ANALYZING THE ASSOCIATION BETWEEN INCOME INEQUALITY AND MORTALITY INEQUALITY

by

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DEDICATION

To my baby Nyla. You gave me strength and determination to bring you into a world decorated by success.

To the adorable twins. Your immense love, unwavering support and your prayers gave me the strength to burn the midnight oil.

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ABSTRACT

This research examines the association between income inequality and mortality inequality. Analysis was drawn on statistics from a sample of 178 countries. This was broken down into three sub-samples comprising 107 countries forming a global sample with both developing and developed countries; a second sample of 34 OECD member countries; while the developing/low income sample comprised of 44 countries from Africa, Sub Saharan region. Econometric estimation was based on a fixed effects model that controlled for year and country- level time-variant and time-invariant factors. The research found a strong positive and statistically significant association between income inequality and mortality inequality and a weaker association with other confounding variables. Therefore, income inequality cannot be singled out as the only key driver of mortality inequality, while gender inequality in mortality is not influenced by income inequality. Thus, policies to reduce mortality inequality would require that modelling social policy be broad based.

LIST OF ABBREVIATION USED

SSA	Sub Saharan Africa
UN	United Nations
UNDP	United Nations Development Programme
US	United States
OECD	Organization of Economic Cooperation and Development
HIV	Human Immuno-Deficiency Virus
WHO	World Health Organisation
GDP	Gross Domestic Product
GNI	Gross National Product
HIC	High Income Countries
LMIC	Low and Medium Income Countries
WIID	World Income Inequality Data
SWIID	Standardized World Income Inequality Data
SES	Socio Economic Status
CIA	Central Intelligence Association
SDG	Sustainable Development Goals
RE	Random Effects
FE	Fixed Effects
OLS	Ordinary Least Squares
GBD	Global Burden Disease

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CHAPTER 1 INTRODUCTION

This study explores the extent to which inequality in mortality (lifespan inequality) is explained by income inequality. The argument here is that changes in income inequality accounts for disparities in opportunities to good health which are reflected through inequality in mortality. It is postulated that more unequal societies have a wide range of social problems such as physical and mental health, educational performance, violence, imprisonment or social immobility to the extent that people who live in disadvantaged circumstances have poorer health, more disability and shorter lives than those who are more affluent (Wilkinson, 2006 and Wilkinson & Pickett, 2009). In like manner some studies have found persons with a lower socioeconomic status experiencing poorer health status and ultimately, higher mortality. Since, it can also be argued that the number of years lived essentially indicates a certain level of welfare, this brings in another dimension in which overall societal inequality is increasing (Currie and Schwandt, 2016). This chapter will also highlight prior research work in the subject matter, how the inequalities are measured, providing justification for further research and critical value addition to literature emanating from this thesis before outlining the organization of the write up.

Inequality in life span is the ultimate of all inequalities, given that all other types of inequality are qualified upon being alive. Living a long and healthy life is among the most highly valued and universal human goals, as enshrined in the 2030 Sustainable Development Goals which aim to ensure healthy lives and promote well-being at all ages, with notable achievements in increasing life expectancy(UN.org). These unparalleled longevity gains recorded all over the world signal significant development as shown by a huge body of scholarship on the global, regional and national trajectories in life expectancy over time (Riley, 2005). As such mortality is arguably considered the ultimate measure of health, of which lifespan inequalities should be seen as the most fundamental manifestations of health disparities.

The transformation of health conceptualization, as a result of scientific and technical advances in medicines and proving conditions in terms of housing, hygiene and food, leading to increases in life expectancy and changes in the dominant pattern of morbidity with the focus shifting from highly lethal cute diseases to disabling chronic conditions. This is consistent with definition of health by World Health Organisation (1947) who define health as "…not merely the absence of diseases but also physical, mental and social welfare". This ushered in the beginning of a period in which health assessment has gone beyond the gathering of data on the presence/absence of disease and the quantification of individual`s "amount of life". This new focus put emphasis on areas such as the individual`s ability to operate in society, disability access to health services or the individual`s subjective perception of general well-being amoung others. This broad horizon in life expectancy measurement sheds light on understanding the dynamics in inequality in lifespan, since the equality aspect in life span is not substantially documented.

The existence of very unequal length of life distributions might go beyond purely natural causes and could be indicative of an unfair state of affairs in which some population groups might be disadvantaged or discriminated against. Considerable disparities in life chances exist amoung different societies, as shown by the 2017 CIA estimates, where the country with the lowest average life expectancy at birth, Chad estimated at 50 years while in Monaco with the highest average life expectancy estimated to 89 years. This measure is largely driven by changes in infant mortality where over the years the changes have made the largest single contribution to improvements in the average life expectancy. For example, in South Korea, average life expectancy at birth increased from 52 years in 1960 to 82.63 years in 2017(South Korea National Statistical Office), attributing changes in infant mortality as the single largest contributor to both genders (Yang, S., Khang, Y. H., Harper, S., Davey Smith, G., Leon, D. A., & Lynch, J. 2010). As such estimation of mortality inequality in this paper will consider adult mortality where our age range will start from 10 to 110 years since infant mortality has a relatively strong effect on mortality inequality. However, a counterfactual which includes the whole lifetables from 0 to 110 years will also be reported to show the potentially strong impact of infant mortality. Other key factors determining life expectancy include gender, genetics, access to health care, hygiene, diet and nutrition, exercise, lifestyle, and crime rates.

While there has been a corresponding longevity inequality to the notable increases in life expectancy, continued disparities in inequality in years lived across countries provide a basis for further research to substantiate the association between disparities in incomes and inequality in lifespan (Currie, 2018).

Numerous researchers argue that there has been a mixed trend with mortality gaps widening across some geographic areas and certain educational groups, while overall life expectancy has been falling in some areas in the US (Murray et al. 2006). With the overall trend of increasing life expectancy, Permanyer and Scholl (2019) find high-income countries have always had the highest longevity (regional life expectancy of 65 years in 1950–55 up to 78.6 years, in 2010–15). At the other extreme, Sub-Saharan Africa is the region with the lowest life expectancy across all periods (except in 1950–55, when South Asia was the region with the lowest regional life expectancy). Given the improvements in life expectancy and its importance in measuring welfare, the increasing incidence of inequality in years lived, surely heralds a captivating dimension in which overall societal inequality is increasing.

The improvements in longevity in South Korea was accompanied by rapid economic growth beginning, with the 1960s with GNI per capita increasing from less than US$100 in 1960 to US$200 in 2007. More so, improvements in living standards, nutrition, healthcare have often been cited as major contributors to Korea`s impressive improvements in health.

While much interest has been on income inequality, social policy has now broadened its span towards inequalities in health (Lynch, Smith & Harper, et al., 2014). Inequalities in health have a tremendous bearing on longevity since they affect the ability to perform essential life cycle tasks, as ultimately, the prematurely dead have been deprived of everything. Therefore, greater income inequality between households is systematically associated with greater inequality in non-income outcomes (UNDP, 2015). This notion is supported by Wilkinson, (1992) who postulated the hypothesis that income inequality was not simply a summary of the balance of income between the rich and poor, but is a health risk in its own right.

The ultimate impact on inequality in mortality emanates from the fact that the monetary transfer for the health of the poor would result in a significant access to opportunities for a longer livelihood, as the additional money would allow the acquisition of goods and services that would improve health status of the poor and consequently decrease inequality in mortality of the society at large. However, the transfer would not negatively affect the health of the rich with the same strength as it would positively impact the health of the poor. This outcome is attributable to the non-linear relationship between income and health at individual level, where an increase in income results in stronger health gains for the poor than for the rich. As such economic inequality also affects political decision-making as the wealthy exercise strong influence via lobbying and donations pushing their political and economic interests ahead of the low income and poor people`s interests (Gilens, 2012). As a result, policies are skewed in favor of the rich and powerful while the poor sink further into the dungeons of poverty as services like public health which benefit the poor may not receive adequate budgetary allocations.

Redistributive outcomes from such unequal societies impact on inequality in life span since they end up with inadequate shares of the national budget in favor of public health expenditures, which in turn hurts those of low income who usually rely on the public health system since private health is beyond their means. Against this background, this study estimates the correlation between income inequality and inequalities in health care outcomes which are measured as the inequality in life span across 178 developing and developed countries.

1.1 PATHWAYS BETWEEN INCOME INEQUALITY AND MORTALITY INEQUALITY

Wilkinson and Pickett (2009) allude that income inequality could impact inequality in mortality through a psychosocial pathway as income inequality serves as a measure of how hierarchical a society is. Thus income is important in its relative value, rather than the absolute value compared to other members of society. Social competition for resources and social comparisons of individuals on different levels in the income hierarchy breeds material hierarchies which lead to status differentiation which normally results in psychosocial effects of income inequality such as stress and anxiety. Similarly, Clyde Hertzman and Tom Boyce (2015) also attribute such experiences “under the skin” to influencing key biological systems over the long term to produce social gradients that result in adverse social contrasts within an uneven societies and in the end causing more susceptibility to a host of health problems, which affects the health of individuals across all social stratums, ultimately translating to increased inequality in mortality.

From an institutional perspective income inequality has short and long run consequences for the organization and development of societies resulting in a strong negative empirical relationship between income inequality and investments in public goods such as the health services and infrastructure (Galor & Zeira, 1993). While good health services and infrastructure are instrumental for improving the population health in countries with higher income inequality the public health services and infrastructure would be less developed than in countries that are more equal and as a result, the public health would be worse. Another institutional pathway implies a spurious relationship between income inequality and health outcomes and subsequent inequality in mortality. It argues that income inequality stems from specific economic development, political and historical development trajectories that are responsible for shaping a particular country's institutions and infrastructure. This institutional fabric will in turn shape specific policies and arrangements affecting the labour market, health and education (Lynch, 2000 and Coburn, 2004). However, there remains a contentious debate on the effects of the unmeasured characteristics of the country's infrastructure on health outcomes, while economic literature argues for a causal relationship between income inequality and the country's resources.

Socio-economic resources like income and wealth have been known to be key in enabling people to afford long life as alluded by Gosling & Firebaugh (2004). It is in this vein that inequalities in income translate to varying capabilities in accessing services and goods that foster superior health outcomes. Thus income differences result in variability in the levels of accessing healthy diets that yield more inequalities in length of life. More generally, there has been a rising trend in income inequality in OECD countries over the past five decades, with the exception of income inequality falling only in Mexico, and Turkey while in countries like

America the top 1% of income earners enjoy an increasing share of income (OECD, 2016). Income inequality is even more glaring in the developing countries where a significant majority of households, are living today in societies where income is more unequally distributed than it was in the 1990s. However recent research has started to explore inequality in lifespan such as the study by Neumayer and Plumber (2018), whose found that inequality in years lived is positively associated with income inequality before taxes and transfers.

1.2 MEASUREMENT OF INCOME AND MORTALITY INEQUALITIES

Currently, the average level of length of life is high in many countries and it is stimulating to study to what extent this advantage is equally accessible to all people. This is compelling enough to establish reason why measures of variability in respect to length of life have drawn growing attention (Anand et al., 2001). The Gini coefficient which is a statistical measure of distribution developed by Corrado Gini (1912) is used to measure income inequality and mortality inequality. This is a social index which is a desirable policy instrument of development where one prominent approach has been the equity orientated approach which places greater emphasis on the attainment of distributive justice as a means of accelerating the pace of development (McEwin, 1995). Gini coefficient is the most common statistical index of diversity or inequality in social sciences (Kendall and Stuart, 1969, Allison, 1978). It is widely used in econometrics as a standard measure of inter-individual or inter-household inequality in income and wealth (Atkinson, 1970; Sen, 1973 and Anand, 1983). In this study, Gini coefficient is also used as a measure of inequality in length of life (or as a degree of inter-individual variability in age at death.

The Gini-coefficient which is expressed by the formula:

$$\frac{\frac{1}{2n}\sum_{i=1}^{n}\sum_{j=1}^{n}|Y_i - Y_j|}{\overline{Y}}$$

Where: n = total classes/categories in population
Yi = income of class i
$\overline{Y}$ = Mean income
Yj = income of class j

It is often conveniently presented using the Lorenz curve which shows that even if life expectancy is increasing, the variation of lifespan could also be increasing, which suggests increased inequality in death. This implies that while a greater proportion of the population are dying at older ages, there is also an increased proportion dying prematurely.

To accurately capture the extent of social inequality, differences in longevity within a society must be embraced fully. For instance, if individuals, X and Y had identical annual incomes but X lives twice as long as Y, then their social distribution of welfare in rather unequal. As such, researchers are persuaded to focus on the correlation between income and longevity as illustrated by the "Preston Curve". It shows that longevity increases with average income but at sharply decreasing rates either within or between societies (Deaton, Cutler and Lleras-Muney, 2006 and Preston, 1975).

Given that income inequality and mortality inequality are being measured by the Gini coefficient, it becomes imperative to delve into the intuition and conceptual framework. A recap of the Gini coefficient of income using the Lorenz Curve which shows the actual distribution of income in a society, with the percentiles of individuals on the horizontal axis and the cumulative percentage of income held by those on the vertical axis as shown in Fig 1 below:

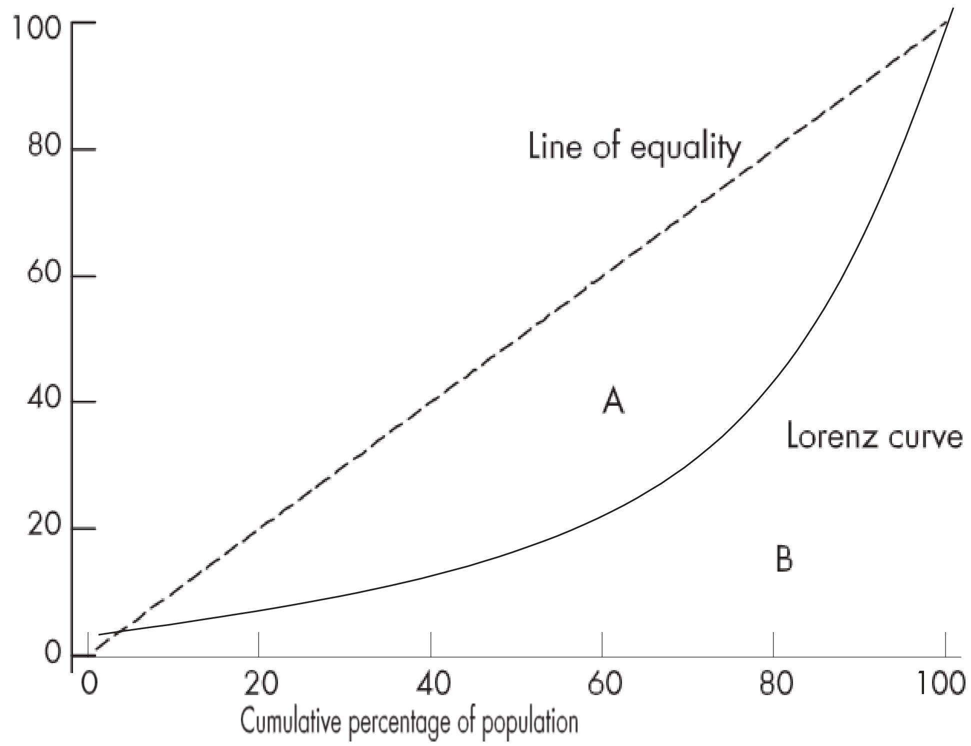

Figure 1 Lorenz Curve Framework

It shows the distribution is cumulated by income rank of individuals/households from the poorest to the richest. As such the egalitarian hypothetical would lie on the 45-degree line where each individual would have the same income.

Thus 20% of the individuals would have 20% of the total income. However, in an unequal society, the poorest usually have a smaller share of the income. Therefore, the bottom 20% of the population will have less than 20% of the total population. The Gini coefficient is the area between the two lines, the 45-degree line showing complete equality of incomes and the Lorenz curve showing the actual distribution of incomes as shown above. It is represented as area A divided by area A+B. The Gini coefficient grows with the degree to which a nation`s income is concentrated in a few hands. On one extreme end, one person receives all the income, the Lorenz Curve would occupy none of this space and the Gini coefficient would be 100%. On the other end is perfect equality where the Gini coefficient is zero since the Lorenz curve would correspond to the hypothetical 45-degree line. In real world the actual Gini coefficients of income inequality would range from 20% in the Scandinavian welfare states to around 30% in continental Europe to 40 % in US and over 60% in Sub Saharan Africa (OECD, 2018)

This analysis applies similarly in calculating the Gini coefficient of mortality inequality. Instead of considering total income in a given year, we consider total well-being as measured by years of life. Applying the Lorenz concentration framework to mortality-by-age schedules, a person's years lived from birth to death is equivalent to the "income" and cumulative death numbers to be "population". Then the Lorenz curve can be constructed from the life table distribution by age at death. For instance, considering a cohort born today in Canada, the poor amoung them in terms of life years will die tomorrow or shortly thereafter, while the rich amoung them in terms of years of life (higher income earners) will live for perhaps a century. On average each of these infants can expect to live well into their 70s but as with average income per person, there will be dispersion around this average.

