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Analyzing the health implications of rising income inequality: What does the data say?

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Abstract

Does income inequality worsen a country's health outcomes? In this study, we examine the effect of income inequality and redistribution on health outcomes using a panel dataset for a global sample of 154 countries from 1990 to 2020, and the instrumental variable method. The evidence from the empirical analyses revealed that, on average, higher income inequality is associated with poor health outcomes. On the other hand, this study documented that, on average, countries with higher income redistribution have better health outcomes. From regional analyses, we documented that income inequality strongly worsens health outcomes in South Asia, the Middle East and North Africa, sub-Saharan Africa and the Caribbean and Latin America. We found that education, environmental pollution, health expenditure and GDP per capita are the potential channels through which income inequality affects health outcomes. The findings established in this study suggest that a political environment that supports better income distribution would lead to better health outcomes.

KEYWORDS

causal channels, egalitarian democracy, health outcomes, inequality

JEL CLASSIFICATION

D31, I15, O50, P36

1 | INTRODUCTION

The literature is inundated with studies on factors contributing to or determining health outcomes. Remarkable among these factors is income (Gravelle et al., 2002; Judge et al., 1998; Pickett & Wilkinson, 2015), and there is a consensus that it relates positively to health. Despite the resounding evidence of the income (absolute income) effect on health, the same cannot be said about income inequality (Bechtel et al., 2012; Judge et al., 1998; Karlsson et al., 2010; Soobader & LeClere, 1999; Wilkinson & Pickett, 2006). Notwithstanding the rise in global incomes and unprecedented economic growth in the last decades, income inequality remains a challenge even in developed countries. For example, the 2020 World Social Report (UN, 2020) shows dire income inequality within and across countries. The report indicates that income inequality has been amplified mostly in developed and middle-income countries since 1990, and these countries account for about 71% of the global population. Income and wealth distribution were progressively concentrated at the top between 1990 and 2015; for instance, the share of income to the richest 1% rose, and the bottom 40% earned less than 25% of income (UN, 2020). Disparities in income and inadequate opportunities are developing a vicious continuum of inequality, poverty, disappointment and dissatisfaction across generations.

The widening global income inequality gap has reignited interest in its implications, especially on population health. Income inequality could generate adverse wellbeing effects, notably dire health consequences (Celeste et al., 2009; Matthew & Brodersen, 2018; Pickett & Wilkinson, 2015; Rostila et al., 2012). The UN (2013) asserts that income inequality leads to uneven access to health and generates poverty traps. The distribution of income is considered a major determinant of population health. As Kawachi and Kennedy (1997) note, an income disparity destroys social cohesion and leads to the deterioration of population health. Inequality could deepen social hierarchies, intensify stress and eliminate social and material resources supporting health (Elgar et al., 2017). Relative income is also considered a more important determinant of health than absolute income (Celeste et al., 2009; Coburn, 2004; De Maio, 2008; Pickett & Wilkinson, 2007; Rostila et al., 2012; Rözer & Volker, 2016). The World Health Organization (WHO) shows that life at birth has generally increased from about 66.8 to 73.3 years between 2000 and 2019 and that healthy life expectancy has increased from 58.3 to 63.7 years over the same period (WHO, 2022). Despite this trajectory, health inequalities continue to be a bane to societies and many people lack or have fewer resources. Life and healthy life expectancy were at least 10 years less in low-income and high-income countries in 2019 (WHO, 2022). Again, despite the impressive gains made in global maternal and child health (maternal mortality rate and under-five mortality rate dropping by close to 40% and 60%, respectively), the share of deaths attributable to non-communicable diseases rose from nearly 61% in 2000 to 74% in 2019 (WHO, 2022). Communicable diseases also remain the prevalent cause of death in low-income countries, accounting for almost 50% of all mortalities. The global pandemic (COVID-19) has worsened the global health situation. The WHO (2022) still emphasizes the adverse effect of rising income inequality with its ensuing poverty entrapment on health access and health inequality. This motivates the revisitation of the income inequality-health nexus literature in this paper.

Despite a plethora of studies examining the income inequality-health nexus, the empirical literature has been inconclusive (Bechtel et al., 2012; Lynch et al., 2004; Paul, 2021; Pickett & Wilkinson, 2015; Wilkinson & Pickett, 2006). For instance, Bechtel et al., 2012, Gravelle et al. (2002), Adjaye-Gbewonyo et al. (2016) and Zagorski et al. (2014) documented that income inequality is not a significant determinant of health outcomes, while Anderson et al. (2019), Vincens and Stafström (2015), Asafu-Adjaye (2004) and Pickett and Wilkinson (2007) revealed that income inequality is associated with worse health outcomes. In addition to these conflicting findings, the scrutiny of the literature reveals some limitations that warrant addressing. First, the existing studies have either been based on single-country analyses or a panel of few countries (Bechtel et al., 2012; Matthew & Brodersen, 2018; Paul, 2021; Ram, 2005; Rostila et al., 2012; Vincens & Stafström, 2015; Wen et al., 2003; Zhang & Churchill, 2020) with global evidence elusive. Many of these studies have also been cross-sectional (Cai et al., 2021; Karlsson et al., 2010; Pickett & Wilkinson, 2007; Ram, 2006; Soobader & LeClere, 1999), giving only a limited view of the impact of income inequality.

Second, the existing studies have employed limited indicators of health, mostly using either one of these; mental health, life expectancy and infant mortality indicators (Bechtel et al., 2012; Gravelle et al., 2002; Judge et al., 1998; Ram, 2005, 2006; Vincens & Stafström, 2015). Some studies have also focused on some specific diseases such as diabetes, hypertension, sexually transmitted infections, stroke, etc. (Anderson et al., 2019; Harling et al., 2014; Vincens & Stafström, 2015) and many others self-rated/reported health status (Cai et al., 2021; Rözer & Volker, 2016; Wen et al., 2003; Zagorski et al., 2014), which is very subjective. This makes the effect of income inequality on population health unclear. Population health has to be as encompassing as possible, as health is more than just the nonexistence of illness (Matthew & Brodersen, 2018; Rose & Hatzenbuehler, 2009).

Thirdly, the analytical methodologies used in the existing literature do not explicitly cater for plausible endogeneity bias since they have mainly used methods such as the OLS or panel fixed-effect methods (Gravelle et al., 2002; Judge et al., 1998; Matthew & Brodersen, 2018; Ram, 2005; Rözer & Volker, 2016; Soobader & LeClere, 1999), making the relationship between income inequality and health murky for more constructive inferences to be drawn at the country, regional and global levels. As emphasized by the WHO (2022), income inequality pushes many into poverty, making access to health a challenge; however, with good health, people can work to earn income, lifting them from poverty and closing the inequality gap. In not addressing the plausible reverse causality between income inequality and health, one could only claim to have found a correlation or association between the two factors. The failure of previous studies addressing endogeneity is a critical concern, which has been highlighted in several studies (see, for instance, Bechtel et al., 2012; Pickett & Wilkinson, 2007, 2015). Finally, a few studies (Delhey & Dragolov, 2014; Zhang & Churchill, 2020) have shown that trust mediates the effect of income inequality on health outcomes. We argue that while social capital is very important, many macroeconomic factors, such as GDP per capita, environmental pollution, health expenditure, education, employment and others, could potentially serve as the medium through which income inequality affects health outcomes. However, none of the empirical studies that tested for the mediation effect have gone beyond using trust as the meditating factor.

The conflicting evidence in the identified literature gaps motivates this paper to critically re-examine the relationship between income inequality and health using a global sample from 1990 to 2020. Our study contributes to the burgeoning yet unsettled literature on the relationship between income inequality and health by taking a global perspective. In relation to previous literature, the present study makes at least six contributions to literature and policy. Firstly, the current paper employs a global sample of 154 countries relative to previous studies that have been based on a single or few countries and does this over a longer period of time. Even though Ram (2006) is based on 108 countries, the study used cross-sectional data and narrowly measured population health (life expectancy and infant mortality). With the global sample analysis, the effect of income inequality is better ascertained for better constructive deductions. Secondly, to distinguish our work further, we perform regional analyses to establish sample heterogeneity. This permits a comparative analysis of whether the outcomes differ from region to region. Hence, we make cases for East Asia and Pacific, Europe and Central Asia, Latin America and the Caribbean, Middle East and North Africa, South Asia and sub-Saharan Africa. This is the first study to do this.

Thirdly, we employ several indicators of population health, the first study to do this in relation to income inequality. Specifically, we use life expectancy, neo-natal mortality, under-5 mortality, infant mortality and maternal mortality. This is unlike the chunk of the studies that have focused on one or limited aspects of health. Fourthly, unlike most of the existing studies that employed only a measure of income inequality, we also consider the effect of income distribution, which serves as a way of extenuating income inequality on health. Fifthly, the study explicitly accounts for endogeneity bias. This bias could emerge from at least three sources: i) reverse causality, that is, the healthy population could work and move up the income ladder bridging the income gap; ii) omitted variable bias, that is, in countries with rising income inequality, population health outcomes could simultaneously improve due to unobserved factors that positively affect both income inequality and health outcomes and iii) measurement errors. We address the plausible endogeneity bias by employing an instrumental variable (IV) technique with an external instrument. Finally, we examine the macroeconomic variables that could serve as pathways through which income inequality affects global health outcomes.

We consider this study relevant to both literature and policy. As emphasized by Rodgers (1979), countries, on average, become richer over time, and we must give credence to the likelihood that the impact of income and its distribution is varied for low and high incomes. The consequences of rising income inequality for social and economic development are enormous (UN, 2013), requiring major policy attention. Therefore, it is unsurprising that eliminating inequality of any form and improving people's social and economic development is core to the Sustainable Development Goals (SDGs). This study aligns with at least two SDGs, Goals 3 and 10. Income inequality threatens the attainment of SDG 10, which seeks to reduce inequality (including that of income) within and among countries. Income inequality jeopardizes SDG 3, which seeks to ensure healthy lives and promote well-being for all ages. The remainder of the paper proceeds as follows: the next section presents related literature on the topic. Section 3 presents the methodology. Section 4 presents the results and their discussion. Section 5 concludes the paper.

2 | REVIEW OF RELATED LITERATURE

The literature expounds on several pathways or mechanisms through which income inequality or distribution may have health consequences. The relative deprivation hypothesis (Walker & Smith, 2002; Yitzhaki, 1979), for example, explains that inequality generates deprivation, and the negative effect of deprivation emanating from an individual not having a particular good (say X) is an increasing function of the number of individuals in a particular reference group that have the good. Thus, when people in the low-income bracket compare their income to people with high income, a sense of dissatisfaction and unhappiness—which are damaging to health and well-being—are developed (Cai et al., 2021; Chen & Crawford, 2012; Rözer & Volker, 2016; Zagorski et al., 2014; Zhang & Churchill, 2020). In their theoretical framework, Clark and Oswald (1998) posit that the comparative social and economic position of people in society partially explains their utility. In their theory of rational emulation and deviance, they assume that people care about the relative status of other people and are in constant competition amongst themselves. People repetitively compare themselves to others and feel a sense of higher well-being when they seem to do better than others and a sense of failure and lower well-being when they lag behind others (Anderson et al., 2019; Clark & Oswald, 1998; Karlsson et al., 2010). This is in line with the relative income hypothesis that the health of people in a society is also influenced by the extent of income distribution in the society, where high-income inequality becomes important in explaining health (Asafu-Adjaye, 2004; Cai et al., 2021; Gravelle et al., 2002; Rözer & Volker, 2016). Inferences can be drawn from this theoretical exposition of Clark and Oswald (1998) to suggest that people feel a lower sense of well-being if they find themselves at the bottom of the economic ladder, and lower well-being plausibly contributes to health issues (Anderson et al., 2019; Bechtel et al., 2012; Zagorski et al., 2014).

