOLS model are chosen as per AIC criterion. The model estimates a negative coefficient for income inequality and is highly significant at 1% level. The estimation output of the FMOLS model is mostly similar. Hence, a causal relationship could be established.

In Table 6, the estimation results of equation (4) are shown. *ECT* is the error correction term. The result of a fixed effects model is plotted.

Table 6
Income Inequality and Life Expectancy: PECM

Dependent Variable: Δlie_x	
	Coefficients
ECT	-0.1113*** [0.032]
$\Delta gini$	0.357* [0.205]
$\Delta edin$	3.759* [2.073]
Δafr	0.04* [0.0225]
$\Delta heaexpen$	0.03 [0.025]
$\Delta gdppc$	0.043 [0.062]
Δsaf	0.004 [0.04]
Obs. (N)	666
R ²	0.5024
Note: ***, ** and * represent significance at 1%, 5% and 10% level respectively. Standard errors are shown in []	

From the PECM outputs, it is observed that income inequality increased life expectancy in the short-run, which is a surprising result. A potential explanation for this outcome could be that in the short-run, the effects of the well-off section of the population is stronger. The coefficient of the ECT is negative and significant at the 1% level indicating that the short-run disturbances are persistent and that a deviation from the long-run equilibrium is corrected by approximately 11.13% over the following years. In other words, there is long-run convergence towards equilibrium.

3.5. Robustness Check

In order to check the robustness of the empirical findings, I resorted to fixed effects, random effects and pooled OLS estimators. The pooled OLS estimations were carried out with clustered standard errors by countries, given that standard errors are correlated among countries by construction. The outcomes are mostly similar (Appendix IV). Additionally, to have a brief historical context about the life expectancy-inequality relationship, data were collected between the period of 1820 and 1990, inclusive. However, the dataset was really thin due to lack of data availability. All the available variables and observations were included. No matter the inaccuracies arising due to less available control variables and data points, the results still confirm that income inequality has been inimical to life expectancy, keeping in mind the negative coefficients of the independent variable of interest (Appendix V).

The multiple-step checks confirmed the robustness of the empirical findings. Hence, we can safely establish the answer of the primary research question that inequality has negative impacts on human capital or precisely, life expectancy at birth in the African countries.

4. Conclusion

Comprehending the relevance and the impacts of diminishing socioeconomic inequalities, and in particular income inequality, in developing countries is of paramount importance. Inequality is detrimental not only from socioeconomic perspectives, but also for the health conditions of a population. Bearing the poor income inequality conditions in Africa and mediocre performance to ameliorate the condition in mind, this paper investigates the impacts of income inequality on the health aspect of human capital in the African continent.

The empirical analysis was carried out on a panel dataset consisting of data from 52 African nations, covering the period of 1995-2018. Life expectancy at birth has been used as measure for the population health. The relationship has been estimated using IV-2SLS estimation and a Panel Error Correction Model. Agricultural land per capita was used as the instrument for the Gini index. The long-run cointegrating relationship was estimated using PDOLS estimator. The outputs of both the static and dynamic estimation models suggested that income inequality has negatively affected life expectancy at birth. Though a positive short-run causal relationship was established, in the long-run, income inequality was prejudicial to population health. The robustness of the finding was proved following a series of steps.

However, the study is not free of shortcomings. Due to lack of data availability, the dataset had fewer observations and multiples gaps in cross sections. Hence, enhanced panel cointegration tests like Westerlund could not be performed. For the same reason, I could not perform dynamic CCE estimation which is robust in presence of cross-sectional dependence, even though cross-sectional dependence was confirmed. The data availability problem also led to dropping out multiple cross sections in the PDOLS estimation. Hence, there potentially exists certain degrees of inaccuracies in the dynamic analysis. Lastly, the dynamic model wasn't checked for endogeneity, or to be precise, the direction of causality. Further scopes on studies in this area includes finding more data, using more inclusive indices of income inequality, using household-level data for better policy formulation, checking the direction of causality and if there exists any reverse causality, more advanced estimation methods like CCE-GMM estimation should be employed finding suitable instruments.

Declarations

Availability of data and materials

The datasets generated and/or analysed during the current study are available in the World Bank World Development Indicators (2020 Q4 Edition), Polity5, UNFAO, UNDP HDR, SWIID, Penn World Table and Clio Infra repository,

Competing interests

The author declares that he has no competing interests.

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Figures

Figure 1

Individual-Level Relation between Income and Health

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