Conceptually a Gini coefficient of this dispersion could be calculated by changing income to life years and preceding in a similar manner as with income inequality. Thus given that 1000 people are born today, and we can follow them until death, perhaps ten will die right away and these will have none of the life years enjoyed by the cohort. Assuming another four die at the age of 100, so they will have a total of 400 life year. A hypothetical egalitarian distribution of this would entail each infant living up to a total of perhaps 75 000 life years, so that each infant would live up to 75. As with income distribution the actual life year distribution would die before this hypothetical because some (the poorest /low income earners) would die before 75.

Therefore, mortality Gini would be the area below the egalitarian cumulative distribution that is not occupied by the Lorenz Curve of the cumulative distribution of lifetimes. However, this analysis is impossible to follow for a contemporary birth cohort, unless we wait around another century, or so. As a result of this limitation, researchers have adopted the short cut of using contemporary mortality records to generate an estimate of the year life distribution for contemporary birth cohorts, born after early twentieth century because significant, number of them are still alive. This estimate is called the lifetable which lists the number of survivors at each age from a hypothetical birth of (age zero) cohort of 100 000. The negative first difference of this survival function is mortality, or, the mortality rate. For example, if the first 3 entries (for ages 0,1,2) in a life table are 100 000, 90 000 and 88 000 respectively, it would be telling us that 10 000 infants out of a hypothetical 100000 births die before their first birthday and another 2000 die before their second. The table would also imply a mortality rate or risk of death of 2,22% between the first and second birthdays.

In practice a lifetable is built from mortality rates. So life tables are built from mortality rates, hence they are a summary of contemporary mortality experience with the most well-known statistic derived from a lifetable being expected years of life at birth which is 78 for the US. It is just a summary statistic for the life table at birth and does not mean that babies born today can expect to live 78 years but a summary statistic for the life table- the mortality weighted average age of death or equivalently, total years of life for the cohort/ 100 000 for today`s population. [1]Therefore, today`s babies would have average lifetables of 78 years only if progress in reducing mortality stops cold so that today`s babies will incur the same mortality risk at each future age as we observe in today`s population since mortality risks gave been

[1] Life tables up to age 110 for both sexes providing a set of values showing the mortality experience of a hypothetical group of infants born at the same time and subject throughout their lifetime to the specific mortality rates of a given period.

declining over time, a more realistic life expectancy for a baby born today in the US would exceeding 78 years. Life tables. The formula for calculating the Gini coefficient of income inequality is as follows.

Gini coefficient of income inequality= $\dfrac{\frac{1}{2n}\sum_{i=1}^{n}\sum_{j=1}^{n}|Y_i - Y_j|}{\bar{Y}}$

Where:

n = total classes/categories in population
Yi = income of class i
$\bar{Y}$ = Mean income
Yj = income of class j

The same principle applies in measuring the Mortality Gini Coefficient by replacing income by life years. [2]Peltzman (2009) borrows from the same formula of the Gini Coefficient of income inequality and makes use of life tables to develop the Gini coefficient of Mortality inequality as follows:

$$gini(ofmortalityInequality) = \frac{mean(g)}{mean(cumort)} = \frac{\frac{\sum_{n=1}^{N} mort}{100000} - \frac{\sum_{n=1}^{N} age \times mort}{totly}}{\frac{\sum_{n=0}^{110}(mort)}{100000}}$$

Where:

Cumulative mortality is then $cumortsh = \dfrac{\sum_{n=0}^{110} mort}{100000}$ ……………………………(2)

[2] The life tables provide the following series: age specific mortality rates (mx), probabilities of dying (qx), probabilities of surviving (px), number surviving (lx), number dying (dx), number of person-years lived. (Lx), survivorship ratios (Sx), cumulative stationary population (Tx), average remaining life expectancy (ex) and average number of years lived (ax).

This is the cumulated mortality at each age divided by 100 000. This is the cumulative mortality for each cohort of 100 000 persons at any given time.

Cumulative life years $$culysh = \frac{\sum_{n=0}^{110} (ly)}{totly}$$ ……………………………..(3)

This is the sum of the life years (of the age and preceding ages) divided by the grand total of life years lived. For each year, the cumulative years is equal to the sum of the life years (of the age and preceding ages) divided by the grand total of life years lived. This is like a fraction measure of the life years up to a given age over the total life years by the population.

Therefore $$g(cumortsh - culysh) = \frac{\sum_{n=0}^{110} mort}{100000} - \frac{\sum_{n=0}^{110} (ly)}{totly}$$ ………………………(4)

Where:
$totly = total(ly), by(yr)$ which is the total life-years by the population for each of the years
$ly = age \times mort$

Therefore $$g(cumortsh - culysh) = \frac{\sum_{n=1}^{N} mort}{100000} - \frac{\sum_{n=1}^{N} age \times mort}{totly}$$ …………………...(5)

The above shows that mortality Gini coefficient is a statistical measure which is used in order to measure the distribution of the life years among the population of the country, thereby helping in measuring the inequality of life years of the country's population. In essence, it is the sum of the differences in expected life years of everyone at birth the cohort lives through an age minus the actual years lived by those corresponding ages. For example, the mortality inequality for Australia improved from a Gini coefficient of 0.10 in 1960 to 0.08 in 2010 as a result of improvements in healthcare leading to an increase in lifespan. Meanwhile around the world there have been glaring disparities in mortality inequality with Africa Sub Saharan Africa which has a high HIV prevalence with mortality Gini coefficient of 0.25, while East Asia and the Pacific at 0.12, high income at 0.10, while the Latin American and the Caribbean with a mortality Gini coefficient of 0.14 due to varying levels of mortality risk (Permanyer and Scholl, 2019) and Shkolnikov et al., (2003).

Significant differences in mortality inequality seem to persist across countries, despite the celebrated reductions in mortality over time (Edwards and Tuljapurkar, 2011). For instance, a comparison of US and Sweden shows that both countries experienced significant increases in life expectancy and reductions in mortality inequality. US has been characterized by higher incidences in lifetime inequality in stark contrast to Sweden`s low level of mortality inequality from 1975 only 35 years later in 2010 (Neumayer and Plumber, 2015).

The development of more comprehensive life tables by the UN Population Studies, encompassing over 180 countries to date makes this study more compelling than ever given that robust data on health-related targets and indicators is lacking in many countries, at a time where developing better implementation and measurement tools, and linking data across sectors, are pivotal to the attainment of the Sustainable Development Goals and a priority in global health policy dialogue (Mackey, Taryn and Kohler, 2018; Bueno de Mesquita et al., 2018; Wang Torres and Travis, 2018).

This study addresses the question of the association of income inequality and redistributive consequences on inequalities of life span amoung the developed and developing countries. [3]There exists favourable conditions to conduct this study with set of life tables needed to

Mortality Data was obtained from the ***2019 Revision* of *World Population Prospects*** is the twenty-sixth round of official United Nations population estimates and projections that have been prepared by the United Nations Secretariat.

conduct comparative analyses across and within country data now accessible to researchers and complemented by the development in various indices to measure inequalities. This study will go a long way to help development actors, citizens, and policy makers contribute to global dialogues and initiate conversations in their own countries about the extent of inequalities and their impact on life span variation. The study will be informative to social policy innovation towards reducing inequalities in mortality in society.

The focus of this research explores the detrimental effect of inequality in incomes on inequality in longevity in Sub Saharan African 30 countries. However, our analysis will also factor in a comparative basis with the rest of the world to show if the relationship is consistent across different parts of the world, given that previous research implied that the detrimental effect of income inequality on health should be stronger in those countries where the upper limits of economic growth are reached (Wilkinson & Pickett, 2009b). The total sample size is made up of 178 countries, comprising high, middle and low income countries over the period 1980 to 2015.

Some researchers have argued that the effects of inequality on health should be most visible in high income countries, with higher income inequality relating to worse health and poor mortality rates in low income countries. This is illustrated by the Whitehall study which examined mortality rates over 10 years among male British Civil Servants aged 20-64 in one "industry" in which there is little heterogeneity within occupational grades and clear social divisions between grades (Marmot, Kogevinas and Elston, 1987). An inverse association between grade (level) of employment and mortality and a range of other causes was observed, with men in the lowest grade (others = messengers, doorkeepers, etc.) having a three-fold higher mortality rate than men in the highest grade (Marmot, Shipley and Rose, 1984). Nevertheless, mortality inequality is a very important area of human life given that high income inequality can indeed "get under the skin" and make people sick, thereby addressing inequality could prove vital for improving the life of millions thereby decreasing inequality in mortality. This study will go a long way to explore the impact of inequalities in income on inequality of mortality across the socio- economic spectrum in both high and low income countries.

We therefore deliberately choose samples of countries with different levels of economic development in order to be able to derive conclusions on the role of the sample composition for the relationship between inequality in mortality and income inequality. The general research questions guiding this thesis are as follows;

(1) what is the empirical relationship between income inequality and health outcomes

(2) what is the empirical relationship between income inequality and inequality in mortality

(3) how can the relationship between income inequality and inequality in mortality be explained?

(4) is the relationship between inequality and inequality in mortality the same for developed and developing world

The remainder of this document is organized as follows; next is literature review in chapter 2; methodology in chapter 3 while chapter 4 presents the key findings and chapter 5 concludes and presents policy implications.

CHAPTER 2 LITERATURE REVIEW

This chapter critically analyses the existing theoretical and empirical literature that informs this study. The background information presented in this chapter will also enable the researcher to establish importance and familiarity with the subject matter so at to carve out a space for further research. The main hypothesis of this research is that inequality in years lived increases as the income inequality of a country increases. At the core of inequality in mortality are varying opportunities to good health which ultimately impact on the chances of other people living longer than others. This prompts the argument that society should be more concerned with inequality of health inequalities than they are to income inequalities (Lynch, Smith & Harper, et al., 2014). Therefore, inequalities in mortality are regarded as undesirable as they represent inequalities in functional capabilities. Likewise, many countries evaluate health and social policies by their success in eliminating gaps in life expectancy between race, ethnic, or socioeconomic groups. But few countries monitor the variation in age at death within and across such groups, which ignores an important and substantial part of the inequalities in years lived.

Research in this domain has typically concentrated on aggregate population health outcomes while missing the measures of inequality in health and longevity. Explanatory studies have identified behavioral risk factors such as tobacco smoking, excessive alcohol consumption, and physical inactivity and 'upstream' social and economic risk factors such as social isolation, low income, unemployment, and occupational risks, contributing to inequalities in health (Mackenbauch, Stirbu, Roskam, Menvielle et al,.2008; Laaksonen, Talala, Martelin, Rahkonen, Roos et al., 2008 and Marmot, 2003).

Wilkinson and Pickett, 2009b, postulated that increasing societal income results in the development of the health of the population up until a certain optimal level economic development has been attained. When this critical level has been reached in the case of high income countries, the main thrust is to reduce inequalities in income in a bid to attain incremental value, in the health of the population. It is worthwhile noting that there is some discontent over the validity of the correlation between lower levels of income inequality and better population heath.

In their famous book, “the Spirit Level”, Wilkson and Picketty (2002), present a powerful prosecution of the case against inequality. In this book, cross-national differences in income inequality are compared to cross-national differences in a host of social indicators, average levels of health, trust, social mobility, infant mortality, educational performance, violence, obesity, mental illness, teen births, homicides and imprisonment. Cross state comparisons within U. S are also used to replicate the cross-national estimates. The brief summary of their findings is that along all these dimensions, in places where there is more inequality there are also more social problems. Is inequality guilty of causing all this? Can more inequality be proved to be guilty of causing all this? What level of certainty should we demand? Guilty and adequate evidence of guilty are distinguishingly different issues and which side should bear the burden of proof?

Wilkson and Pickett (1992) make it verbally plausible that there is a casual relationship between the level on inequality and these social ills, operating at the micro level as the greater social stresses of more unequal societies impact on individuals. However, distinguishing causation from correlation has, in recent years, become a preoccupation of econometric methodology. The technical requirements for rigorous proof of causality are very demanding, and in this context standard techniques are just not available. When the unit of observation is countries, sample size is also inherently limited, especially since many countries either do not have comparable data or are at levels of development where the impacts of inequality are arguably very different. Hence many of the Wilkinson/Pickett correlations and scatter plots depend on data from only 25 affluent countries, which exposes their work to the critique that this or that "outlier" may be dominating their results. As well, inequality is a complex concept, with a number of plausible alternative theories and many relevant variables that might also influence each dependent variable.

It is hard to imagine that every possible combination of measures and methodologies would produce an unambiguously similar result. As Leigh, Jencks and Smeeding (2009), put it, "In discussing the relationship between inequality and health: a fundamental problem is the fact that this is a field with too many theories for the number of available data points".

In the contribution from this paper we endeavor to examine the relationship between income inequality and mortality inequality both theoretically and empirically, based on the proposed mechanisms in the literature. We further discuss if the relationship is consistent across a sample of both high and low income countries and whether the mechanisms discussed above would work the same for countries in different categories of economic development.

2.1 THEORETICAL BASIS OF THE LINK BETWEEN HEALTH OUTCOMES AND INCOME INEQUALITY

From a broad perspective, inequality refers to "differences among people in their command over resources (Osberg, 2018). Income inequality is quite prevalent in policy matters as economists are often concerned specifically with the monetarily-measurable dimension related to individual or household income and consumption. However, this is just one perspective as inequality can be linked to inequality in skills, education, opportunities, happiness, health, life expectancy, welfare, assets and social mobility. This study focusses on the existence of very unequal length of life distribution that could be indicative of an unfair state of affairs in which some population groups might be disadvantaged or discriminated against. As a result, the relationship between inequality and the development process has long been of interest.

The study of mortality inequality is fairly recent with Janet Curie (2018), coining it as the inequality in life expectancy and notes that numerous researchers, have argued that mortality gaps are widening while life expectancy has been on a downward trend when measured across US geographic areas or educational groups (Olshansky et al., 2012). Meanwhile, Permanyer and Scholl (2019) view it as lifespan inequality which they consider to be the most fundamental manifestation of health disparities and this captures the equality aspect of the gains in longevity over the years. As such mortality can arguably be considered the ultimate measure of health.

The term inequality in health is different from the term inequity in health, as inequalities in health are based upon observed differences on disparities on health. An illustration is whether poor pregnant women visit gynecologists less than the rich women even though both have equal needs during their pregnancy. Then we compare whether they visit on equal number of times in a given time frame. If they are different and those differences are statistically significant, then inequality in access to health care exists, and a disparity exists.

As a matter of caution, it is important to note that pregnancy by itself may imply similar needs in some ideal sense, holding genetic differences in needs constant. However, pregnancy combined with poor nutrition, more insecurity and stress (as it is with a lot of poor women) will create very unequal health needs. As such, an unequal number of visits to gynecologists does not necessarily imply the health system provides equal treatment to rich and poor, since the needs for treatment of poor women are greater. Inequities in health, on the other hand, are based on ethical judgments about the fairness of the differences. Is it fair, for example, that poor pregnant women visit gynecologists the same as the rich ones even though medically both may have unequal needs during their pregnancy.

Over the years, debate about high or rising income inequality emanated from the belief that inequality was undesirable, the discourse has now broadened to its impact on an array of critical outcomes that include health, education, happiness, economic growth and democracy amoung a host of others. Meanwhile income has been known to be a key driver of most welfare goals such as long and healthy life (Gosling & Firebaugh 2004). In addition, a long and healthy life is among the most highly valued and collective goals for sustaining humanity and useful for comparing social inequality amoung societies. This study focuses on the association between income inequality and health outcomes, of which mortality can arguably be considered the ultimate measure of health. As such lifespan inequalities should be seen as the most fundamental manifestations of health disparities.

According to the epidemiological transition theory, as nation transition towards a higher economic trajectory, two things can be bound to occur (Omran, 1971). Initially the composition in epidemiology will shift from death being caused by infectious disease to chronic and followed by a demographic transition with prevalence of deaths being less amoung young and more on the old while life expectancy generally takes an upturn.

This trend ignited research on health inequalities and the distribution of health benefits and economic resources across a wide spectrum of society with the phenomenal Britain`s Black Report on health inequality (Black et al. 1980). Further to this publication more research has been conducted showing that better health outcomes are closely associated income at both the absolute and relative levels. This view was further cemented in the work of Wilkinson (1994) who alluded that “mortality rates are no longer related to per capita economic growth, but are related instead to the scale of income inequality in each society.”