There is also the social cohesion theory that explains that increasing inequality breaks down social cohesion and solidarity, and this results in a dire diminution of societal investment in human development and safety provided by welfare state agencies justified by an increase in market-based systems (Adjaye-Gbewonyo et al., 2016; Anderson et al., 2019; Celeste et al., 2009; Coburn, 2004; Karlsson et al., 2010; Rose & Hatzenbuehler, 2009). The ensuing psychological distress of deprivation and reduced social cohesion due to income inequality and poverty incites dysfunctional withstanding strategies (such as smoking and drinking) (Bechtel et al., 2012; Elgar et al., 2017) that can be detrimental to health. Increased social comparisons warrant reduced satisfaction and self-esteem, and people caught in this are more likely to discount the future and relegate investment opportunities in human capital and health (Anderson et al., 2019; Asafu-Adjaye, 2004; Rözer & Volker, 2016). These people are less likely to engage in healthy lifestyles such as exercising and healthy dieting (Bechtel et al., 2012). People at the bottom of the social and economic ladder also feel devalued and inferior (Asafu-Adjaye, 2004; Wilkinson & Pickett, 2006), which can affect their health. Social hierarchies generate poor health due to the low self-esteem attached to lower status, adversely impacting health through psycho-neurobiological mechanisms (Coburn, 2004). Pickett and Wilkinson (2007) assert that ill health generates huge income disparities between the rich and the poor.

Communities with low incomes and high-income inequality are generally perceived to have higher propensities of crime, violence, vandalism, imprisonment, morbidity, teenage pregnancy, drug issues, alcoholism and all sorts of vices (Adjaye-Gbewonyo et al., 2016; Cai et al., 2021; Li & Zhu, 2006; Pickett & Wilkinson, 2007; Rözer & Volker, 2016; Wilkinson & Pickett, 2006; Zagorski et al., 2014). These factors exert pressure and psychological distress that affect people's health (Rözer & Volker, 2016; Zagorski et al., 2014). This affects the health of the deprived and the wealthy (UN, 2020; WHO, 2022). In addition, if people perceive inequality as unfair or injustice, it reduces trust and kindness, thus undermining health and well-being (Kawachi & Kennedy, 1997; Rözer & Volker, 2016; Wilkinson & Pickett, 2006; Zhang & Churchill, 2020). Further, the aversion to inequality stimulates hatred, conflicts and violence, consequently affecting well-being. However, Pare and Felson (2014) show that when poverty is controlled, income inequality is unrelated to crime (assault, robbery, burglary and theft).

Income inequality and its concomitant poverty can have a direct effect on all aspects of health through the direct psychological stress of inequality and the inability of a section of the society to pay for health services when they are sick (Adjaye-Gbewonyo et al., 2016; Elgar et al., 2017; Rözer & Volker, 2016). The inability to pay for health services results in the deterioration of health. Rose and Hatzenbuehler (2009) assert that poverty and illness are almost inseparable. Generally, the rich have elongated lives and are healthier than the poor (Coburn, 2004). Low economic and social status are traumatic as they lessen the control people have over their lives and work (Wilkinson & Pickett, 2006). Considering that out-of-pocket spending constitutes an essential global health expenditure (about 44% (WHO, 2022)), income inequality and poverty aggravate health situations. Out-of-pocket health spending is estimated to have propelled about 435 million people into extreme poverty (WHO, 2022). Bechtel et al. (2012) assert that perceived deprivation from inequality can provoke people to work longer to increase their income and engage in unwarranted expenditures just to catch up with the "Joneses" in their communities. This attitude due to apparent deprivation can be damaging to health.

The "tunnel effect hypothesis" championed by Hirschman and Rothschild (1973) somehow takes a different exposition on the effect of income inequality on happiness, well-being and health. The hypothesis postulated an inverted U-shaped relationship, where well-being seems to improve or at least not deteriorate at low levels of inequality; however, deterioration sets in when inequality outspreads a certain threshold and persists in widening. The hypothesis suggests that inequality may not be detested by society (including even the poor) at the onset and that higher incomes of others may stimulate some hope and optimism for low-income earners that things may improve, and they could work to gain higher income. This optimism might generate at least a short-term improvement in well-being; however, with the persistence of inequality, people lose the optimism that negatively affects their well-being (Wang et al., 2015; Zhang & Churchill, 2020). Wang et al. (2015) found evidence for this hypothesis.

Following the theoretical expositions above, the income inequality-health nexus has attracted enormous empirical literature, with some finding positive and others negative or no statistically significant relationship. For example, based on cross-sectional data from 108 countries, Ram (2006) found a significant effect of income inequality on life expectancy and infant mortality. Using survey data on people aged 11–15 years from 40 countries from 1994 to 2014, Elgar et al. (2017) found that experience of income inequality from 0 to 4 years predicted psychosomatic symptoms among females. Using data from the United States from 2005 to 2007, Anderson et al. (2019) found inequality positively associated with diabetes and hypertension only in 2007. Using data from 2002 to 2009, Vincens and Stafström (2015) found that as income inequality rises, stroke and mortalities increase in Brazil. Harling et al. (2014) found that higher income inequality is associated with an increase in sexually transmitted infections. For a panel data of 44 countries from 1970 to 1995, Asafu-Adjaye (2004) showed that income inequality has a significant negative effect on health status. Using cross-sectional data from the United States, Soobader and LeClere (1999) showed that income inequality exerts a negative effect on morbidity. Focusing on child well-being, Pickett and Wilkinson (2007) found that income inequality negatively correlated with well-being for a cross-sectional sample of 23 developed countries. Using survey data for 2004/05–2011/12, Paul (2021) found a negative relationship between income inequality and individual health in India. Using data from 2006 to 2014, Matthew and Brodersen (2018) found that income inequality has a significant negative effect on physical, behavioural and mental health dimensions in the United States.

Some other studies have either found no statistically significant or mixed results. For example, using Australian household data, Bechtel et al. (2012) found that income inequality does not affect mental health. Similarly, using data from 15 OECD countries, Judge et al. (1998) did not find income inequality to be a significant determinant of population health. Gravelle et al. (2002), also employing data from 75 countries, concluded that income distribution is never significantly connected with life expectancy. Adjaye-Gbewonyo et al. (2016), using district-level data from South Africa, found that income inequality does not affect depressive symptoms. Using data from the United States for the period 1995–1999, Mellor and Milyo (2002) found no consistent relation between income inequality and individual health status. Using 2001 cross-sectional data from Argentina, De Maio (2008) found that as income inequality is correlated with life expectancy, it did not correlate with other variables such as infant mortality and self-rated poor health. In a systematic review of 98 studies, Lynch et al. (2004) found little empirical evidence that income inequality is a major determinant of population health in rich countries. Despite this, they add that reducing income inequality will improve health outcomes for the underprivileged. Wilkinson and Pickett (2006) also analyzed 168 studies and found that only 70% of the analyses support the thesis that income inequality has a negative effect on health. The remainder either found negative or no statistical significance between the two factors.

Some of the empirical studies have focused on self-rated health status; for example, using data from 30 European countries over the period 1981–2014, Rözer and Volker (2016) show that a rise in income inequality is associated with self-rated health in young adults partly due to the associated reduction in trust. They further found that the adverse effects of income inequality persist until age 36. Using cross-sectional data from China based on self-rated health, Cai et al. (2021) show that income inequality negatively affects health within villages and towns. Zagorski et al. (2014) used 2003 cross-sectional data from 28 European countries and found that income inequality has no statistically significant effect on self-rated health. Using 2006 cross-sectional data on 21 countries, Karlsson et al. (2010) found evidence of an adverse effect of income inequality on self-rated health in high-income countries of the sample. Rostila et al. (2012), using 2000 cross-sectional data from Sweden, found a moderate impact of high and very high-income inequality on self-rated health at the municipality level. However, at the neighbourhood level, no relationship was found.

Scrutiny of the literature reveals extensive work done on the relationship between income inequality and health. However, much of what has been done has focused on single-country analysis (mainly the United States) or a panel of just a handful of countries. Most of these studies have also been cross-sectional studies. This largely contributes to the inconclusive nature of the relationship in literature. In this study, we employ a global sample over a longer time and perform regional analysis to ascertain any disparities. In addition, most of the past studies have focused on a few health indicators or have used self-rated health proxies. These do not adequately capture the health of the population. In response, this study employs five indicators to comprehensively measure population health. Furthermore, the previous studies have generally not catered for the issue of potential endogeneity bias between the two variables under scrutiny, and at best, the relationship found so far may be said to be a correlational analysis. This study explicitly accounts for this plausible endogeneity by employing an IV estimation method.

3 | METHODS AND DATA

3.1 | Empirical models, identification and estimation strategies

Following the empirical literature, we estimate the effect of income inequality on health outcomes using the empirical equation specified below:

$$Health_{i,t} = \alpha_0 + \beta_1 GINI_{i,t} + \gamma_i X_{i,t} + \varepsilon_{i,t} \tag{1}$$

Where $Health_{i,t}$ indicates the health outcomes in country i at time t. In the right-hand side variables, $GINI_{i,t}$ is the income inequality variable in country i at time t. Also, β_1 is the coefficient of the impact of income inequality on the health outcomes variables. $X_{i,t}$ represents the control covariates and γ_i denotes the coefficient of the impact of the control variables on the health outcome variables. $\varepsilon_{i,t}$ is the error term.

Previous studies have estimated the effect of income inequality on health outcomes using mainly the OLS method (Bechtel et al., 2012; Gravelle et al., 2002; Judge et al., 1998). Preliminarily, we follow a similar approach to estimate the baseline results. One of the main criticisms of studies that have analyzed the impact of income inequality on health outcomes is their failure to address endogeneity. We argue that OLS estimates would be biased in the presence of endogeneity. As a contribution to the literature, we attempt to address the endogeneity problem using the IV technique. As a requirement for IV techniques, an appropriate instrument is needed for identification.