2.2 THEORETICAL LITERATURE REVIEW (INCOME INEQUALITY AND HEALTH OUTCOMES)

The interplay between lifespan/mortality inequality and income inequality stems from the ensuing debate, on whether income inequality harms population health or not. Kenworthy (2016), alludes that there are three possible hypotheses of interest. The first one is that inequality in health outcomes rises with rising income inequality.

A critical issue is whether the growth in incomes over the years, has had a corresponding effect on inequality in years lived. This coincides with social sciences concerns about the unequal distribution of resources and rewards among the members of societies. This view is also shared by Pradhan et al, (2003) who alluded absolute deprivation more closely linked to that variability in life span as compared to the impact of education, occupation, or income. The dire consequences of inequality in longevity, however, may imply that lives end much earlier, which is irreversible. More so, those of low economic means face this risk as they usually rely on the public health system, which usually gets a lower share of public-to-total health expenditures at the country level, thereby exposing them to premature death, unlike the wealthy, who can afford private health care.

The second is when increasing income inequality causes a fall in a country’s GDP per capita growth, resulting in increased inequalities in health which are undesirable as they represent inequalities in people’s functional capabilities.

The third hypothesis is also suggested by Wilkinson (1992), who postulated the hypothesis that income inequality was not simply a summary of the balance of income between the rich and poor, but is a health risk in its own. His hypothesis was "higher income inequality contributes to lower average life expectancy" upon which inequality of life span indices are computed.

He proposes three mechanisms that explain why average life expectancy may be reduced by increasing income inequality. The first possibility could be that "the marginal utility of income in improving health goes down as income increases. This implies that, while average life expectancy goes up with increases in income, further increases in income result in additional units of life expectancy decreasing. Life expectancy rises with income, but as we move up the income ladder the degree of improvement per extra unit of income declines. Likewise, a transfer of money from a poor person to a wealthy person would improve the life expectancy of the wealthy person by less than it decreases the life expectancy of the poor person. In relatively developed countries, additional resources for health care, often go into cutting-edge medical treatment, which prolongs the lives of some, often the already elderly, but does not systematically prevent premature deaths. In other words, moving from high to even higher spending on health care does not necessarily reduce inequality in longevity.

The second mechanism alludes that stress levels are increased as income disparities in society rise. Thus, "Greater inequality seems to heighten people's social evaluation anxieties by increasing the importance of social status…." (Wilkinson and Pickett, 2004). Therefore, if income inequalities are bigger, so that some people seem to count for almost everything and others for practically nothing, where each one of us is placed becomes more important. Greater inequality is likely to be accompanied by increased status competition and increased status anxiety which is associated with poor health outcomes.

Similarly, Marmot et al., (1991) alluded that higher mortality is often driven by lower socioeconomic status as demonstrated by the Whitehall studies. However, socioeconomic status is "a composite measure that typically incorporates economic status, measured by income; social status, measured by education; and work status, measured by occupation" (Dutton & Levine, 1989). This implies that associations between socio- economic status and health are found with each of the indicators thereby suggesting a broader underlying dimension of social stratification or social ordering as the potent factor.

The last mechanism involves public policy. Usually the rich exercise a lot of influence amoung politicians as they offer donations and fund political campaigns. As such, the rich are likely not to favour any increases in taxes which are detrimental to the functioning of public policy thereby reducing expenditure in public health on which the poor depend on. Thus high income disparities result in further disparities in health outcomes between the rich and the poor. Ultimately the poor die prematurely, thereby increasing mortality inequality.

Several studies including multilevel studies within countries and cross-country ecological studies examined the link between income distribution and population health (Lynch JW, et al, 2004; Wilkinson & Pickett 2006). However, no agreement has yet been reached because of discrepancies between the results of different studies with the view that rising income inequality leads to rising inequality in mortality being strongly contested (Smith, 1999).

Paxson and Case (2011) demonstrate that poor health in childhood results in lesser socioeconomic status in infancy rather than lower socioeconomic status inferior health later in life, using data from the White Hall studies of British civil servants. This could be attributable to the fact that health pathways are having their foundation formed early at infancy (Almond and Currie, 2011), thereby giving credence to current mortality trends between older adults and middle-aged people. Similarly, Aizer and Curie (2014), using US data show a convergence between those of higher socio economic status and those in the lower socio economic status fast catching up. This convergence is probably attributable to an array of modern day policies targeted at improving the prospects of these children (Aizer and Curie, 2014).

2.3 PATHWAYS FROM INCOME INEQUALITY TO INEQUALITY IN HEALTH OUTCOMES

Theoretically, there are various mechanisms through which income inequality impacts on health outcomes. Foremost, income inequality could relate to health through a mechanism known as the "absolute income hypothesis" or the "statistical artefact" criticism.

2.3.1 Absolute Income Hypothesis

This mechanism works in such a way that, everything else being constant, if a monetary transfer occurs from the rich to the poor, the societal income inequality would be lower but the average income would remain unchanged. The monetary transfer to the poor would be instrumental as it would allow the purchase of products that would improve health. However, the transfer would not negatively affect the health of the rich with the same strength as it would positively impact the health of the poor. This is attributable to the non-linear relationship between income and health at individual level, where an increase in income results in stronger health gains for the poor than for the well to do. Therefore, at national levels, Subsequently, at aggregate level, it is witnessed that, given countries with same average income, those countries with lower income inequality usually depict superior health outcomes at the mean.

2.3.3 Relative Income Hypothesis

Secondly, income inequality could impact health through a psychosocial pathway as advocated by Wilkinson and Pickett (2009b), who allude “that income inequality serves as a measure of how hierarchical a society is. This hierarchy stratifies a society as a person`s income is more important in its relative value to the other members of society” than in its absolute form. These in turn breed anxiety and stress amoung the society especially on those on the lower part of this social hierarchy which may result in vulnerability to health challenges. By this measure, countries with adverse income inequality, tend to experience inferior individual health which aggregates into poorer population health in contrast to countries with lower income inequality.

There have been several research designs which support the relative income hypothesis. A good example is the study which found a strong gradient in mortality related to the gap between the rich and poor within English wards/counties (Ben-Schlomo, White, and Marmot, 1996). They concluded that the effect of relative income is primarily an ecological or contextual phenomenon. Meanwhile Kaplan et al., (1996) established a statistically significant association of the mortality amoung US states and the percentage of income received by the low income.

The prevalence of income inequality amoung states was also significantly associated with social ills such as crime, homicides, imprisonments as well as low birth rate, low educational attainment, disability and lack of medical insurance. Also buttressing this view is the study by Kennedy, Kawachi, and Prothrow-Stith (1996) whose findings show that inequality in the distribution of income is a key driver of a significant proportion of cross-state variance in several causes of mortality in the United States, independent of smoking and poverty. Furthermore, it is estimated that apart from the average income itself, the size of the gap in income between the poor had an impact on the mortality amoung the US states. As measured by the Robin Hood Index of inequality[4], it was estimated that excess mortality with the US states emanating from income inequality is between 64,7 to 96.8 deaths per 100 000 (Lynch et al. 1998). On this basis, equalizing incomes could result in a reduction of overall mortality by as much as 139.8 deaths/100,000 in the US states. In addition, a study by Kahn et al., (1998) revealed that income inequality partly caused higher abdominal weight gain among a sample of U.S. men, which is a cause for differences in mortality rates. Similarly, low income women reported some symptoms of poor health status that contributed to more deaths (Kahn et al. 2000).

2.3.5 Social Pathway

The social pathway is such that the variation in incomes amoung individual often leads to a deterioration in social cohesion and trust, leading to a decline in levels of social support which will in turn lead to worsening individual health outcomes (Karachi & Kennedy, 1997).

Declining social fabric is often characterized by increasing levels of violent crime. This can be explained by an exacerbated feeling of shame and humiliation resulting from the strong differences in social statuses thereby triggering violent acts. On the flip side, people living in high crime areas with unbefitting social tendencies are prone to higher stress levels which pose a negative impact on their health (Wilkinson & Pickett, 2009b). Again, the expectation is that via aggregation, generalized poor individual health would result in worse societal health in societies that are more unequal.

[4] It measures the percentage of income from the top50% of Income earners necessary to transfer to the bottom 50% so as to have equality of incomes for all.

2.3.6 Alternative Hypotheses

Gravelle (1998) presented the view of a concave relationship between health at individual level and income, implying that rises in income have a marginal impact on mortality beyond a certain point. As a result, he finds that a statistical artifact best explains the observed relationship between health (of which mortality is the penultimate sign of failure of functional abilities) and income inequality. The rationale is that, if country A has a more equal distribution of income than country B, it implies that there are more individuals at the middle income levels and more outliers, thereby implying worse health status for those at the lowest income groups as the curvilinear relationship would mean that more people at the higher end of income will be less likely to influence health outcomes. He argues that on aggregate level, if a rich person transfers money to a poor person, the average income level remains constant while the income inequality goes down. Therefore, the improvement in the health of the poor will be necessitated by the monetary transfer which allows access to goods and services that positively impact on their health.

The risk of mortality will be lessened since the average poor person will seem to be well off in a more equal society where there are high prospects of having some higher individual earnings. This then qualifies the relative income hypothesis as just an artifact of absolute income. To buttress their views, Gravelle, Wildman, and Sutton (2001) conducted a multivariate regression analysis on two time periods (1988-1990) and (1980-1982) which proved an insignificant relationship between longevity and income inequality. Similarly, nonparametric estimations found insignificant association between longevity and income inequality, thereby justifying the claim by Gravelle that the relationship between, mortality inequality and income inequality was basically a statistical artifact.

Other scholars are persuaded by the intricate relationship between health and income inequality which takes into consideration the link between income and racial and ethnic minority populations where often these groups are segregated economically resulting in higher mortality amoung these groups which occupy lower income deciles. This is illustrated by studies in the United States by Deaton and Lubotsky (2002) which showed after controlling for race, income inequality has no effect on mortality inequality, thus attributing a certain percentage of the black race to have income inequality embedded in it. On the contrary a study by Wilkins (1992) found that minority groups have a small impact on health in England, implying that the scale of income inequality was too large to be accounted for by ethnic minorities alone. Meanwhile, Shi and Starfield (2001) found that income inequality was a significant predictor of mortality for both black and white populations in their study of US in 1990, even after controlling for confounding variables like urban residence, income, education and unemployment.

Another dimension is by Judge and Paterson (2002) who postulated the likelihood of the health of the top income earners being negatively affected by income inequality. This assertion was also backed by a study by Weich, Lewis, and Jenkins (2001), who established a statistically significant relationship on the wealthiest income quintile between self-reported mental health and income in Britain after taking into consideration such confounding variables like physical health status, age, social class and gender.

2.3.4 The institutional pathway

Inequality could relate to health through an institutional pathway. Economists have argued that inequality has short and long run consequences for the organization and development of societies (Galor & Zeira, 1993), resulting in a strong negative empirical relationship between inequality and investments in public goods such as the health services and infrastructure.

However, good health services and infrastructure are instrumental for improving the population health. Subsequently, in countries with higher income inequality the public health services and infrastructure would be less developed than in countries that are more equal.

Another view of the institutional pathway was advanced by Lynch (2000) and Coburn (2004) who argued that income inequality is a result of a specific historical, political and economic development that also shaped a particular country's infrastructure through specific policies and arrangements affecting education, health and labour market. The arguments of these authors imply a causal relationship between income inequality and health because it reflects the effects of unmeasured characteristics of the country's infrastructure.

2.6 THE LINK BETWEEN POPULATION HEALTH AND INEQUALITY IN LOW AND MIDDLE INCOME COUNTRIES

The hypothesis of this study states that reducing income inequality is beneficial for improving health and reducing lifespan inequality. This aspect is important since this study focuses on the low income countries, with particular emphasis on Sub Saharan Africa. There has been considerable research on the relationship between income inequality, health outcomes and lifespan inequality in samples of HICs, partially motivated by the argument that inequality should be more relevant to health when the upper limits of economic growth are reached (Wilkinson & Pickett, 2009b). However, some authors also examined the relationship between inequality and well-being measures in samples of low and medium income countries and the results were mixed and even contradictory to expectations derived from the study`s hypothesis. For instance, Biggs, King, Basu, and Stuckler (2010), focused on a sample of Latin American countries, found that an increase in inequality measured by Gini Index of income was associated with a significant increase in life expectancy and with a significant decrease in mortality and infant mortality rate.

Other studies used mixed samples of countries, pooling together low, middle and high developed countries. An example is the study by Babones (2008), who found a significant negative relationship between income inequality and indicators of population health. The author, however, points out that the results were not robust in different subsamples of countries. On the other hand, Jen and Jones et al. (2009), using data from the World Value Survey and applying multilevel models, found no significant relationship between income inequality and self-rated health.

An important point that needs to be considered when analysing the relationship between inequality and well-being in LMICs regards the measurement of inequality. These countries are characterized by high levels of informal labour arrangements and a large part of the households still depend on subsistence agricultural practices. Because of these reasons it is very difficult to measure the level of disposable income of the household and subsequently, to compute reliable measures of income inequality. As a result, Fox (2012), empirically evaluated income inequality in samples of LMICs measured inequality using indicators of wealth based on the assets available and the characteristics of the household. While such literature is scant in LMICs, it remains questionable whether LMICs can make policy inferences using the findings from the HICs given the vast differences in cultural, economic, political, institutional difference and diverse healthcare systems between the LMICs and the HICs. Furthermore, the limited literature that examined the relationship between income inequality and health among LMICs showed mixed results. We conclude that there is still huge scope for more research on the impact of income inequality and lifespan inequality in LMICs.

2.7 MEASURING INEQUALITY

Social indices are used to measure inequality, which is very topical as it conceptually defined over an entire population, rather than poverty which focusses only on the poor in society. In essence, "social indicators are measures of social well-being which provide a contemporary view of social conditions and monitor trends in a range of areas of social concern over time" (McEwin, 1995). They facilitate concise, comprehensive and balanced judgements about conditions of major aspects of society and the implication of relevance to policy making. Key indices that measure inequality include the Gini coefficient, Theil index and Atkinson Index. These conform to certain axioms, namely the Pigou-Dalton Transfer Principle, scale independence, decomposability and the principle of population.[5]Table 1 below gives an analysis of the measures of inequality

[5] The Pigou-Dalton Transfer states that income transfers from a poorer to a richer person should register a rise in inequality or at least not a fall, while the income scale independence states that inequality measures should be unaffected if there is a uniform proportional change in households` income. Decomposability requires that overall inequality should be related consistently to constituent parts of the population such as population sub-groups while the principle of population states that inequality measures should be invariant to replications of the population.

Table 1 Measures of Inequality

Gini Coefficient = $\dfrac{\frac{1}{2n}\sum_{i=1}^{n}\sum_{j=1}^{n}\lvert Y_i - Y_j \rvert}{\overline{Y}}$	Where: n = total classes/categories in population Yi = income of class i $\overline{Y}$ = Mean income Yj = income of class j
Theil Index = $\dfrac{1}{n\overline{Y}}\sum_{i=1}^{i=n} Y_i \ln(\dfrac{Y_i}{\overline{Y}})$	
Atkinson = $1 - \left[\sum (\dfrac{Y_i}{\overline{Y}})^{1-\alpha}\right]^{\frac{1}{1-e}}$	ε = weighing parameter that measures aversion to inequality

Source: Author`s Compilation

The main advantage of the Gini coefficient is that it incorporates all information available and it allows comparisons between various populations, regardless of their size and structure. The advantage of Gini Coefficient is that it facilitates direct comparison of two populations, regardless of their sizes. This means that, with the Gini coefficient one can directly compare the inequality in a classroom to the inequality in a country (Illsey and Le Grand, 1987), who justified the use of Gini coefficient for the analysis of inequality in health in the 1980s, as they emphasized that the individual-based measurement of inequality in health is a way to a universal comparability of degrees of inequality over time and across countries. This makes a difference to the problematic comparability of group-based (social class-based) measurement of inequality in health, which can be biased by differences in subjective labels of social classes and differences in their relative sizes that includes the difficulty in attaching social-class labels to people who are not of working ages or do not work for other reasons.

However, Gini coefficient has its shortcomings. Given that most people and hence most pairs of people are in the middle of the income distribution, it implies that changes in the Gini index are in practice influenced by what is happening to incomes in the middle and are less responsive to changes in top one percent income shares. Therefore, it is quite insensitive to income shares of the elite to such an extent that in other circumstances it can remain completely unchanged even as the income share of the top 1% varies by a factor over sixteen (Osberg, 2018). In addition, the inequality represented by Gini Coefficient cannot be decomposed into inequality within and between differently defined population subgroups.

Taking the example of US, the Gini coefficient won't give any idea about the inequalities between or within 50 states (say between Florida and Texas, or for that matter between two counties within Texas) or population groups such as Chinese, White Caucasians, African Americans, Indians, American Indians, Hispanics and so on. Significant work by Atkinson (1970), demonstrated that comparisons between Gini coefficients based on Lorenz curves that intersect have to be made with caution, since the existence of intersecting Lorenz curves clearly imposes a limit to the 'rich- to-poor reasoning' because a consistent ordering of income distributions in terms of inequality is no longer possible.

Another group of inequality measures are based on Generalized Entropy (GE) theory. A measure of inequality derived from these principles is the Theil Index, which seeks to quantify the level of disorder within a distribution. It has the advantage of being additive across different subgroups or regions in the country. The Theil index, however, does not have a straightforward representation and lacks the appealing interpretation of other measures.

Another measure of inequality is the Atkinson Index which presents the percentage of total income that a given society would have to forego in order to have more equal shares of income between its citizens. The measure allows for the researcher to specify which end of the distribution contributed is most important to the observed inequality. Thus the Atkinson index allows for varying sensitivity to inequalities in different parts of the income distribution, unlike the Gini or Theil framework.

An important feature of the Atkinson index is that it can be decomposed into within- and between-group inequality. In order to ensure comparability of the measures and of the results, inequality is measured consistently throughout the studies by the Gini coefficient. This measure is easily understandable, has a confined range, takes into consideration the whole information available and allows comparisons between populations with different size and compositions. We also make use of the Gini Index of the income available for consumption, which in net of taxes and transfers.

There is variability in the data form and the methodologies used to compute inequality indices and this makes various studies differ. For example, when computing income inequality, studies differ on whether they use disposable or total income earned as well as considering adjustment for household size. Wide use of disposable income is on the basis that it is net of taxes and transfers, leaving comparison to the aspect of the household real purchasing power. However, taxes and transfers differ amoung countries. Thus in countries with a progressive tax systems use of gross household income may show relatively higher levels of inequality. This is bolstered by the World Income Database which claim that Gini coefficients computed from gross income are usually 5 to 10% points high than those calculate from net income.

Consideration of equivilisation of income data for household size would entail dividing household income of three does not necessarily mean a family of six would need twice the income of a family of three to leave at equal standards. Thus correctly adjusting for household size would make any comparability more reliable.

2.8 EMPIRICAL REVIEW

Seminal work by Rodgers (1979) heralded the beginning of academic interest with the relationship between income inequality and health. Using a dataset covering 56 low and high income countries, he was the first to show that population health measures such as life expectancy or infant mortality rate were negatively associated with income inequality. However subsequent studies using the same macro level research design provided mixed evidence, as some authors found supporting evidences for a relationship between societal income inequality and population well-being measures (Cantarero, Pascual and Sarabia, 2005; Kawachi and Kennedy, 1997b; Wilkinson, 1992), while others concluded that this relationship is not robust or cannot be replicated with newer data (Ash and Robinson, 2009; Deaton and Lubotsky, 2003; Mellor and Milyo, 2001 and Ram, 2006). As a result of the glaring inconsistencies in the findings, there was criticism of the research design used.

The criticism originated in the study by Gravelle (1998), was that the empirical relationship observed at country level was just a result of the population composition. His argument was that between two countries with the same level of average wealth, the country where the incomes are more unequally distributed has a larger part of the population living in precarious conditions and poverty. The inadequacy of material resources at the low level incomes translate to worse health outcomes as the poor lack adequate shelter, food or access to medical services. Therefore, by aggregation, the country with the higher level of inequality will have more people with bad health and thus, will score lower on aggregated health indicators. The second criticism regarded the ecological fallacy committed when inferring conclusions about mechanisms working at individual level based on evidence found at macro level (Ellison, 2002; Jen, Jones, & Johnston, 2009). The studies by Wilkinson and Pickett (Wilkinson, 1999, Wilkinson and Pickett, 2009b) were especially targeted as being sensitive to the ecological fallacy criticism, because the authors developed a full argumentation on how inequality affects the health of individuals by specifying processes that take place at individual level, while supporting their claims with evidence derived from macro level analyses.

Judge, Mulligan, and Benzeval (1998a) provided a critical analysis of the methodologies mainly used in the domain of health and income inequality research. Since there are many determinants and only a few countries with good data, it is hard to distinguish hypotheses. Secondly some studies make use of very small sample sizes which often produce spurious results. Thirdly, over the years, income equality data has been scare and at times unreliable for many countries over a long range of years and lacked consistent adjustments for household size and taxes and transfers. Fourth, there has been some tendencies for some studies to adopt data from the developed world and generalize it to the developing countries where fundamentals are in stark contrast. However, some of this critique fails to hold water, in the face of multilevel and time series studies using a variety of outcome variables (Soobader and LeClere, 1999).

Other researchers such as Fiscella and Franks (1997) drawn evidence to the contrary and found no significant relationship between income inequality and mortality inequality from their U.S based longitudinal cohort study which used a multilevel model to test the relationships between individual income, neighborhood-level income inequality, and an individual's risk of dying. After adjusting for household income, they found a more bivariate relationship between survival rates and community income inequality as it appeared that that poverty, rather than income inequality, was a key driver of mortality inequality. Similarly, literature review by van Doorslaer and Wagstaff (2000) found that many of the individual level studies done in the US were fraught with poor methodologies, however these studies largely supported the relative income hypothesis with only a few in favour of the income inequality hypothesis.

One of the most notable studies is by Mellor and Miylo (2001), who carried out over 54 regressions the country-level association between aggregate health outcomes such as infant mortality and life expectancy and income inequality across 30 countries over a 40-year period and examined 48 U.S. states over 50 years. They used the Gini coefficient as a measure of income inequality and used various causes of mortality as dependent variables and found no significant relationship. However, after controlling for median income, educational levels, and year-specific effects there was a significant relationship.

A study by Iñaki Permanyer and Nathalie Scholl (2019) documented global trends in life span inequality found that the world is facing a new challenge of the occurrence of deviating trends in life span worldwide, especially in the developed countries although there has been overall a general decline in overall lifespan inequality in the last 75 years. Therefore, as larger fractions of the world population survive to more advanced ages, it will be necessary for national and international health planners to recognize the growing heterogeneity that characterizes older populations.

A study by van Raalte, Kunst and Deboosere (2011), measured life span variation as measured using the standard deviation restricting survival to age 35, covering 10 European countries, and found educational inequalities to be the explanatory variable. Their methodology relied on synchronised, census-based mortality data to compute life tables by educational level grouped as high, medium, and low as well as gender. In addition, they also broke down the differences in life span variation by reason behind mortality and by age at death.

Variation in life span was also examined by Yannan Hu et al., (2017), using a sample of 43 European, countries using comparable data between 1987 and 2008, found that national levels of income inequality do not have an independent impact on mortality. They used pooled cross-sectional regressions and controlled for both time-invariant and time-variant country-level factors, with their results showing significant correlations between mortality indicators and income inequality. Countries with higher mortality were found to have larger income inequalities. However, after adding country fixed effects, all associations between mortality indicators and income inequality became insignificant, except for mortality from homicides among men. cancers among women and external causes. Their methodology is generic without looking at age specific mortality such as mortality and infancy, middle age and old ages which all vary in significance.

As more research builds in this discourse, Neumayer and Plumber (2018) conducted a study of the impact of income inequality and its distributive aspect on inequality in mortality. They used the ordinary least squares estimator with standard errors clustered on countries with mortality inequality as measured by the Gini Coefficient computed from age specific mortality drawn from life tables, on a sample of 28 OECD member countries. Their key findings were that income inequality was positively associated with inequality in mortality. However, missing in their methodology were country specific effects and applying the Gini coefficient of income net of taxes so as not to overstate the disposable income aspects of income expenditure variations.

The literature review demonstrates the variations in both theoretical and empirical studies by methodologies, different sample populations, econometric techniques used, the different measures of mortality inequality and income inequality as well as the confounding variables and period of analysis. However, it is evident that there are still mixed views amoung researchers on the relationship between income inequality and mortality inequality.

All in all, the literature review has endeavored to present a structured analysis from the historical development of both theoretical and empirical angles. Various positive and negative findings, categorizing of many criticisms and alternative explanations were given, with most studies relying on cross sectional data. The impetus for further research is justified by the inconsistent findings presented in the literature review above.

A close look at this overall evidence does not clearly show how one should assume trends in mortality inequality to have evolved over the recent two decades. Fenelon and Preston (2012) estimated that about 20 percent of US mortality may be attributed to smoking. They have also observed massive increases in obesity rates and addiction to prescription painkillers. contributing to mortality over the years.

Income inequality represents an important determinant of health in high-income countries, but few studies have analysed its effects in developing countries. There are no evidences on the effect of a strong and rapid reduction of income inequality, driven by economic growth and effective social policies, on income inequality and life expectancy in developing countries. Evidence of this association in developing countries where both income inequalities and mortality inequalities are glaring is also scant. Thus evidence on global length of life inequality and its between and within-country subcomponents is still incomplete. In general, unconditional length of life inequality within countries has tended to decrease as longevity increases (Smiths and Monden, 2009). However, Engelman, Canudas- Romo and Agree (2010) found a rise in variation in years lived among the elderly in the developed countries.

Cross-national studies found global convergence in life expectancy levels between the 1950s and 1980s (Goesling and Firebaugh, 2004). However, this trend suffered a huge drawback in the face of the fall of communism and the spread of HIV/AIDS in Africa. As part of the conceptual framework of health determinants, future studies should include, at the very least, a macro-level measure such as GDP per capita and health systems and services, as well as micro (or aggregate) measures of individual income, socioeconomic status (SES) measures of education or occupational prestige (or social class), and racial/ethnic composition. In addition, the link between the theoretical literature and the empirical model used to test hypotheses is often weak. At the very least, the range of covariates and the specific theoretical framework for each study should be better justified in terms of the health outcomes linking income inequality to mortality inequality.

As we continue to seek better research outcomes some effort could be directed towards betterment of frameworks by organizing the various determinants of mortality inequality from the ecological levels such as the national, state, county, city amoung others to the individual levels that are convenient to link to income inequality.

An attempt should also be made towards unifying and simplifying the various measures of both income inequality and mortality inequality given the diversity of the data and complexity in the construction of some of the measures so as to allow study comparability. Studies on income inequality have interchangeably used measures such as the Coefficient of Variation, Atkinson

Index, Theil indices and the Gini coefficient. In addition, economics literature suggests that household income selected for calculating income inequality measures must be net of taxes and other transfers and also be equalized for family size. Therefore, future studies will need to be explicit about the income data used to derive the inequality index and discuss the implications of the limitations of the income data they employ.

Furthermore, because of the complexity of the analyses required, methodological problems continue to plague most published studies. Time lags (Blakely et al., 2000), data quality (Judge 1995; Judge, Mulligan, and Benzeval 1998a; Wagstaff and van Doorslaer 2000), controlling for median versus mean income (Blakely and Kawachi, 2001), just to name a few issues—have all been found to influence results. Moreover, issues such as multi-collinearity among economic variables are rarely dealt with systematically. To date, no single study has comprehensively addressed each of these potential limitations. This study will employ various econometric techniques to rid the data of such problems to ensure efficient and reliable estimates.

In the end, regardless of the relationship between income inequality and health detected, nearly every study has confirmed the importance of individual income on health outcomes, even within countries with universal insurance and relatively generous social welfare policies. This suggests that one benefit of research on mortality inequality and income inequality is bringing to the fore, the role of economic and social resources and their impact on health inequalities (Mackenbach, 2002).

One of the main aims of this paper is to expand the scope of previous studies by providing a detailed analysis of the association between mortality inequality and income inequality during the last 50 years in Sub Saharan Africa by exploring both unconditional and conditional age-at-death distributions and compare it with the rest of the world to establish robustness of findings and improve efforts in social policy innovation that addresses mortality inequality. The findings will go a long way towards social policy development and improving mortality health outcomes that have a bearing on limiting the variability found in inequality in years lived.

CHAPTER 3 METHODOLOGY

This research examines the correlation between income inequality and inequality in years lived. The econometric estimation will employ panel data regression methods with either fixed effects or random effects as guided by the Hausman test. This estimation technique is most suitable to our data, which is of a cross sectional-time series nature and grouped into clusters, with regression model errors correlated within clusters but independent across clusters.

3.1 RESEARCH STRATEGY

We will regress mortality inequality on market income inequality in a cross sectional time-series sample of 180 countries, predominantly high income, middle and low income countries while controlling for potential confounders. We broke down our analysis into the global perspective which comprised the rest of the 180 countries, then subsets of the OECD and Sub-Saharan Africa, to be able to draw a triple comparative basis. We targeted low and middle income countries from Sub Saharan Africa for the period 1960-2015, while the inclusion of high income countries was strictly to form a comparative basis to ascertain if the impact of income inequality on mortality inequality is the same for both high and low income countries.

We will use life tables to compute the Gini coefficients of mortality inequality. Life tables allow us to compute age specific mortality. We then adjust the analyses for year dummies. Robust standard errors will be used to account for heteroscedasticity (Wooldridge, 2002). To allow for within country correlation, between error terms, we will use clustered sandwich estimators to permit for within-country correlation between error terms (Wooldridge, 2010).

3.2 DISCUSSION OF VARIABLES

3.2.1 Dependent Variable: Mortality Inequality

While there are many measures of inequality, this research makes use of the Gini-coefficient. It has many desirable properties, namely anonymity, continuity, scale independence, symmetry, and satisfies the principle of transfer implying that a transfer of income from the richer to poorer person always reduces the magnitude of inequality (Pandey and Nathwani, 1996). The regression analysis is twofold to allow for comparison of inequality using the entire life table and those conditional upon survival to 10 years to account for the impact of infant mortality which is a significant cause of mortality in some countries.

3.2.2 Gini coefficient of income inequality

This research also relies on the Gini coefficient to measure income inequality. It considers the actual disposable income net of taxes and transfers. Income inequalities are known to lead to disparities
in individual expenditures on health. Such disparities may be a temporary state as they can be compensated by social redistribution mechanisms.

In order to ensure a high level of comparability of the Gini index of income across countries and time, this research relied of the Gini Coefficient from the Standardized World Income Inequality Database (SWIID) (Solt, 2009). This dataset was developed in an effort to improve the comparability of the Gini index of income across countries and periods and to address the biggest problems that affected comparative research. Measures of income inequality were rarely comparable because of the differences in the definition of income (before or after taxes) or the differences in the reference unit (households or persons). Since income is instrumental in reaching key welfare goals of which mortality is the ultimate (Sen, 1985), and that high income inequality implies high chances of reduced access to decent healthcare which in turn increases the risk of dying. Therefore, the expectation is that of a positive correlation between income inequality and inequality in years lived.

3.3 OTHER POTENTIAL CONFOUNDERS

3.3.1 Life Expectancy

Life expectancy is a summary of people`s health conditions, it is another dimension of individual welfare, whose obvious attractions are comparable to that of income but a lot easier to evaluate than other non-income dimensions like safety, freedom, or access to justice or education (Bourguignon and Morrison, 2002). It has been argued that mortality inequality should also be controlled for life expectancy given the close association between life expectancy and inequality in life years (Wilmorth & Horiuchi, 1999). Life expectancy has evolved over the years. Since the advent of the Industrial Revolution, death rates have been declining in industrialized countries. During the 20th century mortality decline spread worldwide. This was also complemented by the decline in childhood and consequently reproductive-age mortality, thereby moving age-at-death distributions to more advanced ages. For example, since 1950, life expectancy rose from 67 years to just over 80 years in the world`s more developed countries, while it increased in less developed countries from 37 to 68 years (Lomborg, 2001). An important added advantage for longevity as a measure of welfare is that, in contrast to other common measures, separate data on this aspect of well-being are available for each sex.

Life expectancy increased in all of the countries in the study sample during the last three decades. Income inequality also increased during this period. However, the adverse effect of income inequality on life expectancy, has been limited by increased access to medical care, improved quality of medical care, better diet, more exercise, less smoking amoung others (Wilkinson, 2002). This study anticipates a negative association between income inequality and life expectancy.

3.3.2 GDP per capita

This is an important confounding variable which has been used by many existing studies. It represents national income (Gross domestic product per capita). Health expenditure is said to be more unequally distributed as compared to the national income (Deaton 2013). In the same vein, some like Ray and Linden, (2020), have argued that those with poor health conditions are guilty of spending very little on health. We then draw our expectations of a positive relationship between GDP per capita and mortality inequality. The GDP per capita figure would be log transformed to counter the potential nonlinear effects.