For the identification strategy, this study employs "*egalitarian democracy*" as an instrument for the endogenous variable (income inequality). Egalitarian democracy is a political system that gives equal rights and freedom to citizens and allocates resources in a manner that allows meaningful political involvement for all citizens and nurtures an atmosphere in which all persons can influence political and governing practices (Sigman & Lindberg, 2019). Sigman and Lindberg (2019) assert that egalitarianism hinges on three general dimensions: equal protection of rights and freedoms, equal distribution of resources and equal access to power. Egalitarianism effectively dampens

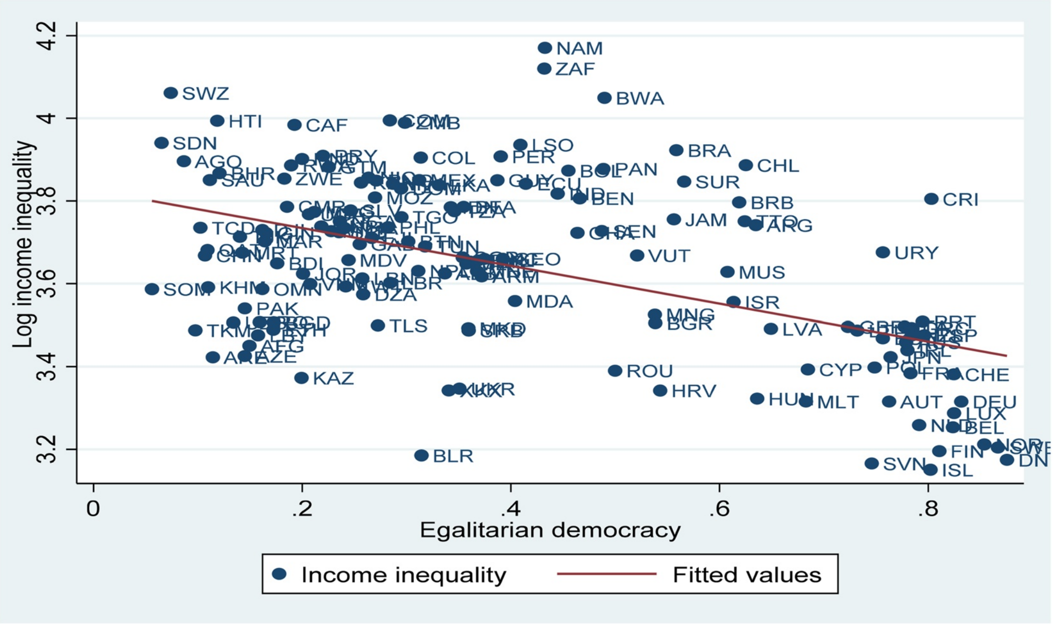

FIGURE 1 First-stage relationship between income inequality and egalitarian democracy.

social and economic inequalities by supporting economic opportunities for all and ensuring a fairer income distribution (Peragine, 2002). Income inequality is perceived to generate inferiority, status and social cohesion anxieties that eventually affect the health and well-being of people (Pickett & Wilkinson, 2007, 2015; Wilkinson & Pickett, 2006). An egalitarian culture, however, dampens these anxieties (Steckermeier & Delhey, 2019). Steckermeier and Delhey (2019) argue that in-egalitarian cultures or societies—those that accentuate hierarchy, achievements and exclusions—worsen the feelings of people; however, those that are more egalitarian emphasize equality and inclusiveness that reduce these bad feelings. Egalitarianism could work to alleviate the negative effects of income inequality. With the increased economic opportunities for all and income distribution associated with egalitarianism, this is expected to abridge income inequality. We expect egalitarianism democracy to have a significant direct relationship with income inequality rather than health outcomes. Egalitarianism works directly to reduce income inequality and increase income distribution.

Based on the above discussions on the strategies for addressing endogeneity, we adopt the two-stage least squares (IV-2SLS) technique. In the first stage, we regress income inequality on egalitarian democracy as specified in equation (2).

$$GINI_{i,t} = \alpha_0 + \theta_1 EDEM_{i,t} + \gamma_j X_{i,t} + \varepsilon_{i,t} \quad (2)$$

Figure 1 shows the relationship between egalitarian democracy and income inequality. Figure 1 shows that for the global sample, there is a strong negative relationship between income inequality and egalitarian democracy. This indicates that as egalitarian democracy increases, income inequality declines.

In the second stage regression, as specified in equation (3), we estimate the impact of the exogenous component of income inequality predicted in equation (2) on the health outcomes variables.

$$Health_{i,t} = \alpha_0 + \beta_1 \widehat{GINI}_{i,t} + \gamma_i X_{i,t} + \varepsilon_{i,t} \quad (3)$$

The literature suggests that an instrument should satisfy the following conditions: (i) it must have a stronger relationship with the endogenous, (ii) it must satisfy the orthogonality condition and (iii) it must be properly excluded from the model so that the instrument has no direct relationship with the outcome variable (Baum et al., 2012). The argument of what constitutes a better instrument is debatable, and it has been argued that getting an instrument that fulfils these requirements, especially condition (ii), is often challenging, and this poses a significant problem for using the IV estimators in most empirical studies (Baum et al., 2012; Stock et al., 2002). In view of this practical challenge, we use the Lewbel (2012) two-stage least squares (Lewbel 2SLS) as an alternative estimator to test the consistency of the IV-2SLS estimates. The Lewbel 2SLS estimator is applied when it is challenging to find an appropriate external instrument to identify the equation or when the instrument is weak. Thus, the Lewbel 2SLS estimator helps identify structural parameters in the regression models with endogenous or mismeasured regressors without traditional identifying information (Lewbel, 2012). As a novelty, the Lewbel 2SLS generates internally constructed heteroskedasticity-based instruments from the residuals of the auxiliary equation, which is multiplied by each of the included exogenous variables in a mean-centered form (Lewbel, 2012). The ability of the Lewbel 2SLS estimator to construct its internal instrument makes it an instrument-free estimator. In other words, the Lewbel 2SLS estimator provides reliable estimates without relying on external instruments (Lewbel, 2012). To show that the effect of income inequality on health outcomes is robust using the Lewbel 2SLS estimator, we estimate one model without using egalitarian democracy as an external instrument and another model with egalitarian democracy as an external instrument.

3.2 | Data description

We constructed yearly panel data for a global sample of 154 countries[1] from 1990 to 2020. The outcome variable, health outcome, is represented by life expectancy, neo-natal mortality, under-five mortality, infant mortality and maternal mortality. Higher life expectancy values and lower neonatal, under-five, infant and maternal mortality correspond to better health outcomes and vice versa. In this study, we have opted to use objective measures of health/wellbeing rather than subjective measures. As much as we agree that self-reported data could allow people to tell how they feel, they could be misleading. People could exaggerate their feelings for the sake of sympathy. People could also forget their prior feelings and underreport or over-report their feelings. Besides, self-reported data from surveys exist for fewer individuals and countries. To overcome these challenges and present a macro cross-country analysis, we opt for a more scientific health assessment.

The income inequality variable was represented with the post-tax/post-transfer Gini index. A higher index denotes increasing income inequality and vice versa. As an alternative to income inequality, we also considered the effect of income redistribution on health outcomes. The income redistribution variable is represented by the absolute income redistribution index. Absolute income redistribution is the number of Gini-index points market-income inequality is reduced due to taxes and transfers. It is the difference between market and net income inequality (Solt, 2016). The Gini and absolute income redistribution index range between zero (0) to 100; therefore, a lower Gini value and higher absolute income redistribution index correspond to a reduction in the income gap and vice versa. Post-tax/post-transfer Gini index and absolute income redistribution data were drawn from Solt's (2016) standardized world income inequality database (SWIID). We used the SWIID because it combines and standardizes inequality data from well-established income inequality databases such as

[1]See Appendix Table A1 for the countries sampled for the analysis.

the World Income Inequality Database, Luxembourg Income Studies, and the World Income Distribution Database, among others (see Solt, 2016).

The egalitarian democracy variable, used as an instrument, seeks to address inequality across groups and individuals within a society (Coppedge et al., 2018). Egalitarian democracy seeks to (i) protect the rights and freedoms of individuals across all social groups, (ii) distribute resources equally across all social groups and (iii) ensure groups and individuals enjoy equal access to power (Coppedge et al., 2018). The egalitarian democracy ranges between 0 and 1, with a higher value corresponding to a higher commitment to promote equality and vice versa.

Previous literature has shown that GDP per capita (Asongu & Le Roux, 2017; Rustagi & Akter, 2022; Williamson, 2008), health expenditure (Bokhari et al., 2007; Gallet & Doucouliagos, 2017), trade openness (Burns et al., 2016; McNamara, 2017), urbanization (Galea et al., 2005; Vu, 2020), education (Davies et al., 2018) and electrification (Acheampong et al., 2021) affect health outcomes. We, therefore, included these benchmark variables in the health outcomes models to address variable omission bias. As a robustness check and a standard practice (see, for instance, Vu, 2020), we further control for other confounding variables such as remittance, carbon emissions, mobile phone penetration and foreign direct investment in the health outcome models to rule out the possible violation of exclusion restrictions and make sure that our results are not driven by omissions of key variables that influence health outcomes. In addition, including these additional control variables is one of the approaches to addressing endogeneity that could emanate from variable omission bias.

A detailed description of the data regarding their proxies, sources and descriptive statistics is presented in Appendix Table A2. Except for the egalitarian democracy variable, we applied the natural logarithms approach to transform the rest of the variables used for the analysis. The natural log transformation helps to address skewness in the data and enables essay interpretation of the estimated coefficients. Figure 2 displays the trends in income inequality, egalitarian democracy and health outcome variables. In Figure 2, life expectancy at the global level has been trending upwards, while the mortality variables have been trending downwards, suggesting that there has been continuous improvement in global health outcomes. Income inequality seems to have been increasing at a decreasing rate but experienced a sharp decline around 2013. As depicted in Figure 2, egalitarian democracy has also been trending upwards, demonstrating an agenda across the globe to promote and achieve equality. In addition, Figure 3 shows the bivariate relationship between income inequality and the health outcome variables. Figure 3 suggests income inequality correlates negatively with life expectancy while correlating positively with neonatal, under-five, infant and maternal mortality.