3.3.3 HIV-AIDS Prevalence

Due to the marked impact of the HIV-AIDS epidemic on length-of-life distributions, we create a separate category for Sub-Saharan African countries that have had an HIV prevalence of more than 3%. This variable is largely insignificant in high income countries and therefore we omitted it in the analysis of the OECD sample.

The threat of HIV is gravest in Sub-Saharan Africa region, which has been ravaged by HIV/AIDS and conflict, leading to a reverse life expectancy reverse in the 1990s from already tragically low levels (UNDP, 2002). The percentage of populations reported to be HIV-positive ranges from a low of 0.1 (Algeria) to a high 35.8 (Botswana). Furthermore, in Sub Saharan Africa in 2018, an estimated 25,7 million people were living with HIV, of whom 16.4 million were taking anti-retroviral therapy. The number of deaths from AIDS –related illness in sub – Saharan Africa could double if the provision of health care to HIV patience is disrupted during the Corona virus crisis (UN, 2020), leading to more than 500 000 extra deaths in the region by 2020-21(WHO and UN, 2020). There is need to identify ways to sustain all vital health services as any knock on effects such as the interruption in supply chains or healthcare services being overwhelmed due to the COVID-pandemic, could be catastrophic for affected populations. It is feared that this could turn back the clock to 2008 when more than 950 000 AIDs-related deaths were recorded in the region. This HIV prevalence is expected to increase inequalities in years lived. Another salient aspect of this tragedy is its relative effect on women as more women than men have died of AIDS in South Africa (United Nations Integrated Regional Information Networks, 2002). It is said that in the 15 to 29 age group, HIV/AIDS deaths among females was about three times higher than among males (Gregson, Garnett, and Anderson, 1994). In addition, there is a general tendency for female partners to be younger than their male counterparts, implying that the increased mortality rates from HIV affects women at younger ages than it does for men. Since the incidence of HIV increases the risk of dying, there is a probable positive relationship between HIV prevalence and mortality inequality.

3.3.4 Armed Conflict/Civil Wars

A research by Neumayer and Plumber (2006) alluded that males are naturally the major direct victims of military operations since combatants in armed conflict are mostly men. However, it has been noted that armed conflicts have important indirect negative consequences on public health provision and social order, amoung other disciplines of life. Such indirect consequences are often discounted and under-appreciated as they will also affect women and arguably more so than men. Thus, Neumayer and Plumber (2006), find that over the entire conflict period, interstate and civil wars on average affect women more adversely than men as it is the ethnic wars that are damaging to women and particularly so if they take place in 'failed' states. Meanwhile in peace times, women typically live longer than men. Therefore, armed conflict tends to decrease the gap between female and male life expectancy. We therefore anticipate increased prevalence of conflicts to increase mortality inequality in both sexes.

3.3.5 Lung Cancer and External Mortality Causes

According to World Health Organization report of 2017, amoung the leading causes of deaths, communicable diseases are prevalent in the developing world, while non-communicable diseases characterize the developed countries and other external causes such as accidents. HIV/AIDS was the major leading cause-of-death across all demographic and socioeconomic spheres in for adults in Sub Saharan Africa, while ischemic heart disease, stroke, chronic obstructive lung disease and lower respiratory infections have remained the top killers in the developed world during the past decade. Chronic diseases cause increasing numbers of deaths worldwide. Diabetes caused 1.6 million (2.8%) deaths in 2015, up from 1.0 million (1.8%) deaths in 2000. Deaths due to dementias more than doubled between 2000 and 2015, making it the 7th leading cause of global deaths in 2015. Injuries continue to kill 5 million people each year. Road traffic injuries claimed about 3700 lives each day in 2015, about three-quarters of whom were men and boys. We thus included the logarithm of average alcohol per capita consumption in liters of pure alcohol.

Data for tobacco consumption, life style and health and safety choice was scarce particularly in the developing countries. As such we relied on data mortality rates from lung cancer and external causes per 100 inhabitants and this comprises of causes such as falls, drowning, smoking, poisoning, intentional self-harm and transport accidents.

3.4 DATA SOURCES

Annual data on mortality Gini, the dependant variable will be computed from life tables obtained from Human Mortality Database, UN World Population Prospects' and (WPP). While there are excellent data on mortality by age group for high-income countries, data are generally sparser and less reliable for developing countries. Nevertheless, the UN population division has assembled a broad data set of country life tables and provides a detailed account of the data sources used in the construction of each country's set of mortality estimates. Although the use of model life tables is unavoidable for constructing complete data series for all developing countries, all missing country-year combinations are estimated via indirect methods based on real data by the UN World Population Prospects. Therefore, while the accuracy of individual inequality estimates might not be perfect for every country in every year, we have compelling reasons to believe that the overall picture that emerges from them is a faithful portrait of reality. Empirical findings from this study square well with those from other renowned studies, and the estimates we obtain from the UN WPP are highly correlated with the estimates derived from other reputable data sources, such as the Human Mortality Database, a fact that can be attributed to the similarity of methods that both sources employ to generate their estimates.

On the income Gini index as a measure of the main independent variable. The main data source was the SWIID version 2.0c of the WIID4, which is the fourth major update of the database. Observations from this database, now go up to 2018 covering 189 countries with almost 3,500 unique country-year observations in the database. Data on all mortality indicators, were log transformed for normalization and obtained from the UN Lifetables and the Human Lifetables.

For the rest of the confounders, GDP per capita data was obtained from the World Bank Development Indicators Database. GDP per capita at 2010 constant prices was used. Meanwhile HIV prevalence data was obtained from the World Health Organisation. Data for armed conflict was obtained from Quality of Government dataset and it ranged from 0 for ‘‘no conflict’’ to “1” for between 25 and 100 battle deaths, 2 for ‘‘more than 1000 battle deaths per year’’.

3.5 SAMPLE

Data was analysed for individuals and by gender to show the dynamics of mortality inequality. The analysis is threefold, at the global level with a sample of 107 countries, a sample of 34 OECD member countries, and another sample of 44 Africa, Sub-Saharan countries to enable comparison and avoid unbefitting generalizations (refer to Appendix I for all the countries in the study sample)

3.6 MODEL SPECIFICATION

There are basically three models that can be used to analyse panel data. The models are Pooled OLS, Random Effects (RE) and the Fixed Effects (FE) model. The models are explained below. The choice of the model to be used is informed by the Hausman test which depends on the data as well.

3.6.1 Hausman Test

According to Greene (2012) the choice of the model to be estimated in the panel data analysis must be based on the information about the individual-specific components and the exogeneity of the independent variables. The Hausman test is the best model in identifying the presence of the endogeneity in the explanatory variables (Greene 2012). The Hausman hypothesis is as follows;

$H_0: Cov(\alpha_i, x_{it}) = 0.$

When the null is accepted over the alternative hypothesis, then the random effect is consistent and efficient.

H_1: $Cov(\alpha_i, x_{it}) \neq 0$.
When the null hypothesis is rejected, the fixed effect is consistent and possibly efficient.

Fixed Effects Model

In order to control for the time-invariant unobserved individual characteristics that can be correlated with the observed independent variables, the fixed effects model is more appropriate (Kohler & Kreuter 2012). The model assumes that countries have different qualities that may have the impact on the dependent variable. The slope of parameters are the same across countries over different time periods and estimates are robust (Baltagi 2013). However, this model is only limited in a way that the model cannot be used to investigate the time-invariant effects (Kohler & Kreuter 2012). According to Baltagi (2013) the time-invariant characteristics are of individual countries are perfectly collinear country dummies.

Random Effects Model

The random effect model assumes that countries are randomly drawn from the population. The key difference between fixed effects and random effects is whether the unobserved individual effect embodies elements that are correlated with the regressors in the model (Greene, 2008). The study will employ either the Random Effects (RE) model or the Fixed Effects (FE) model as informed by the Hausman test results.

3.7 DIAGNOSTIC TESTS

As part of the econometric analysis, some diagnostic tests will be conducted in order to assert adequacy of the data to the appropriate panel data regression model. Firstly, to understand the basics of the raw data, descriptive statistics are computed, to provide basic information about the behavior of variables in the dataset and highlight potential relationships between variables.

The diagnostic tests are informed by the common problems faced in panel data regression which include autocorrelation, heteroscedasticity by time and by cross, multi-collinearity and unit root.

Prior to the estimation of the model chosen by the Hausman test, the study will check for the multi-collinearity among explanatory variables. Post the model estimation, the study will check for contemporaneous correlation and the heteroscedasticity. If the model fails, to comply with these assumptions, necessary actions will be taken to correct them. These tests are explained in the subsequent paragraphs.

3.7.1 Panel unit root test

If a shock to a variable persists overtime, so that the variable does not revert back to its mean or trend-line, that the data is said to contain a unit root, or that it is non-stationary (Wooldridge, 2015). Therefore, running least squares -regressions on series containing unit root can lead to spurious results, and consequently it is not possible to make meaningful inference. The tests suggested by Levin, Lin and Chu (2002) (LLC hereafter), Im, Pesaran and Shin (2003) (IPS hereafter); Dickey and Fuller (1979); Fisher (1932); and Philips & Peron (1988) have been used to check for the existence of panel unit root test. All these tests depend on whether there exists cross-sectional dependence or not, hence they are categorised into two generations. The first generation assume that individual series are cross-sectionally independent. On the other hand, the second generation relax this assumption and capture the cross-sectional dependence through a factor structure.

3.7.2 Endogeneity

It is the bias which usually arise from reverse causality, omitted variables and measurement error. Its presence usually this means that an independent variable is correlated with the disturbance term (Angrist and Pisscke, 2009). This results in inconsistent estimates and incorrect inferences that lead to misleading conclusions.

3.7.3 Autocorrelation

It is necessary to test for serial correlation in in the idiosyncratic error term in linear panel-data models as it presence results in biases in the standard errors and causes the results to be less efficient. Serial correlation is responsible for too optimistic standard errors (Torres, 2007). Therefore, to check for the presence of autocorrelation the study employed a Wooldridge test where the null hypothesis assumes no first- order autocorrelation. The XtSerial test by Wooldridge (2002) is very convenient as it requires relatively few assumptions and is easy to implement.

3.7.4 Multicollinearity Test

Multi-collinearity refers to a situation in which there exists an exact (or nearly exact) linear relation among two or more of the explanatory variables. The presence of perfect multi-collinearity can make the usual least squares analysis of the regression model dramatically inadequate. Methods of analysis cannot fully distinguish the explanatory factors from each other or isolate their independent influence. This may lead to paradoxical results with misleading individual p-values. In this study, the correlation matrix was used to detect the presence of multi-collinearity. The test contains values which ranges from zero to one with the main diagonal consisting of ones indicating correlation of a variable against itself and the offdiagonals indicate some level of correlation. If the absolute value of the correlation coefficient exceeds 0.8, there is serious problem of multi-collinearity and the results produced are biased due to large standard errors and covariance and this might as well lead to the acceptance of the false null hypothesis (type I error).

3.7.5 Heteroscedasticity

This entails testing whether the variance of the data is approximately equal to the variance of the model or whether the variance are all equal across the data. Determining the heteroscedasticity of the data is essential for determining if one can run typical regression models on the data. Testing for heteroscedasticity could be done using the stata command, xtgls fits panel-data linear models by using feasible generalized least squares or Xtest2 or Xttest3. This allows estimation in the presence of AR (1) autocorrelation within panels and cross-sectional correlation and heteroscedasticity across panels.

3.8 ESTIMATION

Given the nature of data in this research being panel or longitudinal/cross sectional time-series in which the behaviour. the Hausman test will be used to determine between fixed effects and random effects. Thereafter perform a linear regression of inequality in years lived on income inequality net of taxes and transfers, and control for possible confounders, namely GDP per capita, life expectancy, external mortality, HIV- prevalence, conflict, smoking and lung cancer mortality. This research uses unbalanced data due to as data unavailability challenges, but trust that the data will provide unbiased estimates since the missing values that found in this data are not systematically correlated with the independent variables.

Standard errors would be clustered on countries in order to account for the fact that observations from one country at different points in time are not truly independent observations in a cross-national- time series sample. Cameron and Traveli (2010), alludes that such treatment is necessary to ensure that findings are robust to arbitrary serial correlation and heteroscedasticity. The study will run three models for each region, which are SSA, OECD and World.

The correct model specification test will be guided by the Hausman test as to whether to adopt fixed effects or random effects.

The generic fixed effects model is specified as:

$$y_{it} = \beta_1 X_{it} + \alpha_i + \mu_{it} \quad (1)$$

The fixed effects with both country and year fixed effects

$$y_{it} = \beta X_{it} + \gamma_t + \alpha_i + \mu_{it} \quad (2)$$

Where, y_{it} is the dependent variable, mortality inequality Gini coefficient, where i is country and t is time. β is the matrix of time-variant fixed effects of the independent variables X_{it} = the time-variant 1 x k = the regressor vector where the independent variables are, the Gini coefficient of income inequality net of taxes and inequality, life expectancy, lung cancer mortality rate , GDP per capita(log squared), incidence of conflicts, external mortality rate, HIV-prevalence, and smoking rate. α_i (i=1…. n) is the unknown intercept for each entity (n entity-specific intercepts), while γ is year fixed effects. u_{it} is the error term.

3.9 ROBUSTNESS CHECKS

We will do some robustness checks to help validate our main findings and prove that they are reliable. By using different scenarios of changed assumptions we assess how the findings change. These include:

i) The alternative use of the dependent variable for the full life years of 100 and another for life years starting at 10 years to factor in infant mortality.

ii) We also analyse the results after factoring in time and country effects

iii) Another model will include heath system fixed effects

iv) Another without US which has high income inequality in OECD and South Africa in Sub Saharan Africa to see if these country are the key drivers of mortality inequality.

CHAPTER 4 ECONOMETRIC RESULTS

Econometric results would serve to signal social policy dynamics based on the association between income inequality and mortality. The specification of the econometric model, data sources and confounding variables used in the estimation procedure used to establish this association were discussed in the preceding chapter. This chapter begins with analysing the descriptive data which just shows the summary of all the data in its raw form. This is then followed by the results of diagnostics tests performed on the data to ensure our data conforms to underlying assumptions befitting the econometric analysis so as to produce estimates that are efficient and not misleading. The main regression results are then presented and discussed.

4.1 DESCRIPTIVE STATISTICS

Descriptive statistics represents a good yardstick that helps the researcher to visualize the raw data before further analysis is done, to show if there are any outliers or usual characteristics of the data. As indicated in Table 2 below the mean of average life expectancy for females at 64.99 years is higher than that of males at 59 years. This is consistent with findings by Esteban Ortiz-Ospina (2018). Meanwhile the mean of life expectancy in Sub-Saharan region is lower at 56 years than that OCED at 75 years. Similar inequality in years lived in the Sub Saharan region is less than that of years lived in the OECD region where incomes and standard of living are generally higher that in Sub Saharan Africa region populated by some of the world`s poorest countries. Meanwhile, the mean of the mortality Gini index of SSA for full life years is higher at 0.25 than that of OECD 0.12, which is consistent with statistics from WHO (2018). The mean of Gini Index of income is also higher in SSA (0.41) against that of OECD (.29) which is consistent with current trends from the OECD and WHO databases. Overall, the means of all the variables are as expected, while the ranges, standard deviations and variations of all the variables are quite small with no outliers identified. However, mortality from external causes and HIV-prevalence are positively skewed while incidence of conflict is negatively skewed.

Table 2 Descriptive Statistics

Table 1a: Descriptive Statistics Global

Variable	Obs	Mean	Std. Dev.	Min	Max
Female Mortality Gini	2487	.216	.097	.064	.857
Male Mortality Gini	2474	.239	4.996	.077	77.442
Male Average Life Expec	2446	59.86	12.04	11.876	81.604
Female Ave. Life Expec	2487	64.66	12.99	18.12	87.53
Income Gini	2341	.415	.686	.173	33
ln GDP	2316	6.88	1.36	1.21	10.054
ln smoking	2335	.937	.559	-.285	6.806
ln external mortality causes	2371	1.49	.516	.134	7.564
Incidence of Conflict	.	.	.	.	.
1	2473	.427	.495	0	1
2	2473	.573	.495	0	1

Table 1.b: Descriptive Statistics OECD Sample

Variable	Obs	Mean	Std. Dev.	Min	Max
Mortality Gini 0 to 100 years	1907	11.53	2.05	8.15	22.52
Mortality Gini 10 to 100 yrs.	1907	10.10	.013	0	15.45
Average Life Expectancy	1907	74.64	4.386	17.97	84.1
Income Gini	1861	29.24	5.54	.197	.52
Lung cancer mortality rate	1728	.429	.141	.082	.788
External mort rate	1695	.77	.371	.176	3.55

Table 1.c: Sub Descriptive Statistics: Sub Saharan Africa

Variable	Obs	Mean	Std. Dev.	Min	Max
Mortality Gini 0 100yrs	1246	.255	.057	.111	.41
Mortality Gini 10 100	1246	.169	.049	.078	.38
Average Life Expectancy	1241	55.928	7.64	21.789	76.272
Income Gini	1244	.441	.067	.318	.65
ln GDP per capita	1246	3.488	1.273	2.216	8.625
HIV Prevalence	1246	5.134	6.543	0	28.2
Incidence of Conflict	1246	.258	.552	0	2

Source: Author`s Own Calculations based of UN, WIILD4, OECD and WHO database

4.2 DISCUSSION OF RESULTS

The findings are consistent with previous research by Wilkinson (2002) and Neumayer (2018) that found positive cross sectional associations between income inequality and mortality inequality. Results in Table 3 show the key variable of major interest, for the SSA region, the coefficient of income inequality to be positive and statistically significant at 5%. The coefficient of income inequality was also positive and statistically significant at the 10% level of significance for OCED sample/region.

The results show that a unit increase in income inequality is associated with in a rise in mortality inequality by 0.0133 and 0.0175 respectively, for OECD and SSA region where the impact of income inequality is stronger.

This finding is consistent with the work of Sen (1985) who found a positive association between income inequality and mortality inequality and also postulated that income is instrumental in reaching key welfare goals of which mortality is the ultimate outcome of welfare. However, there is a stronger association in the SSA region where Table 2, the descriptive statistics shows income inequality is highest at an average of 44%, compared to 29% in OECD region The stronger association in low income countries could be explained by the income convergence theories where the developing countries are still trying to play catch up and coming from a very low base income base as well as adapting to medical technologies that are pivotal in improving life expectancy, which again is still lagging behind that of the developed countries.

The coefficient of life expectancy was negatively and statistically significant at 10% for all the three regions. The results for OECD imply that a unit increase in life expectancy will lead to a fall in inequality of mortality by 0.00484 for full life years and by 0.00213 after factoring in infant mortality. This finding is consistent with the general improvement in mortality inequality which has been corresponding to unparalleled gains in life expectancy, recorded all over the world (Riley, 2005). Reinforcing these results is research by Wilmoth and Horiuchi (1999) who found a strong, negative association between life expectancy and mortality inequality. However, the SSA region whose average life expectancy was 56 years is lower than that of OECD at 75 years, has a stronger association as SSA is still developing its health systems and behind in adopting medical technology and is therefore catching up on the gains in longevity already made by countries in the OECD region.

Table 3 Regression Results from fixed effects models linking mortality inequality and income inequality

VARIABLES	OECD(1) Mortality Gini 0 to 100 years	OECD(2) Mortality Gini 10 to 100 years	SSA(3) Mortality Gini 10 to 100years	SSA(4) Mortality Gini 0 to 100years
Life Expectancy	-0.00484***	-0.00213***	-0.00252***	-0.00237***
	(0.00112)	(0.000402)	(0.000596)	(0.000443)
Income Gini	-0.0118	0.0133**	0.0175*	0.0445
	(0.0114)	(0.00497)	(0.0989)	(0.0801)
Log GDP per capita	0.00301	-0.000829	-0.00157	0.00243
	(0.00191)	(0.000700)	(0.00632)	(0.00520)
Log Alcohol	-0.00245	0.000490		-0.00105
	(0.00173)	(0.000809)		(0.000721)
Lung Cancer Mort	0.00479	-0.00104		0.00616*
	(0.00440)	(0.00279)		(0.00352)
External Mortality	0.00162	-0.000355		0.00624
	(0.00113)	(0.000601)		(0.00512)
Life Expectancy(female)				
Life Expectancy(male)				
HIV-Prevalence			-0.00109	
			(0.000862)	
Incidence of Conflict (less than 100 deaths)			0.00927**	
			(0.00387)	
Incidence of Conflict (1000 deaths)			0.0117*	
			(0.00662)	
Constant	0.460***	0.258***	0.262***	
	(0.0714)	(0.0248)	(0.0447)	
Observations	1,354	1,354	1,239	
R-squared	0.924	0.877	0.698	
Countries	34	34		
Countries			44	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

(1) Results from regressing mortality inequality over the full life of from 0 to 100 years for OECD sample
(2) Results from regressing mortality inequality conditional upon survival from 10 to 100 years for OECD sample
(3) Results from regressing mortality inequality over the full life of from 0 to 100 years for SSA sample
(4) Results from regressing mortality inequality conditional upon survival from 10 to 100 years for SSA sample

On average, considering full life years, countries characterized by conflict categorized by at least 100 deaths per year have a mortality Gini-coefficient which is higher by 0.00927 than countries without conflict. Meanwhile, after factoring in infant mortality countries characterized by high incidence of conflict of more than 1000 people per year have a 0.117 higher mortality inequality than peaceful countries. These estimates are significant at 10% level of significance. This is consistent with finding by Neumayer and Plumber (2006), find that over the entire conflicts interstate and civil wars reduce chance of longevity. The coefficient of conflict is statistically insignificant at the global level and the OECD region.

The coefficients of the rest of confounding variables that were controlled for that include GDP per capita, external mortality causes, prevalence of smoking, prevalence of HIV, are all statistically insignificant in all the samples except for lung cancer mortality showing a statistically significant coefficient in the SSA only, conditional upon survival to ten years with a coefficient of 0.00616. This means that a unit increase in lung cancer mortality will increase mortality inequality by 0.00616. With greater affordability of tobacco products, however, smoking prevalence in many sub-Saharan African countries has started to rise, and this increase has been predicted to continue if appropriate tobacco control interventions are not implemented (Blecher and Ross, 2013). The impact is exacerbated by the weak law enforce effective tobacco control policies in order to reduce smoking prevalence in these poor countries in SSA where budgetary allocations towards public health expenditures are thin facilities.

Variations in impact of confounding factors on mortality inequality after factoring in infant mortality in SSA region and show that infant mortality in some countries, particularly the Sub Saharan region is still a major driver of mortality inequality. This is in contrast with previous researches by Avendano (2012); Mackenbac (2015) and Neumayer and Plumber (2018) which found insignificant associations between income inequality and mortality inequality after factoring in infant mortality.

4.2.1 Mortality Inequality by Gender

The association between income inequality and mortality inequality was statistically, insignificant in the global sample, where the Gini coefficient of mortality inequality is factoring in gender as shown in Table 4 below. Therefore, income disparities by gender do not appear to affect mortality inequality, or that gender differences in mortality inequality may not be accounted for by income inequality.

Similarly, at a global level there is a strong negative association between life expectancy and mortality inequality for both males and females. The association is stronger for females where a unit increase in life expectancy will result in a decrease in mortality inequality by 0.00480 while for a unit increase in life expectancy for males will lead to a decrease in mortality inequality by 0.00388. This is also consistent with world averages where there are higher chances of living more life years by females as found in the paper by Esteban Ortiz-Ospina (2018).

Table 4 Regression Results from fixed effects models linking mortality inequality by gender and income inequality

VARIABLES	Global(1) Mortality Gini(female)	Global(2) Mortality Gini(male)
Income Gini	**0.000489**	**0.000302**
	(0.000158)	**(0.000185)**
Log GDP per capita	**-0.000141**	**0.000599**
	(0.00159)	**(0.00173)**
Log Alcohol		
Lung Cancer Mort		
External Mortality		
Life Expectancy(female)	**-0.0048*****	
	(0.000520)	
Log Smoking	**-0.00340**	**-0.00200**
	(0.00698)	**(0.00607)**
External Mort Causes	**-0.00108**	**0.00376**
	(0.00589)	**(0.00533)**
Incidence of conflict-2		
Life Expectancy(male)		**-0.00388*****
		(0.000802)
HIV-Prevalence		
Incidence of Conflict (less than 100 deaths)	**-0.00239**	
	(0.00520)	
Incidence of Conflict (1000 deaths)		
Constant	**0.582*****	**0.504*****
	(0.0440)	**(0.0449)**
Observations	**1,282**	**1,257**
R-squared	**0.666**	**0.813**
Countries	**107**	**105**
Countries		

Robust standard errors in parentheses

***** p<0.01, ** p<0.05, * p<0.1**

(1) Results from regressing mortality inequality(female) over the full life of years for Global sample

(2) Results from regressing mortality inequality(male) over the full life of years for Global sample

4.3 DIAGNOSTIC TESTS

Diagnostic tests were conducted in order to assert adequacy of the data to the fixed effects regression model with clustered standards errors. Tests done include the test for unit root, endogeneity, multi-collinearity autocorrelation, normality and heteroscedasticity by time and by cross. Appendices A, B, C, D, E, F and G show results of diagnostic tests.

Endogeneity bias which usually arise from reverse causality, omitted variables and measurement error Usually this means that an independent variable is correlated with the disturbance term (Angrist and Pisscke, 2008). This results in inconsistent estimates and incorrect inferences that lead to misleading conclusions. Fairly reliable data was obtained from reputable statistical agencies of OECD, UN Lifetables and World Health Organization`s European Health for all database.

4.3.1 Multi-collinearity

Multi-Collinearity occurs when two or more explanatory variables are highly correlated to each other such that they do not provide unique or independent information in the regression model. A Pearson's correlation test was carried out for all the variables. Variables are correlated if the correlation statistic is more than 0.8 or less than -0.8. The results of the test showed that there was low correlation among explanatory variables. The results show that all the absolute values of the partial correlation coefficient are less than 0.8 as shown in Appendix A. This implies that there is no multi-collinearity among the variables. Therefore, we can isolate individual effects of explanatory variables on the explained variable.

4.3.2 Unit Root Test

Stationarity was tested using the Augmented Dickey Fuller Fisher Type unit root Test which is suitable such unbalanced data. The null hypothesis is that the series in the panel contains a unit root and the alternative hypothesis allows for the series to have no unit roots. Appendix B and C, shows all the results for the unit root tests done. Based on these the null hypothesis is rejected. The p-value of the P, Z, L* and Pm tests are all smaller than 0.01, at the 1% level of statistical significance. This means there are no unit roots in our panels under the given test conditions (included panel mean and time trend). Refer to Appendix C for more results on unit root tests.

4.3.5 Heteroscedasticity and Serial Autocorrelation

Serial autocorrelation and Heteroscedasticity were present in the data. We tested Serial Autocorrelation using the XTserial test (Wooldridge, 2002) while heteroscedasticity was tested using the Httest and ttest3. (Refer to Appendix 4,5,6 for graphical representation of data). We corrected these using the –vce (robust)- option in stata to calculate the variance co variance matrix and adjust the standard errors so that they are valid.

Because our data exhibited cross- sectional heterogeneity we then accounted for it using health care system fixed effects, which was informed by Bo¨ hm et al.'s classification, which groups healthcare systems according to a deductively generated typology by Rothgang and Wendt (2013). This is guided by three core dimensions of the healthcare system: regulation, financing, and service provision, and three types of actors: state, societal, and private actors. One of the models included the dummies for health care systems while another did not include the dummies, but instead used the generalized least squares test to correct for heteroscedasticity and serial autocorrelation.

Since our data depicted some strong trends over time emanating from the fact that over time, medical and other progress that reduces infant mortality and premature deaths positively impacts on longevity inequality. The resultant upward trend in life expectancy will trigger a downward trend in mortality inequality which is desirable.

Countries with large population sizes could be inherently more heterogeneous, but population size did not contribute significantly to our estimation model and we therefore did not include it as a control variable and long-term negative health impacts of armed conflict on life years.

4.3.6 Model Specification: Hausman Test

To determine between the fixed effects and random effects the Hausman test was duly conducted. The null hypothesis is that the preferred model is random effects model versus the alternative model of fixed effects (Green, 2008). This model tests whether unique errors (u_{it}) are correlated with regressors, guided by the null hypothesis that the errors are not correlated. If the p-values is less than 0.05. the model is significant and we therefore use fixed effects as shown in Appendix H.

The Fixed Effects(FE) model was therefore used since the study is aimed at analyzing the association of variables that change over time. Fixed effects explore the relationship between predictor and outcome variables with countries and each country does have individual characteristics that may or may not influence the opinion towards certain issues such as the GDP per capita, income inequality, political systems. This is the rationale behind the assumption of the association between a county`s error term and predictor variables. Fixed effects therefore eliminates the impact of those time invariant characteristics so we can measure the net effect of the predictors on the outcome variable.

The FE model also assumes that the time invariant characteristics are exclusive to the individual country, hence each country is different and therefore its error term and the constant that captures individual characteristics should be independent. To allow for within country correlation, between error terms, we used clustered sandwich estimators to permit for within-country correlation between error terms (Wooldridge, 2010).

4.4 ROBUSTNESS CHECK

Table 5 below shows results for the same regression as above but excluded South Africa with the highest income inequality and HIV-prevalence in the SSA region (1) and (2) and excluded USA from the OECD (3) and (4) region since it has the most unequal society.

Table 5 Regression results excluding South Africa from SSA and US from OECD

	SSA		OECD	
	(1)	(2)	(3)	(4)
VARIABLES	Mortality Gini 0 to 100 years	Mortality Gini 10 to 100 years	Mortality Gini 0 to 100 years	Mortality Gini 10 to 100 years
Average Life Expectancy	-0.00252***	-0.00237***	-0.00484***	-0.00213***
	(0.000596)	(0.000443)	(0.00112)	(0.000402)
Income Gini Coefficient	0.175*	0.0445	-0.0118	0.0133**
	(0.0989)	(0.0801)	(0.0114)	(0.00497)
Log GDP per capita	-0.00157	0.00243	0.00301	-0.000829
	(0.00632)	(0.00520)	(0.00191)	(0.000700)
Log Alcohol Consumed			-0.00245	0.000490
			(0.00173)	(0.000809)
Lung cancer Mortality			0.00479	-0.00104
			(0.00440)	(0.00279)
External Mortality Rate			0.00162	-0.000355
			(0.00113)	(0.000601)
HIV Prevalence	-0.00109	-0.00105		
	(0.000862)	(0.000721)		
Incidence of Conflict 1	0.00927**	0.00616*		
	(0.00387)	(0.00352)		
Incidence of Conflict 2	0.0117*	0.00624		
	(0.00662)	(0.00512)		
Constant	0.262***	0.387***	0.460***	0.258***
	(0.0447)	(0.0449)	(0.0714)	(0.0248)
Observations	1,239	1,239	1,354	1,354
R-squared	0.698	0.813	0.924	0.877
Number of countries	44	44		
Number of countries			34	34

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(1) Results from regressing mortality inequality over the full life of from 0 to 100 years for SSA region after dropping South Africa
(2) Results from regressing mortality inequality conditional upon survival from 10 to 100 years for SSA region after dropping South Africa
(3) Results from regressing mortality inequality over the full life of from 0 to 100 years for OECD region after dropping United States
(4) Results from regressing mortality inequality conditional upon survival from 10 to 100 years for OECD region after dropping United States

The results are quite similar to the main regression results in table 2. The coefficient of income inequality is statistically significant at 10% for SSA and 5% for OCED, showing a positive association with mortality inequality. The magnitude of this association is the same as when the two countries had not been dropped. This serves to show whether the results were driven by the presence of South Africa, the most unequal society in sub-Saharan Africa amoung the low income and developing countries, and United States which is most unequal in mortality and relatively high income inequality amoung the OCED group of developed and high income countries. The estimation dropped these two countries from the respective samples to determine the extent to which they determined the results. The findings showed that the variables of key interest, the income inequality, life expectancy and incidence of conflict were very robust across the new different samples, thereby giving credibility to the main regression findings.

4.5 LIMITATIONS

Data availability was limited particularly for some low income countries. While, computation of inequality in years lived is based on the UN Life Tables, due care may be exercised when making inference to such data as the completeness of the submissions of the data from censuses and death records available for the population in question, varies from one country to the next.

Knowing causes of death facilitates designing and targeting of appropriate health interventions to save lives. However, in 2013, 56 per cent of the deaths worldwide were not officially reported (GBD 2015 Mortality and Causes of Death Collaborators 2016), implying that the causes of these deaths remain unknown. This scenario is more prevalent in most sub-Saharan African countries where death registration is incomplete due to inefficient and rudimentary civil registration and vital statistics systems (World Health Organization 2010; United Nations, 2015). The coverage of death registration is less than 25 per cent in majority of the sub-Saharan African countries (World Health Organization, 2010). This therefore calls for caution when making inferences using results for the SSA region, from this study.