4 | EMPIRICAL RESULTS

4.1 | OLS estimates

The OLS estimates, which are the baseline results, are presented in Table 1. In Table 1, it is observed that the estimated coefficient on the effect of income inequality on life expectancy is negative and statistically significant at a 1% level, while the estimated coefficient on the effect of income inequality on neonatal mortality, under-five mortality, infant mortality and maternal mortality is positive and statistically significant at a 1% level. Based on the magnitude of the estimated coefficients, a 1% increase in income inequality decreases life expectancy by 0.123% [Column 1]. At the same time, a 1% increase in inequality is associated with a 1.606% increase in neo-natal mortality [Column 2], 1.850% increase in under-five mortality [Column 3], 1.817% increase in infant mortality [Column 4] and a 2.465% increase in maternal mortality [Column 5], ceteris paribus. Contrarily to the claim of

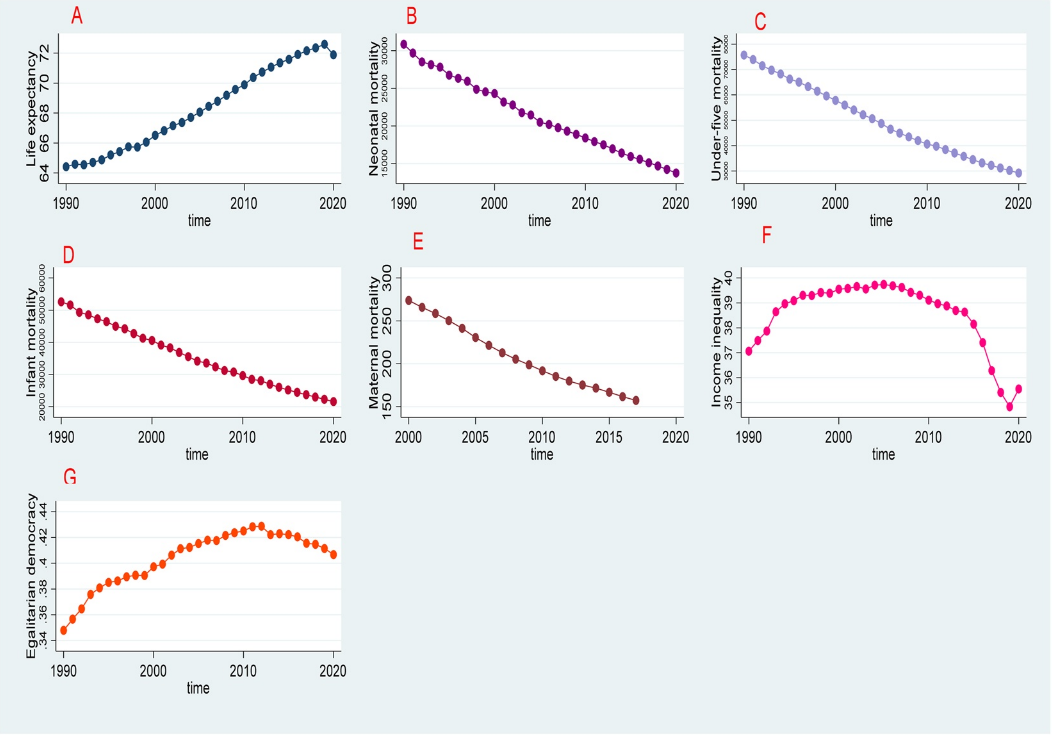

FIGURE 2 Global sample trends of health outcome, income inequality and egalitarian democracy variables. The plotting is based on the countries used in this study.

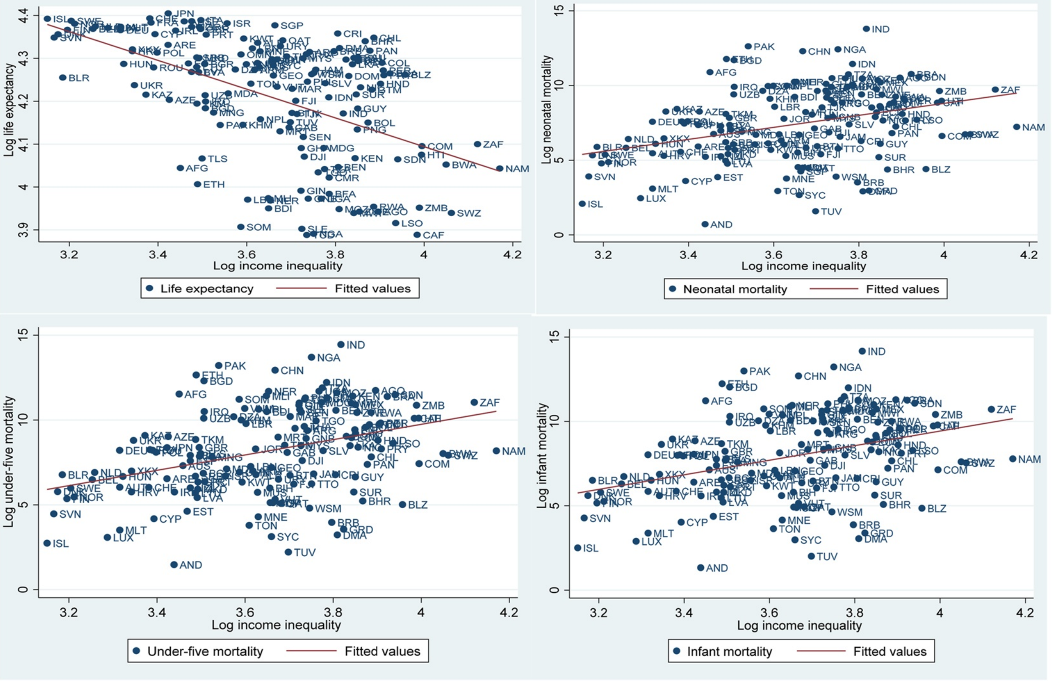

FIGURE 3 Relationship between health outcome variables and income inequality.

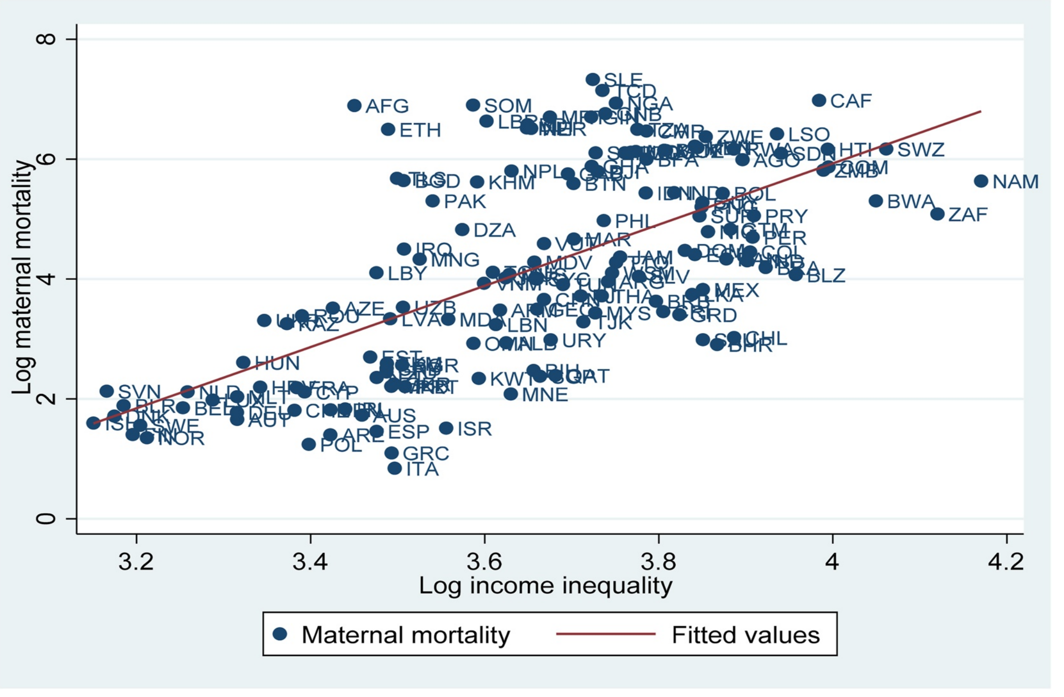

FIGURE 3 (Continued)

some previous studies (see, for instance, Adjaye-Gbewonyo et al., 2016; Bechtel et al., 2012; Gravelle et al., 2002; Zagorski et al., 2014), our results show that income inequality is a major determinant and that higher income inequality is associated with worse health outcomes.

Regarding the baseline control covariates, GDP per capita is found to be associated with an improvement in the health outcomes. The estimated coefficient on the impact of GDP per capita on life expectancy is positive and statistically significant at a 1% level, while the estimated coefficient on the effect of income inequality on neonatal mortality, under-five mortality, infant mortality and maternal mortality is negative and statistically significant at a 1% level, ceteris paribus. This evidence indicates that increasing GDP per capita contributes to better health outcomes, supporting the findings of Acheampong et al. (2022) and Salahuddin et al. (2020). The results show that the impact of urbanization on health outcomes is mixed. For instance, the estimated coefficient on the impact of urbanization on life expectancy is positive and statistically significant at 10%, indicating that urbanization increases life expectancy by 0.001%, ceteris paribus. Similarly, the estimated coefficients on the impact of urbanization on neonatal mortality, under-five mortality and infant mortality are positive and statistically significant at a 1% level [Columns 2–4], suggesting that urbanization increases neonatal mortality, under-five mortality and infant mortality by 0.897%, 0.900% and 0.895%, respectively. In Column 4, the effect of urbanization on maternal mortality is negative and statistically significant at a 1% level, suggesting that urbanization reduces maternal mortality by 0.023%. This result suggests that while urbanization increases life expectancy, it significantly worsens mortality, aligning with the findings of Acheampong et al. (2022).

We also observe in Table 1 that the impact of trade openness on health outcomes is mixed. The estimated coefficients on the impact of trade openness on life expectancy are negative and statistically significant at a 1% level, indicating that trade openness reduces life expectancy by 0.022%, ceteris paribus. Contrarily, estimated coefficients on the impact of trade openness on neonatal

TABLE 1 Income inequality and health outcomes, OLS estimates.

Variables	1 Life_exp	2 Neo_mort	3 Under_5 mort	4 Infant_mort	5 Mat_mort
Income inequality	−0.132***	1.606***	1.850***	1.817***	2.465***
	(0.013)	(0.079)	(0.083)	(0.079)	(0.073)
GDP per capita	0.027***	−0.544***	−0.539***	−0.554***	−0.369***
	(0.002)	(0.022)	(0.021)	(0.021)	(0.026)
Trade openness	−0.022***	−0.231***	−0.223***	−0.223***	0.019
	(0.004)	(0.035)	(0.034)	(0.034)	(0.034)
Urbanization	0.001*	0.897***	0.900***	0.894***	−0.023***
	(0.001)	(0.008)	(0.009)	(0.009)	(0.008)
Health expenditure	0.016***	−0.488***	−0.500***	−0.491***	−0.483***
	(0.004)	(0.033)	(0.033)	(0.032)	(0.035)
Electrification	0.106***	−0.325***	−0.606***	−0.478***	−0.487***
	(0.008)	(0.043)	(0.044)	(0.042)	(0.046)
Education	0.004	−0.554***	−0.541***	−0.490***	−0.380***
	(0.010)	(0.059)	(0.063)	(0.060)	(0.067)
Constant	4.081***	−2.368***	−1.518***	−2.185***	2.583***
	(0.063)	(0.467)	(0.481)	(0.463)	(0.429)
Observations	1768	1773	1773	1773	1657
R^2	0.794	0.952	0.955	0.955	0.872

Note: Heteroscedasticity robust standard errors in parentheses. Life expectancy (Life_exp); Neo-natal mortality (Neo_mort); Under-5 mortality (Under_5 mort); Infant mortality (Infant_mort); and Maternal mortality (Mat_mort).

**p* < 0.10, ***p* < 0.05 and ****p* < 0.01.

mortality, under-five mortality and infant mortality are negative and statistically significant at a 1% level [Columns 2–4], suggesting that increasing trade openness reduces neonatal mortality, under-five mortality and infant mortality by 0.231%, 0.223% and 0.223% respectively. In Column 4, the maternal mortality effect of trade openness is positive but statistically insignificant. This result suggests that while trade openness reduces life expectancy, it significantly improves mortality. It supports Levine and Rothman's (2006) results that trade openness reduces mortality rates, but found contradictory evidence on trade and life expectancy relationship findings. Also, consistent with prior literature (Bokhari et al., 2007; Gallet & Doucouliagos, 2017), our results imply that health expenditure is associated with improvement in health outcomes, and the impact is statistically significant at a 1% level. For instance, the estimated coefficients on health expenditure suggest that a 1% increase in health expenditure increases life expectancy significantly by 0.016% [Columns 1], while neonatal mortality, under-five mortality, infant mortality and maternal mortality decrease by 0.488%, 0.500%, 0.491% and 0.483%, ceteris paribus, respectively.

In support of Acheampong et al. (2021) and Banerjee et al. (2021) findings, our findings suggest that the coefficients on the estimated effect of electrification on life expectancy are positive and statistically significant at a 1% level, indicating that electrification increases life expectancy by 0.106%. At the same time, the coefficient of the estimated effect of electrification on neonatal mortality, under-five mortality, infant mortality and maternal mortality is negative and statistically significant at a 1% level, showing that neonatal mortality, under-five mortality, infant mortality and maternal mortality decreases by 0.325%, 0.606%, 0.478% and 0.478%, respectively. This result implies that better health outcomes can be achieved through increasing access to electricity. We also observed that education has a statistically insignificant positive effect on life expectancy. However, the coefficient of the estimated effect on neonatal mortality, under-five mortality, infant mortality and maternal mortality is negative and statistically significant at a 1% level, implying that neo-natal mortality, under-five mortality, infant mortality and maternal mortality decrease by 0.554%, 0.541%, 0.490% and 0.380%, respectively. This evidence supports prior literature that claims that education is associated with better health outcomes (Davies et al., 2018; Raghupathy, 1996; Weitzman, 2017).

4.2 | The IV-2SLS estimates

We report the IV-2SLS results in Table 2. In Panel A of Table 2, the coefficient of the estimated effect of egalitarian democracy on income inequality is negative and statistically significant at a 1% level in the models. This implies that democratic institutions that seek to achieve equality contribute to reducing income inequality. In evaluating the validity of egalitarian democracy as an instrument, the Kleibergen–Paap Wald F statistic and Cragg–Donald Wald F are large, greater than the Stock–Yogo weak ID test critical values at 10%. This implies that the Kleibergen–Paap Wald F and Cragg–Donald Wald F statistics show that egalitarian democracy is a strong and relevant instrument. Again, the Kleibergen–Paap Lagrange Multiplier (LM) statistics *p*-value rejects the null hypothesis that the structural equation is under-identified. In Panel B of Table 2, the coefficients on the estimated effect of income inequality on health outcomes are largely consistent with the OLS results. For instance, income inequality has a negative and statistically significant effect on life expectancy at a 1% level. At the same time, the coefficient of the estimated effect of income inequality on neonatal, under-five, infant and maternal mortality is positive and statistically significant at a 1% level. Based on IV-2SLS, a 1% increase in income inequality decreases life expectancy by 0.143%, ceteris paribus [Column 1]. At the same time, a 1% increase in inequality increases neo-natal mortality by 3.110% [Column 2], under-five mortality by 3.316% [Column 3], infant mortality by 3.593% [Column 4] and maternal mortality by 2.368, ceteris paribus [Column 5]. Comparing these estimates to the OLS estimates, we can observe that the OLS estimated coefficients are mostly downwards biased, which could be attributed to attenuation bias emanating from measurement errors in the income inequality variable.[2] In other words, applying the IV technique with a plausible external instrument has contributed to the amelioration of attenuation bias in the OLS estimates. From the IV-2SLS estimates, we argue that higher income inequality causes poor health outcomes.

Do the IV-2SLS estimates imply that differences in income inequality can help to clarify the significant variations in health outcomes across countries? For illustration, let us compare two countries, Iceland, with an average smallest log income inequality value of 23.442, and Namibia, with an average highest log income inequality value of 64.742. The IV-2SLS estimate in Column 1 is −0.143. This estimated coefficient suggests that there is an average of a negative 5.906 log-point difference in life expectancy at birth between Iceland and Namibia. In addition, in Column 2, the estimated coefficient is 3.110, suggesting that there is an average of 128.443 log-point difference in neo-natal mortality between Iceland and Namibia. In the under-five mortality model (Column 3), the estimated coefficient of 3.316 implies an average of 136.95 log-point difference in under-five mortality between Iceland and Namibia. In Column 4, the estimated coefficient of income inequality is 3.593. This estimated coefficient suggests that there is an average of 148.391 log-point difference in infant mortality between Iceland and Namibia. Finally, the estimated coefficient in Column 5 is

[2]See Acemoglu et al. (2001) on the discussion on the source of attenuation bias.

TABLE 2 Income inequality and health outcomes, IV-2SLS.

Variables	1 Life_exp	2 Neo_mort	3 Under_5 mort	4 Infant_mort	5 Mat_mort
Panel B: Second-stage regression estimates. Dependent variable: Health outcome variables					
Income inequality	−0.143***	3.110***	3.316***	3.593***	2.368***
	(0.041)	(0.331)	(0.336)	(0.341)	(0.310)
GDP per capita	0.026***	−0.407***	−0.399***	−0.388***	−0.374***
	(0.004)	(0.038)	(0.038)	(0.039)	(0.037)
Trade openness	−0.023***	−0.060	−0.041	−0.012	0.022
	(0.006)	(0.054)	(0.051)	(0.053)	(0.045)
Urbanization	0.002	0.929***	0.939***	0.937***	−0.020*
	(0.001)	(0.011)	(0.010)	(0.011)	(0.010)
Health expenditure	0.016***	−0.445***	−0.459***	−0.441***	−0.485***
	(0.004)	(0.036)	(0.036)	(0.036)	(0.035)
Electrification	0.106***	−0.404***	−0.691***	−0.576***	−0.481***
	(0.008)	(0.052)	(0.050)	(0.052)	(0.048)
Education	0.005	−0.597***	−0.591***	−0.545***	−0.396***
	(0.010)	(0.068)	(0.068)	(0.069)	(0.068)
Constant	4.128***	−9.789***	−8.908***	−11.036***	2.964**
	(0.185)	(1.664)	(1.665)	(1.699)	(1.484)
Panel A: First-stage regression estimates. Dependent variable: Income inequality					
Egalitarian democracy	−0.310***	−0.310***	−0.310***	−0.310***	−0.322***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
Observations	1734	1734	1734	1734	1623
R2	0.794	0.939	0.945	0.940	0.872
Kleibergen–Paap rk Wald F statistic	124.034	124.034	124.034	124.034	130.670
Cragg–Donald Wald F statistic	121.796	121.796	121.796	121.796	122.115
Kleibergen–Paap rk LM statistic	91.303	91.303	91.303	91.303	94.262
Kleibergen–Paap rk LM statistic (*p*-value)	0.000	0.000	0.000	0.000	0.000

Note: Heteroscedasticity robust standard errors in parentheses. Life expectancy (Life_exp); Neo-natal mortality (Neo_mort); Under-5 mortality (Under_5 mort); Infant mortality (Infant_mort); and Maternal mortality (Mat_mort). The null hypothesis of Kleibergen–Paap rk LM test is that the structural equation is under-identified. The null hypothesis of Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic is that the instrument is weakly correlated with the endogenous variable. The Kleibergen–Paap rk LM test *p*-value rejects the null hypothesis that the structural equation is under-identified. The Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic reject the null hypothesis that instrument is weakly correlated with the endogenous variable since their values are greater than the Stock–Yogo weak ID test critical values at 10%.

*$p < 0.10$, **$p < 0.05$ and ***$p < 0.01$.

2.368, indicating an average of 97.798 log-point difference in maternal mortality between Iceland and Namibia. These demonstrations show that if Namibia had experienced the average lowest income inequality as Iceland, it would have probably experienced better health outcomes. This result suggests that the difference in income inequality among countries could explain part of the difference in health outcomes among countries.

4.3 | Robustness checks and further analysis

4.3.1 | Additional control covariates

In Table 3, we test the robustness of our results by including additional variables that may be correlated with income inequality and health outcomes. The additional variables in the regression analysis include remittance, carbon emissions, mobile phone penetration and foreign direct investment. We observe from Table 3 that the inclusion of these variables does not change the significant levels nor the signs on the estimated coefficients on the effects of income inequality on the health outcome variables. However, we note a significant change in the magnitude of the estimated coefficients on the effect of income inequality. Based on the IV-2SLS estimates with additional control variables, a 1% increase in income inequality decreases life expectancy by 0.112%, ceteris paribus [Column 1]. In addition, a 1% increase in inequality increases neo-natal mortality by 3.734% [Column 2], under-five mortality by 3.855% [Column 3], infant mortality by 4.134% [Column 4] and maternal mortality

TABLE 3 Income inequality and health outcomes, IV-2SLS (Additional controls).

Variables	1 Life_exp	2 Neo_mort	3 Under_5 mort	4 Infant_mort	5 Mat_mort
Panel B: Second-stage regression estimates. Dependent variable: Health outcome variables					
Income inequality	−0.112***	3.734***	3.855***	4.134***	3.128***
	(0.042)	(0.338)	(0.337)	(0.347)	(0.311)
Control variables	YES	YES	YES	YES	YES
Constant	3.649***	−11.878***	−10.019***	−12.106***	−2.948**
	(0.165)	(1.439)	(1.409)	(1.448)	(1.392)
Panel A: First-stage regression estimates. Dependent variable: Income inequality					
Egalitarian democracy	−0.324***	−0.324***	−0.324***	−0.324***	−0.338***
	(0.030)	(0.030)	(0.030)	(0.030)	(0.030)
Observations	1573	1573	1573	1573	1481
R2	0.795	0.932	0.942	0.935	0.865
Kleibergen–Paap rk Wald F statistic	119.898	119.898	119.898	119.898	124.522
Cragg–Donald Wald F statistic	114.350	114.350	114.350	114.350	115.231
Kleibergen–Paap rk LM statistic	88.610	88.610	88.610	88.610	91.057
Kleibergen–Paap rk LM statistic (*p*-value)	0.000	0.000	0.000	0.000	0.000

Note: Heteroscedasticity robust standard errors in parentheses. Life expectancy (Life_exp); Neo-natal mortality (Neo_mort); Under-5 mortality (Under_5 mort); Infant mortality (Infant_mort); and Maternal mortality (Mat_mort). We include baseline control and other control variables in all the models. The baseline control variables include GDP per capita, trade openness, urbanization, health expenditure, electrification and education. The additional variables included are remittance, carbon emissions, mobile phone penetration and foreign direct investment. The null hypothesis of Kleibergen–Paap rk LM test is that the structural equation is under-identified. The null hypothesis of Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic is that the instrument is weakly correlated with the endogenous variable. The Kleibergen–Paap rk LM test *p*-value rejects the null hypothesis that the structural equation is under-identified. The Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic reject the null hypothesis that instrument is weakly correlated with the endogenous variable since their values are greater than the Stock–Yogo weak ID test critical values at 10%.