Gini coefficients are not unique. It is possible for two different Lorenz curves to give rise to the same Gini coefficient. Furthermore, it is probable for the Gini Index of a developing country to increase (due to increasing inequality of income), while the number of people in absolute poverty declines, since the Gini coefficient is a relative measure of income. Another limitation of the Gini coefficient is that it is not additive across groups, i.e. the total Gini of a society is not equal to the sum of the Gini's for its sub-groups. Thus, country-level Gini coefficients cannot be aggregated into regional or global Gini's, although a Gini coefficient can be computed for the aggregate. Because the underlying household surveys differ in methods and types of welfare measures collected, data are not strictly comparable across countries or even across years within a country. Two sources of non-comparability should be noted for distributions of income in particular. First, the surveys can differ in many respects, including whether they use income or consumption expenditure as the living standard indicator.

The distribution of income is typically more unequal than the distribution of consumption. In addition, the definitions of income used differ more often among surveys. Consumption is usually a much better welfare indicator, particularly in developing countries.

This study however, only relied on the WIILD which is a reliable source data for the Gini Index and did not use other sources which could have caused comparability challenges.

CHAPTER 5 CONCLUSION

This chapter presents the summary, conclusion and policy recommendations before suggesting areas for future research.

5.1 SUMMARY AND CONCLUSION

The study examined the extent to which inequality in mortality is explained by income inequality. This was premised on the argument that the level of income inequality accounts for disparities in opportunities to good health which are reflected through inequality in mortality. It was envisaged that more unequal societies have a wide range of social problems such as physical and mental health, educational performance, violence, imprisonment or social immobility to the extent that people who live in disadvantaged circumstances have poorer health, more disability and shorter lives than those who are more affluent (Wilkinson, 2006 and Wilkinson & Pickett, 2009). In like manner some studies have found persons with a lower socioeconomic status experiencing poorer health status and ultimately, higher mortality. Since, it can also be argued that the number of years lived essentially indicates a certain level of welfare, this brings in another dimension in which overall societal inequality is increasing (Currie and Schwandt, 2016).

The study also delved into prior research work in the subject matter, detailing how the inequalities are measured, providing justification for further research and critical value addition to literature emanating from this thesis before outlining the organization of the write up. Literature review showed evidence of reduced inequality in mortality which was consistent with improvements in life expectancy. While much interest has been on income inequality, social policy has now broadened its span towards inequalities in health (Lynch, Smith & Harper, et al., 2014). Inequalities in health have a tremendous bearing on longevity since they affect the ability to perform essential life cycle tasks, as ultimately, the prematurely dead have been deprived of everything. Therefore, greater income inequality between households is systematically associated with greater inequality in non-income outcomes (UNDP, 2015). This notion is supported by Wilkinson, (1992) who postulated the hypothesis that income inequality was not simply a summary of the balance of income between the rich and poor, but is a health risk in its own right. However, persistent disparities in inequality in years lived across countries provided a basis for further research to substantiate the association between disparities in incomes and inequality in lifespan (Currie, 2018).

Numerous researchers argued, that there has been a mixed trend with mortality gaps widening across some geographic areas and certain educational groups, while narrowing in others (Murray et al. 2006). There is an overall trend of increasing life expectancy, with high-income countries having the highest longevity (regional life expectancy of 65 years in 1950–55 up to 78.6years in 2010–15) amoung OECD members. At the other extreme, Sub-Saharan African region has the lowest life expectancy.

Since mortality can arguably be considered the ultimate measure of health, variations in life expectancy imply lifespan inequalities. For this reason, the study of lifespan variability has become topical in the last decade or so (Edwards, Tuljapurkar, 2005; Engelman, Canudas-Romo, Agree, 2010; Van Raalte, Zhang, Caswell, 2013 and Gillespie, Trotter and Tuljapurkar, 2014). Given the improvements in life expectancy and its importance in measuring welfare, the increasing incidence of inequality in years lived surely heralds a captivating dimension in which overall societal inequality is increasing. For example, improvements in longevity in South Korea was accompanied by rapid economic growth beginning with the 1960s with GNI per capita increasing from less than US$100 in 1960 to US$200 in 2007. Moreso, improvements in living standards, nutrition, healthcare have often been cited as major contributors to Korea`s impressive improvements in health.

A possible link between mortality inequality and income inequality is through the health-material pathway derived from the “absolute income hypothesis” by Wilkinson (2006). The mechanism is such that, in the event of a monetary transfer from the rich to the poor, the average income remains unchanged, while income disparity decreases. The ultimate impact on inequality in mortality resulting from a monetary transfer for the health of the poor would result in a significant access to opportunities for a longer life because the additional money would allow the acquisition of goods and services that would improve health status of the poor and consequently decrease inequality in mortality of the society at large. However, the transfer would not negatively affect the health of the rich with the same strength as it would positively impact the health of the poor. This outcome is attributable to the non-linear relationship between income and health at individual level, where an increase in income results in stronger health gains for the poor than for the rich.

Income inequality is likely to impact on inequality in mortality as political decision-making is skewed to the wealthy who exercise strong influence via lobbying and donations suppressing the poor, whose chances of voting are slim. In this vein, more economically unequal societies will be characterized by more unequal access to political decision-making thereby translating to unequal access to economic opportunities and consequently unequal opportunities to increased livelihoods (Gilens, 2012). Policies are skewed in favor of the rich and powerful while the poor, who are dependent on public health systems are exposed to the vagaries of systems that deny them basic opportunities for survival.

Our research findings are comparable to previous studies that found positive cross-sectional association between income inequality and mortality inequality. We strengthened the evidence by extending our study to a global sample of 178 countries where we regressed mortality inequality on income inequality using a fixed effects model which considered a set of socio economic and disease-specific mortality indicators.

The research found a significant positive relationship between income inequality and mortality across the three samples studied. The association was strongest in Sub Saharan Africa countries, whilst weaker in the OECD. Notably other confounding factors showed strong associations with mortality inequality, for instance incidence of conflict and lung cancer mortality which were in SSA. This is consistent with the fact that mortality in developing countries is driven by communicable diseases of which HIV-prevalence remains highest in this region while several SSA member countries have been characterized by the end of colonization which was preceded by civil strife which all increase risks of dying thereby impacting negatively on mortality inequality. There was a significant negative association between life expectancy and mortality inequality across all the three regions under study.

The correlation on mortality inequality with confounding variables was generally weaker in the OECD region due to their well-developed welfare system, especially in some northern and continental European countries, which may help to buffer the adverse effect of impacts on health and ultimately on mortality inequality.

We can only speculate which country characteristics might be responsible for the disappearance of the effect, and suspect that these are historical, social or cultural factors that are associated with both the hierarchical nature of societies, as indicated by income inequality, and the health of their populations. Unfortunately, many of these factors are not available in international databases.

5.2 POLICY IMPLICATIONS AND RECOMMENDATIONS

It is therefore apparent that policy makers need to focus on income inequality as well as the redistributive effects of income from the rich to the poor to advance population health outcomes. Since income inequality and policies that reduce it have a substantively important association with longevity inequality it implies that societies that are more unequal in income are also more unequal in number of years lived. Governments can indirectly influence income inequality via, for example, investment in education and infrastructure and the regulation of markets. They can redistribute incomes directly via taxes and transfers. Governments can thus affect longevity inequality well beyond any specific health care policies or health and safety regulations.

There is a strong impetus driving social policy innovation given that a few confounding variables were statistically significant. This is because underlying factors determining both income inequality and mortality inequality could be social and health policies that vary across countries and are persistent over time. For example, poverty reduction policies such as minimum wage, disability allowances and return to work programs can reduce income inequality and simultaneously improve average population health by improving health of the poorest part of the population. Besides these, health care programs such as smoking cessation strategies, maternal education programs and cancer screening may also play roles since they tend to cluster in countries with strong redistribution policies, although without having a direct impact on income inequality (Avendano, 2012).

Further research is necessary to find appropriate measures for the relevant country characteristics and test their effects on the association between income inequality and mortality. One underlying factor determining both income inequality and mortality could be social and health policies that vary across countries and are persistent over time.

Other responsible factors could be some cultural and historical elements of a country, e.g. egalitarianism (importance of transcending self-interest and promoting the welfare of others), power distance (extent to which the less powerful accept that power is distributed unequally) and ethnic heterogeneity, breeding conflicts which may negatively impact on distribution of resources , leaving out the poor and vulnerable members of societies which are potentially important determinants of population health (Alesina, Baqir and Easterly, 1999), and at the same time could be related to income inequality (Kraal Roseland and Wrench, 2009).

This study was instrumental in avoiding unjust generalizations as it analysed a wide spectrum of both developed and developing countries. Finally, as with all researches that use observational data, fundamental extrapolations from our analysis cannot be made with certainty.

5.3 AREAS FOR FUTURE RESEARCH

This is in indeed a growing area of research, whose contributions have a great impact on social policy innovation, given the rising global interest in social policy development in the wake of the global threats to humanity such as the COVID 19 pandemic which reverse gains made in longevity over the past 50 years. In order to improve social policy innovation, it will be worthwhile to further test the causal mechanisms by which income inequality impact mortality inequality.

Furthermore, research could be devoted to inequality of opportunities which has been argued to result in worse social outcomes than income inequality thereby causing glaring inequalities in life that all sum up to widening chances of longevity amoung societies. While this research covered a wider and bigger sample of the global population, casual inferences from such observational data may not be made with certainty on most developing countries where data was scarce.

Future studies could focus on establishing causality between mortality inequality and income inequality. Thereafter, more research could be committed to the various stimuli through which income redistribution could reduce mortality inequality gaps.

There is more compelling evidence to do further research that includes the countries left out as and when information availability improves, given that many confounding variables were statistically significant.

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APPENDIX A Correlation Results

a: Global Sample: Correlation results

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Life Expec(female)	1.000					
(2) Income Gini	-0.039	-0.055	1.000			
(3) log Smoking	0.017	0.004	-0.018	1.000		
(4) log Ext Mortality	-0.081	-0.066	0.021	-0.027	1.000	
(6) Incidence of Conflict	-0.035	-0.016	-0.014	-0.038	0.088	1.000

b: Sub Saharan Africa: Correlation Results

Variables	(1)	(2)	(3)	(4)	(5)
(1) Life Expec	1.000				
(2) Income Gini	-0.070	1.000			
(3) log GDP per capita	-0.025	0.248	1.000		
(4) HIV Prevalence	-0.038	0.664	0.045	1.000	
(5) Conflict	-0.017	-0.132	0.020	-0.172	1.000

c: OECD Multi-Collinearity Test Results

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Life Expectancy	1.000					
(2) Income Gini	0.105	1.000				
(3) Log GDP	0.691	-0.065	1.000			
(4) Lung Cancer Mort Rate	0.058	-0.033	0.062	1.000		
(5) Log Alcohol Consumption	-0.083	-0.038	-0.051	0.276	1.000	
(6) External Mortality	-0.091	-0.115	-0.055	-0.056	0.014	1.000

APPENDIX B Unit Root Tests

Stationarity Mortality Gini(Male)
Fisher Test for panel unit root using an augmented Dickey-Fuller test (2 lags)
Ho: unit root
chi2(0) = 0.0000
Prob > chi2 = .

Stationarity Mortality Gini(Female)
Fisher Test for panel unit root using an augmented Dickey-Fuller test (2 lags)
Ho: unit root
chi2(0) = 0.0000
Prob > chi2 = .

Stationarity Life Expectancy(Female)
Fisher Test for panel unit root using an augmented Dickey-Fuller test (2 lags)
Ho: unit root
chi2(0) = 0.0000
Prob > chi2 = .

Stationarity Life Expectancy(Male)
Fisher Test for panel unit root using an augmented Dickey-Fuller test (2 lags)
Ho: unit root
chi2(0) = 0.0000
Prob > chi2 = .

Stationarity Income Gini
Fisher Test for panel unit root using an augmented Dickey-Fuller test (2 lags)
Ho: unit root
chi2(0) = 0.0000
Prob > chi2 = .

Stationarity GDP per capita
Fisher Test for panel unit root using an augmented Dickey-Fuller test (2 lags)
Ho: unit root
chi2(0) = 0.0000
Prob > chi2 = .

Stationarity Smoking
Fisher Test for panel unit root using an augmented Dickey-Fuller test (2 lags)
Ho: unit root
chi2(0) = 0.0000
Prob > chi2 = .

.

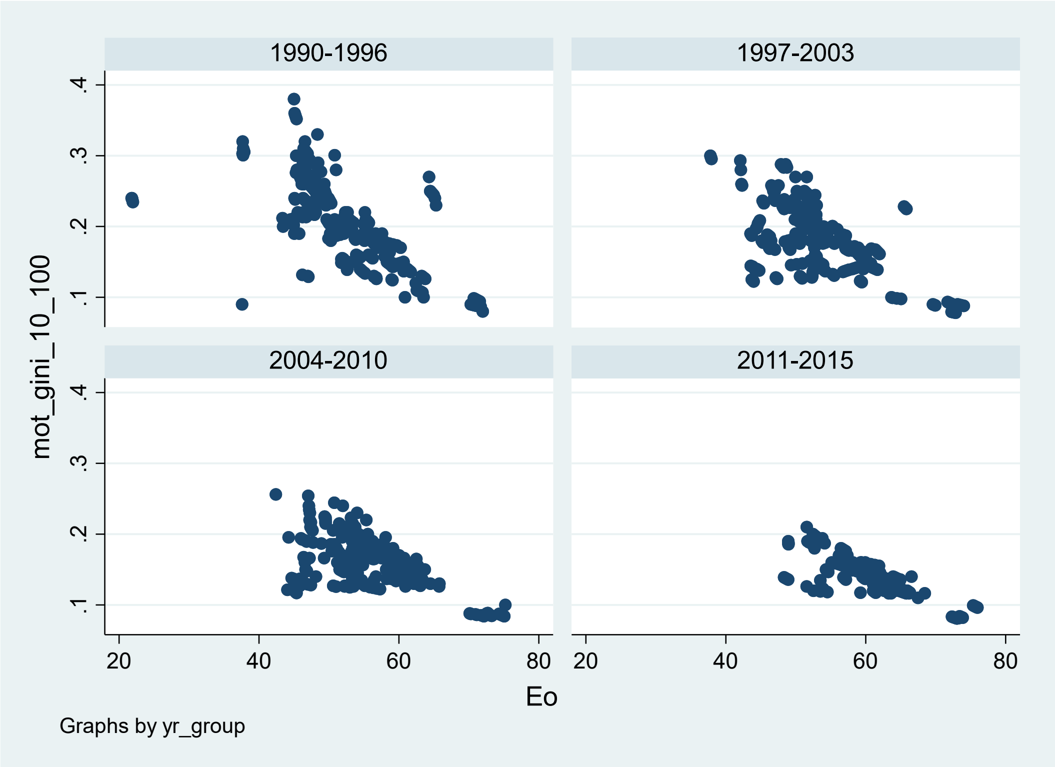
APPENDIX C Sub Saharan Sample: Stationarity tests

Estimated covariances	= 44	Number of obs =	1,196	
Estimated autocorrelations	= 0	Number of groups =	44	
Estimated coefficients	= 7	Obs per group:		
	min =	22		
	avg =	27.18182		
	max =	28		
	Wald chi2(6) =	1858.15		
Log likelihood	= 2251.92	Prob > chi2 =	0.0000	
mot_Gini_0~0 Coef.	Std. Err.	Z	P>z [95% Conf.	Interval]
Eo				
D1. -.0014764	.0004052	-3.64	0.000 -.0022707	-.0006822
income_Gini -.0434498	.0167228	-2.60	0.009 -.0762259	-.0106737
ln_gdp -.0075924	.0005818	-13.05	0.000 -.0087328	-.0064521
hiv_prev -.0013876	.0001271	-10.92	0.000 -.0016368	-.0011385
conf				
1 .0312406	.0023136	13.50	0.000 .0267061	.0357751
2 .0422218	.0038976	10.83	0.000 .0345826	.0498609
_cons .2947592	.0059492	49.55	0.000 .2830989	.3064195