$^*p < 0.10$, $^{**}p < 0.05$ and $^{***}p < 0.01$.

TABLE 4 Income redistribution and health outcomes, IV-2SLS.

Variables	1 Life_exp	2 Neo_mort	3 Under_5 mort	4 Infant_mort	5 Mat_mort
Panel B: Second-stage regression estimates. Dependent variable: Health outcome variables					
Income redistribution	0.018**	−0.641***	−0.742***	−0.743***	−0.855***
	(0.007)	(0.106)	(0.123)	(0.123)	(0.147)
Control variables	YES	YES	YES	YES	YES
	(0.003)	(0.033)	(0.040)	(0.039)	(0.048)
Constant	2.831***	2.609**	7.043***	5.485***	11.928***
	(0.095)	(1.024)	(1.299)	(1.232)	(1.348)
Panel A: First-stage regression estimates. Dependent variable: Income redistribution					
Egalitarian democracy	2.234***	2.234***	2.234***	2.234***	2.378***
	(0.302)	(0.302)	(0.302)	(0.302)	(0.317)
Observations	835	835	835	835	771
R2	0.760	0.953	0.946	0.946	0.775
Kleibergen–Paap rk Wald F statistic	54.730	54.730	54.730	54.730	56.251
Cragg–Donald Wald F statistic	130.672	130.672	130.672	130.672	133.566
Kleibergen–Paap rk LM statistic	44.385	44.385	44.385	44.385	43.529
Kleibergen–Paap rk LM statistic (*p*-value)	0.000	0.000	0.000	0.000	0.000

Note: Heteroscedasticity robust standard errors in parentheses. Life expectancy (Life_exp); Neo-natal mortality (Neo_mort); Under-5 mortality (Under_5 mort); Infant mortality (Infant_mort); and Maternal mortality (Mat_mort). We include baseline control and other control variables in all the models. The baseline control variables include GDP per capita, trade openness, urbanization, health expenditure, electrification and education. The additional variables included are remittance, carbon emissions, mobile phone penetration and foreign direct investment. The null hypothesis of Kleibergen–Paap rk LM test is that the structural equation is under-identified. The null hypothesis of Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic is that the instrument is weakly correlated with the endogenous variable. The Kleibergen–Paap rk LM test *p*-value rejects the null hypothesis that the structural equation is under-identified. The Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic reject the null hypothesis that instrument is weakly correlated with the endogenous variable since their values are greater than the Stock-Yogo weak ID test critical values at 10%.

*$p < 0.10$, **$p < 0.05$ and ***$p < 0.01$.

by 3.128%, ceteris paribus [Column 5]. Comparing the estimated coefficients of income inequality presented in Table 3 to the income inequality coefficients presented in Table 4, we can observe that including additional control variables in the regression increases the magnitudes of the coefficients on the effect of income inequality on neonatal mortality, under-five mortality, infant mortality and maternal mortality [see Columns 4–5]. This indicates that the additional control covariates have minimized the omitted variable bias in mortality models. Overall, we conclude the effect of income inequality on health outcomes is still robust after controlling for additional covariates in the models.

4.3.2 | Considering income redistribution

In this section, we used a measure of income redistribution instead of income inequality in our analysis. The results based on using income redistribution are presented in Table 4. In Panel A of Table 4, the coefficient of the estimated effect of egalitarian democracy on income redistribution is positive and statistically significant at a 1% level in the models. This indicates that egalitarian democracy strongly contributes to the redistribution of income, and this finding is consistent with the effect of egalitarian democracy on income inequality discussed earlier. Again, the Kleibergen–Paap Wald F statistic and Cragg–Donald Wald F are large, greater than the Stock–Yogo weak ID test critical values at 10%, suggesting that egalitarian democracy is not a weak instrument. Further, the Kleibergen–Paap LM statistics *p*-value rejects the null hypothesis that the structural equation is under-identified. In Panel B of Table 4, the estimated coefficient on the effect of income redistribution on life expectancy is positive and statistically significant at a 5% level. In addition, the coefficient of the estimated effect of income redistribution on neonatal, under-five, infant and maternal mortality is negative and statistically significant at a 1% level. Based on the IV-2SLS estimates reported in Table 4, a 1% increase in income redistribution increases life expectancy by 0.018%, ceteris paribus [Column 1]. At the same time, a 1% increase in income redistribution reduces neo-natal mortality by 0.641% [Column 2], under-five mortality by 0.742% [Column 3], infant mortality by 0.743% [Column 4] and maternal mortality by 0.855%, ceteris paribus [Column 5]. These estimates suggest that countries with better income redistribution have better health outcomes.

4.3.3 | Alternative IV-estimator (Lewbel 2SLS technique)

We used the Lewbel 2SLS approach as an alternative IV-estimator to test the robustness and consistency of the IV-2SLS results. The Lewbel 2SLS estimates are presented in Table 5. In Table 5, Columns 1–5 show the estimates based on the Lewbel 2SLS internally generated heteroscedastic instruments. However, the results based on including the external instrument (egalitarian democracy) are displayed in Columns 6–10. We observed in Panel A of Table 5 that the effect of egalitarian democracy on income inequality is negative and statistically significant at a 1% level. The first-stage results align with the IV-2SLS first-stage results. Based on the second stage results [see Panel B of Table 5], the estimates consistently show that income inequality has a statistically significant negative effect on life expectancy [see Columns 1 and 6]. At the same time, the estimated coefficients on the impact of income inequality on neonatal mortality, under-five mortality, infant mortality and maternal mortality are positive and statistically significant at a 1% level [Columns 2–5 and 7–10]. The consistency of the impact of income inequality on health outcomes with and without external instruments confirms Lewbel's (2012) argument that applying the Lewbel 2SLS without external instruments produces estimates very close to those obtained when using the external instruments. The consistency of the Lewbel 2SLS results with the IV-2SLS results indicates that our results are robust to an alternative econometric estimator.

Table 6 also presents the IV-Lewbel 2SLS estimates on the effect of income redistribution on health outcomes. Again, Columns 1–5 in Table 10 show that estimates based on the IV-Lewbel 2SLS internally generated heteroscedastic instruments, while the estimates based on the external instrument (egalitarian democracy) are displayed in Columns 6–10. In Panel A of Table 6, we observed that the estimated effect of egalitarian democracy on income redistribution is positive and statistically significant at a 1% level. The first-stage results align with the IV-2SLS first-stage results in Table 6. Based on the second stage results [see Panel B of Table 6], the estimated coefficient on the impact of income redistribution on life expectancy is statistically insignificant [see Columns 1 and 6]. At the same time, the estimated coefficients on the impact of income redistribution on neonatal mortality, under-five mortality, infant mortality and maternal mortality are negative and statistically significant at a 1% level [Columns 2–5 and 7–10]. These findings are largely consistent with the IV-2SLS results presented in Table 4.

TABLE 5 Income inequality and health outcomes, IV-Lewbel 2SLS.

Variables	1 Life_exp	2 Neo_mort	3 Under_5 mort	4 Infant_mort	5 Mat_mort	6 Life_exp	7 Neo_mort	8 Under_5 mort	9 Infant_mort	10 Mat_mort
Panel B: Second-stage regression estimates. Dependent variable: Health outcome variables										
Income inequality	−0.529***	3.457***	3.969***	3.546***	4.839***	−0.282***	3.247***	3.584***	3.533***	3.662***
	(0.064)	(0.496)	(0.470)	(0.447)	(0.434)	(0.032)	(0.248)	(0.246)	(0.246)	(0.198)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	5.950***	−11.098***	−11.513***	−10.340***	−8.605***	4.780***	−10.434***	−10.168***	−10.758***	−3.128***
	(0.293)	(2.276)	(2.173)	(2.070)	(2.041)	(0.144)	(1.188)	(1.195)	(1.191)	(1.013)
Panel A: First-stage regression estimates. Dependent variable: Income inequality										
Egalitarian democracy						−0.371***	−0.371***	−0.371***	−0.371***	−0.388***
						(0.026)	(0.026)	(0.026)	(0.026)	(0.027)
Observations	1768	1773	1773	1773	1657	1734	1734	1734	1734	1623
R2	0.527	0.935	0.935	0.941	0.811	0.758	0.936	0.941	0.941	0.858
Kleibergen–Paap rk Wald F statistic	7.540	7.520	7.520	7.520	7.357	41.785	41.785	41.785	41.785	42.339
Cragg-Donald Wald F statistic						48.439	48.439	48.439	48.439	48.905
Kleibergen–Paap rk LM statistic	41.063	40.886	40.886	40.886	39.713	157.462	157.462	157.462	157.462	158.030
Kleibergen–Paap rk LM statistic (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: Heteroscedasticity robust standard errors in parentheses. Life expectancy (Life_exp); Neo-natal mortality (Neo_mort); Under-5 mortality (Under_5 mort); Infant mortality (Infant_mort); and Maternal mortality (Mat_mort). We include baseline control variables in all the models. The baseline control variables include GDP per capita, trade openness, urbanization, health expenditure, electrification and education. The null hypothesis of Kleibergen–Paap rk LM test is that the structural equation is under-identified. The null hypothesis of Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic is that the instrument is weakly correlated with the endogenous variable. The Kleibergen–Paap rk LM test p-value rejects the null hypothesis that the structural equation is under-identified. The Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic reject the null hypothesis that instrument is weakly correlated with the endogenous variable since their values are greater than the Stock–Yogo weak ID test critical values at 10%.

*$p < 0.10$, **$p < 0.05$ and ***$p < 0.01$.

TABLE 6 Income redistribution and health outcomes, IV-Lewbel 2SLS.

Variables	1 Life_exp	2 Neo_mort	3 Under_5 mort	4 Infant_ mort	5 Mat_mort	6 Life_exp	7 Neo_mort	8 Under_5 mort	9 Infant_ mort	10 Mat_mort
Panel B: Second-stage regression estimates. Dependent variable: Health outcome variables										
Income redistribution	−0.000	−0.150***	−0.154***	−0.143***	−0.204***	0.003	−0.230***	−0.248***	−0.237***	−0.330***
	(0.003)	(0.030)	(0.032)	(0.032)	(0.045)	(0.003)	(0.034)	(0.036)	(0.036)	(0.052)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	2.853***	2.024**	6.344***	4.772***	11.007***	2.849***	2.120**	6.456***	4.884***	11.186***
	(0.088)	(0.875)	(1.108)	(1.044)	(1.200)	(0.089)	(0.882)	(1.119)	(1.053)	(1.199)
Panel A: First-stage regression estimates. Dependent variable: Income redistribution										
Egalitarian democracy						1.455***	1.455***	1.455***	1.455***	1.525***
						(0.165)	(0.165)	(0.165)	(0.165)	(0.176)
Observations	835	835	835	835	771	835	835	835	835	771
R2	0.781	0.960	0.957	0.957	0.798	0.780	0.961	0.959	0.959	0.807
Kleibergen–Paap rk Wald F statistic	92.993	92.993	92.993	92.993	84.645	110.112	110.112	110.112	110.112	101.777
Cragg–Donald Wald F statistic						110.560	110.560	110.560	110.560	103.153
Kleibergen–Paap rk LM statistic	100.674	100.674	100.674	100.674	93.057	135.107	135.107	135.107	135.107	128.033
Kleibergen–Paap rk LM statistic (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: Heteroscedasticity robust standard errors in parentheses. Life expectancy (Life_exp); Neo-natal mortality (Neo_mort); Under-5 mortality (Under_5 mort); Infant mortality (Infant_mort); and Maternal mortality (Mat_mort). We include baseline control and other control variables in all the models. The baseline control variables include GDP per capita, trade openness, urbanization, health expenditure, electrification and education. The additional variables included are remittance, carbon emissions, mobile phone penetration and foreign direct investment. The null hypothesis of Kleibergen–Paap rk LM test is that the structural equation is under-identified. The null hypothesis of Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic is that the instrument is weakly correlated with the endogenous variable. The Kleibergen–Paap rk LM test *p*-value rejects the null hypothesis that the structural equation is under-identified. The Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic reject the null hypothesis that instrument is weakly correlated with the endogenous variable since their values are greater than the Stock–Yogo weak ID test critical values at 10%.