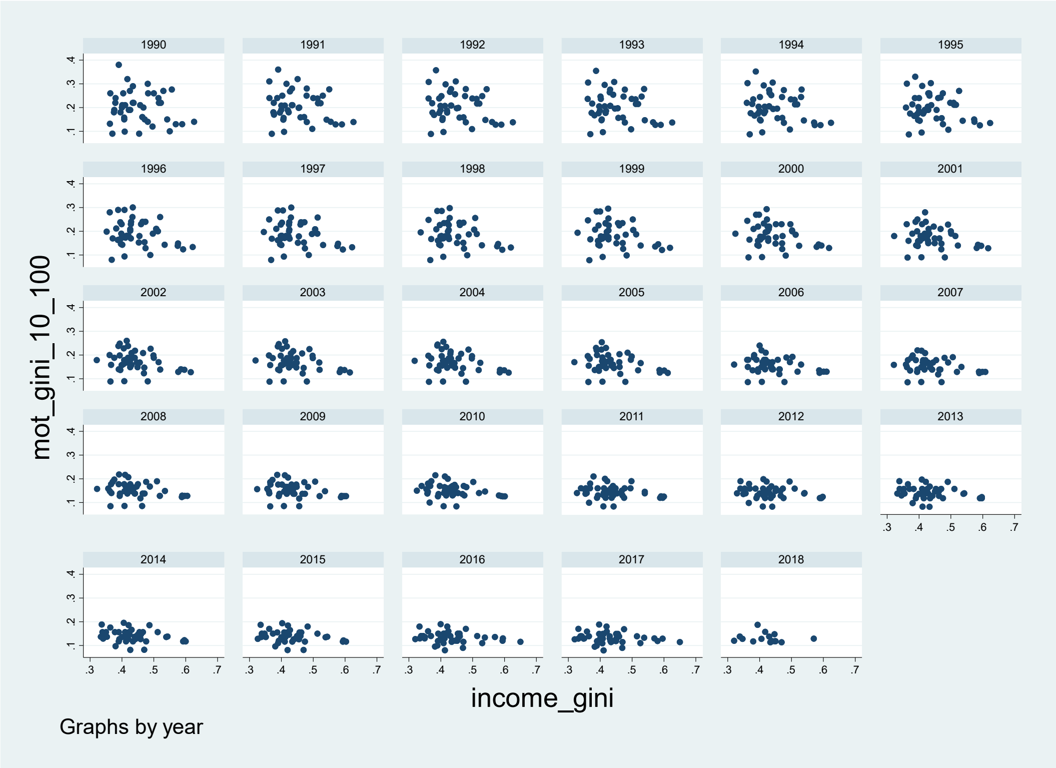
APPENDIX D Global Samples: Normality Tests

Skewness/Kurtosis tests for Normality	
joint ------	
Variable Obs Pr(Skewness) Pr(Kurtosis) adj	chi2(2) Prob>chi2
mot_Gini_0~0 1,907 0.0000 0.0004	. 0.0000
. sktest mot_Gini_10_100	
Skewness/Kurtosis tests for Normality	
joint ------	
Variable Obs Pr(Skewness) Pr(Kurtosis) adj	chi2(2) Prob>chi2
mot_Gini_1~0 1,907 0.0000 0.0000	. 0.0000
. sktest ln_gdp	
Skewness/Kurtosis tests for Normality	
joint ------	
Variable Obs Pr(Skewness) Pr(Kurtosis) adj	chi2(2) Prob>chi2
ln_gdp 1,613 0.0000 0.0000	. 0.0000
. sktest ln_alcohol	
Skewness/Kurtosis tests for Normality	
joint ------	
Variable Obs Pr(Skewness) Pr(Kurtosis) adj	chi2(2) Prob>chi2
ln_alcohol 1,734 0.0000 0.0000	. 0.0000
.	

APPENDIX E Linearity Tests for Global Sample (life expectancy vs Mortality Inequality



APPENDIX F Linearity Tests for Global Sample (Mortality Inequality Vs Income Inequality)



APPENDIX G   Linearity Test: HIV vs Mortality Gini

APPENDIX H Hausman Test

	Statistic	Coefficient
Global	Chi Square	40.412
	P Value	0.00000
OECD	Chi-Square	30.569
	P. Value	0.00000
Sub Saharan Africa	Chi-Square	38.3666
	P. Value	0.00000

APPENDIX I Study Sample by country and main study variables

Country	Start and end year	Gini of Mortality	Gini Of Income
		Entire life tables	
Afghanistan	1950	0.36	0.30
	2015	0.21	0.31
Albania	1960	0.32	0.38
	2015	0.10	0.38
Algeria	1955	0.36	0.52
	2015	0.15	0.34
Angola	1955	0.38	0.46
	2017	0.25	0.45
Antigua and Barbuda	1950	0.25	0.46
	2015	0.11	0.43
Argentina	1950	0.23	0.41
	2015	0.13	0.39
Armenia	1965	0.23	0.32
	2015	0.10	0.36
Australia	1950	0.15	0.30
	2015	0.10	0.33
Austria	1955	0.17	0.29
	2015	0.09	0.28
Azerbaijan	1950	0.33	0.28
	2015	0.13	0.23
Bahamas	1950	0.19	0.52
	2015	0.12	0.44
Bahrain	1955	0.35	0.47
	2015	0.09	0.45
Bangladesh	1955	0.36	0.39
	2015	0.17	0.44
Barbados	1950	0.33	0.45
	2015	0.15	0.32
Belarus	1960	0.17	0.27
	2017	0.12	0.25
Belgium	1960	0.14	0.34
	2017	0.09	0.26
Belize	1955	0.26	0.70
	2015	0.16	0.48
Benin	1950	0.38	0.48
	2018	0.28	0.45
Bhutan	1955	0.36	0.41
	2015	0.19	0.37
Bolivia	1960	0.37	0.54
	2015	0.24	0.44
Bosnia and Herzegovina	1955	0.24	0.34

Country	Start and end year	Gini of Mortality	Gini Of Income
		Entire life tables	
	2015	0.08	0.39
Botswana	1955	0.32	0.59
	2017	0.18	0.53
Brazil	1955	0.31	0.54
	2015	0.16	0.45
Bulgaria	1955	0.27	0.25
	2017	0.11	0.33
Burkina Faso	1955	0.37	0.46
	2017	0.27	0.36
Burundi	1955	0.37	0.39
	2017	0.24	0.40
Cabo Verde	1955	0.32	0.51
	2017	0.13	0.41
Cambodia	1955	0.32	0.38
	2010	0.18	0.34
Cameroon	1950	0.38	0.55
	2017	0.22	0.41
Canada	1950	0.18	0.36
	2016	0.09	0.30
CAR	1955	0.39	0.52
	2017	0.26	0.47
Chad	1955	0.37	0.42
	2018	0.29	0.39
Chile	1950	0.31	0.30
	2017	0.10	0.45
China	1950	0.30	0.56
	2015	0.10	0.42
Hong Kong	1955	0.20	0.39
	2015	0.10	0.41
Colombia	1955	0.30	0.59
	2015	0.16	0.50
Comoros	1955	0.35	0.57
	2015	0.21	0.52
Congo	1955	0.33	0.43
	2016	0.19	0.45
Costa Rica	1960	0.27	0.51
	2015	0.13	0.48
Côte d'Ivoire	1955	0.42	0.43
	2017	0.23	0.41
Croatia	1960	0.17	0.29
	2015	0.09	0.29
Cuba	1960	0.23	0.35
	2015	0.11	0.37

Country	Start and end year	Gini of Mortality Entire life tables	Gini Of Income
Cyprus	1965	0.16	0.32
	2015	0.08	0.32
Czech	1950	0.17	0.32
	2017	0.09	0.26
Korea	1960	0.29	0.30
	2015	0.29	0.30
Denmark	1950	0.14	0.40
	2017	0.09	0.27
Dominican Republic	1950	0.37	0.51
	2015	0.20	0.44
Djibouti	1990	0.29	0.40
	2018	0.21	0.45
Ecuador	1950	0.33	0.68
	2015	0.17	0.43
Egypt	1955	0.43	0.37
	2015	0.12	0.32
El Salvador	1960	0.34	0.50
	2015	0.18	0.40
Equatorial Guinea	1955	0.39	0.52
	2017	0.24	0.46
Eritrea	1955	0.37	0.43
	2010	0.18	0.41
Estonia	1950	0.27	0.26
	2017	0.11	0.26
Eswathini	1955	0.35	0.65
	2017	0.19	0.60
Ethiopia	1955	0.37	0.40
	2017	0.22	0.33
Fiji	1955	0.21	0.44
	2015	0.14	0.41
Finland	1955	0.14	0.40
	2017	0.10	0.26
France	1955	0.16	0.48
	2017	0.09	0.43
Gabon	1955	0.38	0.62
	2018	0.19	0.38
Gambia	1955	0.37	0.47
	2018	0.22	0.41
Georgia	1955	0.22	0.26
	2015	0.11	0.39
Germany	1950	0.18	0.44
	2017	0.09	0.28

Country	Start and end year	Gini of Mortality	Gini Of Income
		Entire life tables	
	2018	0.20	0.44
Greece	1955	0.17	0.40
	2010	0.10	0.38
Grenada	1955	0.25	0.46
	2010	0.12	0.43
Guatemala	1955	0.36	0.56
	2010	0.47	0.47
Guinea	1950	0.37	0.45
	2018	0.26	0.34
Guinea-Bissau	1955	0.38	0.41
	2017	0.23	0.52
Guyana	1950	0.25	0.47
	2015	0.21	0.47
Haiti	1955	0.38	0.53
	2015	0.27	0.53
Honduras	1955	0.36	0.58
	2015	0.18	0.49
Hungary	1950	0.22	0.23
	2017	0.11	0.28
Iceland	1955	0.14	0.28
	2018	0.08	0.29
India	1950	0.34	0.37
	2015	0.17	0.48
Indonesia	1955	0.34	0.36
	2015	0.14	0.47
Iran	1950	0.38	0.48
	2015	0.09	0.37
Iraq	1955	0.35	0.60
	2015	0.15	0.30
Ireland	1955	0.15	0.33
	2017	0.09	0.30
Israel	1950	0.18	0.27
	2017	0.09	0.27
Italy	1955	0.19	0.39
	2017	0.08	0.27
Jamaica	1955	0.26	0.55
	2015	0.13	0.36
Japan	1950	0.21	0.31
	2017	0.09	0.27
Jordan	1955	0.32	0.39
	2015	0.12	0.35
Kazakhstan	1955	0.28	0.27

Country	Start and end year	Gini of Mortality	Gini Of Income
		Entire life tables	
Kenya	1950	0.36	0.67
	2018	0.19	0.43
Kiribati	1955	0.30	0.39
	2015	0.21	0.47
Kuwait	1950	0.33	0.47
	2015	0.07	0.36
Kyrgyzstan	1955	0.30	0.25
	2015	0.12	0.34
Latvia	1955	0.21	0.26
	2015	0.12	0.35
Lebanon	1950	0.24	0.53
	2015	0.10	0.56
Lesotho	1950	0.35	0.56
	2017	0.21	0.54
Liberia	1950	0.38	0.38
	2015	0.23	0.35
Libya	1955	0.38	0.32
	2017	0.23	0.35
Lithuania	1955	0.24	0.25
	2017	0.12	0.27
Luxembourg	1955	0.16	0.29
	2017	0.09	0.27
Madagascar	1990	0.32	0.43
	2017	0.19	0.41
Malawi	1955	0.42	0.47
	2018	0.20	0.45
Malaysia	1955	0.25	0.40
	2015	0.11	0.40
Maldives	1950	0.40	0.41
	2015	0.09	0.40
Mali	1955	0.38	0.38
	2017	0.26	0.36
Malta	1955	0.16	0.29
	2015	0.10	0.27
Martinique	1955	0.22	0.58
	2010	0.12	0.33
Mauritania	1950	0.36	0.41
	2018	0.22	0.32
Mauritius	1950	0.28	0.42
	2017	0.12	0.38
Mexico	1950	0.34	0.53
	2015	0.15	0.46
Mongolia	1955	0.37	0.34
	2015	0.13	0.33

Country	Start and end year	Gini of Mortality	Gini Of Income
		Entire life tables	
	2015	0.13	0.52
Mozambique	1950	0.39	0.40
	2017	0.22	0.46
Mynamar	1955	0.35	0.35
	2015	0.18	0.34
Namibia	1950	0.36	0.65
	2017	0.18	0.58
Nepal	1950	0.36	0.42
	2015	0.15	0.37
Netherlands	1950	0.14	0.44
	2017	0.09	0.27
New Zealand	1950	0.16	0.67
	2017	0.09	0.33
Nicaragua	1950	0.35	0.67
	2015	0.17	0.43
Niger	1955	0.37	0.32
	2017	0.24	0.34
Nigeria	1955	0.36	0.49
	2017	0.26	0.42
North Macedonia	1950	0.29	0.30
	2015	0.09	0.34
Norway	1955	0.14	0.40
	2017	0.09	0.26
Oman	1955	0.38	0.42
	2010	0.12	0.31
Pakistan	1960	0.37	0.38
	2015	0.22	0.33
Panama	1955	0.28	0.50
	2015	0.19	0.50
Papua New Guinea	1955	0.27	0.54
	2015	0.18	0.48
Paraguay	1955	0.25	0.47
	2015	0.17	0.48
Peru	1960	0.35	0.59
	2015	0.15	0.44
Philippines	1955	0.25	0.47
	2015	0.17	0.41
Poland	1955	0.20	0.27
	2017	0.11	0.27
Portugal	1955	0.27	0.41
	2017	0.09	0.27
Puerto Rico	1960	0.21	0.47
	2015	0.13	0.52

Country	Start and end year	Gini of Mortality	Gini Of Income
Qatar	1955	0.29	0.39
	2015	0.10	0.34
Republic of Korea	1960	0.22	0.35
	2015	0.09	33.00
Republic of Moldova	1950	0.23	0.31
	2015	0.11	0.26
Romania	1950	0.26	0.23
	2015	0.10	0.34
Russian Federation	1955	0.23	0.26
	2017	0.14	0.27
Rwanda	1955	0.37	0.35
	2018	0.17	0.47
Saint Lucia	1950	0.31	0.45
	2015	0.15	0.50
Samoa	1950	0.25	1.68
	2010	0.11	0.43
Sao Tome and Principe	1950	0.34	0.33
	2010	0.17	0.31
Saudi Arabia	1950	0.39	0.50
	2015	0.10	0.48
Senegal	1950	0.36	0.50
	2017	0.17	0.39
Serbia	1955	0.25	0.32
	2015	0.09	0.34
Seychelles	1950	0.29	0.47
	2017	0.11	0.47
Sierra Leone	1965	0.40	0.56
	2017	0.25	0.33
Singapore	1955	0.18	0.48
	2015	0.09	0.47
Slovakia	1950	0.23	0.19
	2017	0.11	0.44
Slovenia	1950	0.14	0.22
	2017	0.09	0.27
Solomon Islands	1955	0.32	0.43
	2015	0.14	0.42
Somalia	1955	0.37	0.42
	2015	0.28	0.40
South Africa	1955	0.33	0.54
	2017	0.17	0.65
South Sudan	1950	0.38	0.46
	2018	0.26	0.42
Spain	1960	0.18	0.37
	2017	0.08	0.52

Country	Start and end year	Gini of Mortality	Gini Of Income
Sri Lanka	1960	0.24	0.44
	2015	0.11	0.42
State of Palestine	1955	0.32	0.37
	2015	0.12	0.35
Sudan	1955	0.35	0.45
	2018	0.23	0.35
Sweden	1955	0.12	0.54
	2016	0.08	0.26
Switzerland	1955	0.14	0.32
	2015	0.09	0.31
Syria	1950	0.34	0.43
	2015	0.16	0.34
Tajikistan	1950	0.35	0.29
	2015	0.13	0.44
Thailand	1950	0.36	0.50
	2015	0.14	0.36
Timor-Leste	1960	0.36	0.38
	2015	0.17	0.29
Togo	1955	0.36	0.34
	2018	0.23	0.43
Tonga	1950	0.26	0.38
	2015	0.12	0.38
Trinidad and Tobago	1955	0.21	0.45
	2015	0.16	0.46
Tunisia	1955	0.36	0.48
	2015	0.11	0.33
Turkey	1960	0.39	0.52
	2015	0.14	0.41
Turkmenistan	1955	0.31	0.33
	2015	0.18	0.28
Uganda	1950	0.37	0.35
	2017	0.21	0.43
Ukraine	1950	0.27	0.25
	2016	0.14	0.26
United Arab Emirates	1955	0.35	0.40
	2015	0.09	0.38
United Kingdom	1950	0.14	0.38
	2017	0.09	0.36
Tanzania	1955	0.36	0.48
	2017	0.20	0.43
USA	1950	0.16	0.39
	2017	0.11	0.38
Uruguay	1950	0.20	0.39
	2015	0.13	0.37

Country	Start and end year	Gini of Mortality	Gini Of Income
		Entire life tables	
	2015	0.13	0.34
Vanuatu	1955	0.27	0.40
	2010	0.13	0.38
Venezuela	1960	0.25	0.42
	2015	0.18	0.37
Viet Nam	1955	0.29	0.36
	2015	0.17	0.37
Zambia	1955	0.34	0.48
	2018	0.21	0.57
Zimbabwe	1950	0.32	0.61
	2017	0.19	0.40