$^{*}p < 0.10$, $^{**}p < 0.05$ and $^{***}p < 0.01$.

4.3.4 | Regional analysis

As presented in the Appendix (see Figures), differences exist in health outcomes and income inequality among regions. In this section, we empirically explore if the impact of income inequality on health outcomes differs across geographical regions. We report the regional results in Tables 7 to 9. Across the regions, the first stage results reported in Panel A indicate that egalitarian democracy has a stronger relationship with income inequality. The first stage results show that egalitarian democracy has a statistically significant positive effect on income inequality in South Asia [see Table 7, Columns 1–5], Europe and Central Asia [see Table 7, Columns 6–10] and Caribbean and Latin America [see, Table 9, Columns 6–10]. On the other hand, egalitarian democracy has a statistically significant negative effect on income inequality in the Middle East and North Africa [see Table 8, Columns 1–5], East Asia and Pacific [see Table 8, Columns 6–10] and sub-Saharan Africa [see, Table 9, Columns 1–5].

In Table 7, the second stage results show that in South Asia [see Columns 1–5], the estimated coefficient on the effect of income inequality on life expectancy is negative and statistically significant at 5%. Also, the estimated coefficient on the effect of income inequality on neo-natal mortality is statistically insignificant, while the impact on under-five mortality and infant mortality is positive and statistically significant at a 5% level. Also, in South Asia, income inequality has a statistically significant negative effect on maternal mortality at a 10% level. In addition, in Columns 6–9 of Table 7, the second stage results show that in Europe and Central Asia, income inequality has a statistically significant positive effect on life expectancy and maternal mortality, but the impact of income inequality on neonatal mortality, under-five mortality and infant mortality is statistically insignificant.

In Table 8, the second stage results show that in the Middle East and North Africa [see Columns 1–5], income inequality has a statistically significant negative effect on life expectancy, while the impact of income inequality on under-five mortality, infant mortality and maternal mortality is positive and statistically significant. Income inequality does not significantly affect neo-natal mortality in the Middle East and North Africa. In Columns 6–9 of Table 8, income inequality has a statistically insignificant effect on all the health outcomes variables in East Asia and Pacific. We observe in Columns 1–5 of Table 9 that in sub-Saharan Africa, income inequality has a statistically significant negative effect on life expectancy, while the impact of income inequality on neonatal mortality, under-five mortality, infant mortality and maternal mortality is positive and statistically significant at 1%. In Columns 6–10 of Table 9, the results show that in the Caribbean and Latin America, income inequality has a statistically significant positive effect on life expectancy, neo-natal mortality, under-five mortality and infant mortality, while its impact on maternal mortality is statistically insignificant.

4.4 | Analyzing potential causal channels

The previous studies did not examine the potential causal channels through which income inequality affects health outcomes. As a contribution to the literature, this section presents an empirical analysis of the causal channels (mediators) through which health outcomes are impacted by income inequality. The literature on determinants of health outcomes has shown that GDP per capita (e.g. Rustagi & Akter, 2022), health expenditure (e.g. Gallet & Doucouliagos, 2017), education (e.g. Davies et al., 2018) and carbon emissions (e.g. Dong et al., 2021) significantly influence health outcomes. However, the effect of income inequality on these factors suggests that they could mediate the relationship between income inequality and health outcomes. For instance, from the social-unrest theory, rising income inequality stimulates disruptive and unproductive activities such as riots, crime, political turnovers, etc., which can disincentive investment and further distort labour market activities to hinder long-run economic performance (GDP per capita) (Alesina & Perotti, 1996; Barro, 2000; Perotti, 1996).

TABLE 7 Income inequality and health outcomes in South Asia and Europe and Central Asia, IV-Lewbel 2SLS.

	1	2	3	4	5	6	7	8	9	10
	South Asia					**Europe and Central Asia**				
Variables	**Life_exp**	**Neo_ mort**	**Under_5 mort**	**Infant_ mort**	**Mat_mort**	**Life_exp**	**Neo_mort**	**Under_5 mort**	**Infant_ mort**	**Mat_mort**
Panel B: Second-stage regression estimates. Dependent variable: Health outcome variables										
Income inequality	−0.089**	0.698	1.098**	1.036**	−1.179*	0.042**	0.154	0.025	0.033	1.515***
	(0.041)	(0.473)	(0.464)	(0.463)	(0.622)	(0.018)	(0.569)	(0.505)	(0.527)	(0.540)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	3.784***	3.853***	4.355***	3.829***	15.429***	4.994***	433.785***	448.383***	443.769***	−123.402**
	(0.119)	(1.353)	(1.346)	(1.331)	(1.952)	(1.924)	(75.852)	(86.936)	(85.312)	(49.518)
Panel A: First-stage regression estimates. Dependent variable: Income inequality										
Egalitarian democracy	0.131***	0.131***	0.131***	0.131***	0.168***	0.182***	0.182***	0.182***	0.182***	0.188***
	(0.062)	(0.062)	(0.062)	(0.062)	(0.059)	(0.043)	(0.043)	(0.043)	(0.043)	(0.047)
Observations	76	76	76	76	73	705	705	705	705	634
R2	0.921	0.997	0.997	0.997	0.870	0.764	0.909	0.919	0.917	0.514
Kleibergen–Paap rk Wald F statistic	67.585	67.585	67.585	67.585	81.067	18.459	18.459	18.459	18.459	16.122
Cragg–Donald Wald F statistic	25.691	25.691	25.691	25.691	30.704	27.903	27.903	27.903	27.903	23.871
Kleibergen–Paap rk LM statistic	18.823	18.823	18.823	18.823	18.863	63.141	63.141	63.141	63.141	55.645
Kleibergen–Paap rk LM statistic (*p*-value)	0.009	0.009	0.009	0.009	0.009	0.000	0.000	0.000	0.000	0.000

Note: Heteroscedasticity robust standard errors in parentheses. Life expectancy (Life_exp); Neo-natal mortality (Neo_mort); Under-5 mortality (Under_5 mort); Infant mortality (Infant_mort); and Maternal mortality (Mat_mort). We include baseline control variables in all the models. The baseline control variables include GDP per capita, trade openness, urbanization, health expenditure, electrification and education. The null hypothesis of Kleibergen–Paap rk LM test is that the structural equation is under-identified. The null hypothesis of Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic is that the instrument is weakly correlated with the endogenous variable. The Kleibergen–Paap rk LM test *p*-value rejects the null hypothesis that the structural equation is under-identified. The Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic reject the null hypothesis that instrument is weakly correlated with the endogenous variable since their values are greater than the Stock–Yogo weak ID test critical values at 10%.

*$p < 0.10$, **$p < 0.05$ and ***$p < 0.01$.

TABLE 8 Income inequality and health outcomes in MENA and East Asia and Pacific, IV-Lewbel 2SLS.

	1	2	3	4	5	6	7	8	9	10
	Middle East and North Africa					**East Asia and Pacific**				
Variables	**Life_exp**	**Neo_mort**	**Under_5 mort**	**Infant_ mort**	**Mat_mort**	**Life_exp**	**Neo_mort**	**Under_5 mort**	**Infant_ mort**	**Mat_mort**
Panel B: Second-stage regression estimates. Dependent variable: Health outcome variables										
Income inequality	−0.088***	0.647	1.066**	1.077**	1.022**	0.026	0.617	0.406	0.561	−0.389
	(0.030)	(0.428)	(0.436)	(0.443)	(0.500)	(0.052)	(0.569)	(0.484)	(0.496)	(0.793)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	3.742***	−3.120	−3.790	−4.905	8.287**	3.210***	6.285***	9.002***	8.064***	15.004***
	(0.245)	(3.175)	(3.153)	(3.180)	(3.427)	(0.157)	(1.741)	(1.500)	(1.521)	(2.682)
Panel A: First-stage regression estimates. Dependent variable: Income inequality										
Egalitarian democracy	−0.415***	−0.415***	−0.415***	−0.415***	−0.416***	−0.038***	−0.038***	−0.038***	−0.038***	−0.056***
	(0.044)	(0.044)	(0.044)	(0.044)	(0.045)	(0.019)	(0.019)	(0.019)	(0.019)	(0.023)
Observations	127	127	127	127	123	152	152	152	152	141
R2	0.868	0.979	0.974	0.974	0.904	0.945	0.979	0.987	0.986	0.942
Kleibergen–Paap rk Wald F statistic	48.086	48.086	48.086	48.086	42.729	130.743	130.743	130.743	130.743	86.724
Cragg–Donald Wald F statistic	32.467	32.467	32.467	32.467	30.184	87.392	87.392	87.392	87.392	57.607
Kleibergen–Paap rk LM statistic	45.768	45.768	45.768	45.768	43.136	42.121	42.121	42.121	42.121	39.322
Kleibergen–Paap rk LM statistic (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: Heteroscedasticity robust standard errors in parentheses. Life expectancy (Life_exp); Neo-natal mortality (Neo_mort); Under-5 mortality (Under_5 mort); Infant mortality (Infant_mort); and Maternal mortality (Mat_mort). We include baseline control variables in all the models. The baseline control variables include GDP per capita, trade openness, urbanization, health expenditure, electrification and education. The null hypothesis of Kleibergen–Paap rk LM test is that the structural equation is under-identified. The null hypothesis of Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic is that the instrument is weakly correlated with the endogenous variable. The Kleibergen–Paap rk LM test *p*-value rejects the null hypothesis that the structural equation is under-identified. The Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic reject the null hypothesis that instrument is weakly correlated with the endogenous variable since their values are greater than the Stock–Yogo weak ID test critical values at 10%.

$*p < 0.10$, $**p < 0.05$ and $***p < 0.01$.

TABLE 9 Income inequality and health outcomes in sub-Saharan Africa and Caribbean-Latin America, IV-Lewbel 2SLS.

	1	2	3	4	5	6	7	8	9	10
	Sub-Saharan Africa					Caribbean and Latin America				
Variables	**Life_exp**	**Neo_mort**	**Under_5 mort**	**Infant_ mort**	**Mat_mort**	**Life_exp**	**Neo_ mort**	**Under_5 mort**	**Infant_ mort**	**Mat_mort**
Panel B: Second-stage regression estimates. Dependent variable: Health outcome variables										
Income inequality	−0.709***	3.523***	4.345***	3.970***	3.625***	0.058*	1.789***	1.126**	1.168**	0.456
	(0.072)	(0.364)	(0.414)	(0.381)	(0.428)	(0.034)	(0.522)	(0.472)	(0.486)	(0.542)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	6.650***	−10.967***	−13.629***	−12.928***	−4.842***	2.881***	−0.965	5.772**	4.572*	15.360***
	(0.250)	(1.240)	(1.359)	(1.293)	(1.398)	(0.198)	(2.938)	(2.644)	(2.729)	(2.930)
Panel A: First-stage regression estimates. Dependent variable: Income inequality										
Egalitarian democracy	−0.196***	−0.196***	−0.196***	−0.196***	−0.195***	0.064***	0.064***	0.064***	0.064***	0.050***
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.025)	(0.025)	(0.025)	(0.025)	(0.023)
Observations	365	365	365	365	362	309	309	309	309	290
R2	0.533	0.947	0.950	0.956	0.627	0.723	0.941	0.951	0.949	0.653
Kleibergen–Paap rk Wald F statistic	50.245	50.245	50.245	50.245	51.395	21.029	21.029	21.029	21.029	24.366
Cragg–Donald Wald F statistic	28.878	28.878	28.878	28.878	28.951	20.729	20.729	20.729	20.729	20.970
Kleibergen–Paap rk LM statistic	44.018	44.018	44.018	44.018	44.057	41.061	41.061	41.061	41.061	37.335
Kleibergen–Paap rk LM statistic (*p*-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: Heteroscedasticity robust standard errors in parentheses. Life expectancy (Life_exp); Neo-natal mortality (Neo_mort); Under-5 mortality (Under_5 mort); Infant mortality (Infant_mort); and Maternal mortality (Mat_mort). We include baseline control variables in all the models. The baseline control variables include GDP per capita, trade openness, urbanization, health expenditure, electrification and education. The null hypothesis of the Kleibergen–Paap rk LM test is that the structural equation is under-identified. The null hypothesis of Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic is that the instrument is weakly correlated with the endogenous variable. The Kleibergen–Paap rk LM test *p*-value rejects the null hypothesis that the structural equation is under-identified. The Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic reject the null hypothesis that instrument is weakly correlated with the endogenous variable since their values are greater than the Stock–Yogo weak ID test critical values at 10%.

$^{*}p < 0.10$, $^{**}p < 0.05$ and $^{***}p < 0.01$.

TABLE 10 Effect of income inequality on mediators, IV-2SLS (potential mediators).

	1 GDP per capita	2 Education	3 Health expenditure	4 Carbon emissions
Panel B: Second-stage regression estimates: Dependent variable: Mediating variables				
Income inequality	−5.711***	−0.871***	−3.484***	−2.054***
	(0.231)	(0.057)	(0.206)	(0.136)
Control variables	YES	YES	YES	YES
Constant	30.780***	5.198***	15.732***	−3.036***
	(1.208)	(0.300)	(0.973)	(0.706)
Panel A: First-stage regression estimates. Dependent variable: Income inequality				
Egalitarian democracy	−0.487***	−0.526***	−0.430***	−0.490***
	(0.018)	(0.021)	(0.020)	(0.018)
Observations	2566	1983	2009	2545
Kleibergen–Paap rk Wald F statistic	741.410	608.439	447.141	740.634
Cragg–Donald Wald F statistic	712.107	637.544	438.759	708.552
Kleibergen–Paap rk LM statistic	476.480	385.205	308.098	474.618
Kleibergen–Paap rk LM statistic (*p*-value)	0.000	0.000	0.000	0.000

Note: Heteroscedasticity robust standard errors in parentheses. We included trade openness, urbanization, electrification, remittance, mobile phone penetration and foreign direct investment in all the models. The null hypothesis of Kleibergen–Paap rk LM test is that the structural equation is under-identified. The null hypothesis of Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic is that the instrument is weakly correlated with the endogenous variable. The Kleibergen–Paap rk LM test *p*-value rejects the null hypothesis that the structural equation is under-identified. The Kleibergen–Paap rk Wald F statistic and Cragg–Donald Wald F statistic reject the null hypothesis that instrument is weakly correlated with the endogenous variable since their values are greater than the Stock–Yogo weak ID test critical values at 10%.

$^{*}p < 0.10$, $^{**}p < 0.05$ and $^{***}p < 0.01$.

Also, Ravallion et al. (2000) marginal propensity to emit (MPE) theory indicates that the marginal propensity to emit declines with income and that rising income inequality can limit carbon emissions. Previous empirical studies have documented a negative relationship between income inequality and carbon emissions (Grunewald et al., 2017; Hübler, 2017; Ravallion et al., 2000). At the same time, income inequality affects people's ability to pay for medical and educational expenses. This indicates that rising income inequality could hinder health expenditure and educational enrolment.

We, therefore, used a two-stage procedure used by previous empirical research (Acheampong et al., 2021; Awaworyi & Smyth, 2020; Levine & Rothman, 2006) to test if GDP per capita, education, health expenditure and carbon emissions mediate the effect of income inequality on health outcomes. In the first stage, income inequality should have a significant relationship with the potential mediators (namely, GDP per capita, education, health expenditure and carbon emissions). In fulfilment, we observed that income inequality has a statistically significant negative relationship with the mediators at a 1% level (see Table 10).

In the second stage, we included the mediators as additional variables in the models that link income inequality to health outcomes. To conclude that any of the variables is a mediator, it should either reduce the estimated coefficient on income inequality or render income inequality statistically insignificant. We estimate the comparable (baseline) coefficients [see Table 11, Column 1] by dropping GDP per capita, education, health expenditure and carbon emissions while maintaining the remaining control variables. In the second stage analysis, we observed that including GDP per capita

TABLE 11 Mediation analysis.

	Baseline estimates	Second-stage estimates after including the potential mediators			
	(1)	(2)	(3)	(4)	(5)
		GDP per capita	Education	Health expenditure	Carbon emissions
Dependent variable: Life_exp					
Income inequality	−0.337***	−0.128***	−0.286***	−0.250***	−0.364***
	(0.017)	(0.029)	(0.019)	(0.026)	(0.023)
Dependent variable: Neo_mort					
Income inequality	7.182***	4.743***	5.891***	5.538***	7.396***
	(0.265)	(0.332)	(0.267)	(0.306)	(0.363)
Dependent variable: Under_5 mort					
Income inequality	7.427***	4.909***	6.076***	5.687***	7.614***
	(0.269)	(0.339)	(0.268)	(0.304)	(0.367)
Dependent variable: Infant_mort					
Income inequality	7.468***	5.092***	6.212***	5.876***	7.697***
	(0.270)	(0.345)	(0.273)	(0.312)	(0.371)
Dependent variable: Mat_mort					
Income inequality	6.859***	4.288***	5.675***	4.581***	6.530***
	(0.297)	(0.400)	(0.272)	(0.261)	(0.352)

Note: Heteroscedasticity robust standard errors in parentheses. We omitted the control variables and post-estimation statistics from the Table because of space. The full results are available upon request.

$^{*}p < 0.10$, $^{**}p < 0.05$ and $^{***}p < 0.01$.

reduces the size of the estimated coefficient on the impact of income inequality on life expectancy [from 0.337% to 0.128%], neo-natal mortality [from 7.182% to 4.743%], under-five mortality [from 7.427% to 4.909%], infant mortality [from 7.468% to 5.092%] and maternal mortality [from 6.859% to 4.288%]. Also, accounting for education reduces the size of the estimated coefficient on the impact of income inequality on life expectancy [from 0.337% to 0.286%], neo-natal mortality [from 7.182% to 5.891%], under-five mortality [from 7.427% to 6.076%], infant mortality [from 7.468% to 6.212%] and maternal mortality [from 6.859% to 5.675%]. Similarly, health expenditure reduces the size of the estimated coefficient on the impact of income inequality on life expectancy [from 0.337 to 0.250], neo-natal mortality [from 7.182% to 5.538%], under-five mortality [from 7.427% to 5.687%], infant mortality [from 7.468% to 5.876%] and maternal mortality [from 6.859% to 4.581%]. The inclusion of carbon emissions does not reduce the size of the estimated coefficient on the impact of income inequality on life expectancy, neo-natal mortality, under-five mortality and infant mortality but only reduces the coefficient on inequality on maternal mortality from 6.859% to 6.530%.

From the second stage analysis, it is obvious that GDP per capita, education, health expenditure and carbon emissions (only when maternal mortality is considered) are some of the main channels through which income inequality worsens health outcomes. It must also be noted that as income inequality maintains its signs and statistically significant level after the exclusion of these potential mediators from the analysis [see Table 11, Column 1] indicates that our empirical relationship established earlier between income inequality and the health outcomes are not driven by the inclusion of these potential mediating variables in the empirical models.

5 | CONCLUSION AND POLICY IMPLICATIONS

The role of income inequality in health outcomes continues to attract the attention of researchers and policymakers. To improve global and regional health outcomes, health policymakers need robust empirical evidence to support the design of health policies. While scholars have empirically investigated the impact of income inequality on behavioural, mental and physical health outcomes, their findings remain conflicting. One strand of literature claims that income inequality has no relationship with health outcomes, while other groups support that income inequality is associated with worse health outcomes. Apart from the mixed findings, the results from most of these studies can be interpreted as correlational and not causal. Most of the analytical techniques deployed by the previous studies do not address endogeneity, making it difficult to make causal inferences. Finally, the survey of empirical literature shows that little is done quantitatively to identify the potential causal pathways through which income inequality influences health outcomes. The failure to identify the potential channels would obscure policymakers' understanding of the complex relationship between income inequality and health outcomes, and this could render the health policies ineffective. Motivated by these conflicting findings and research gaps, we used a panel dataset for a global sample of 154 countries from 1990 to 2020 to examine the effect of income inequality and redistribution on health outcomes (life expectancy, neo-natal mortality, under-five mortality, infant mortality and maternal mortality). For the identification strategy, we relied on the IV-2SLS method and used egalitarian democracy as an instrument for income inequality and redistribution. Our study is unique and contributes to the literature as it (i) addresses endogeneity concerns using an external instrument, (ii) considers regional heterogeneity, (iii) conducts a series of robustness checks, including using the alternative IV technique and accounting for more confounding variables in our analysis and (iv) identifies potential causal pathways through which income inequality affects health outcomes.

Our findings revealed a strong relationship between egalitarian democracy, income inequality and income redistribution. Our post-estimation statistics suggested that egalitarian democracy is a strong and relevant instrument. Applying the IV technique with the plausible external instrument (egalitarian democracy) contributed to addressing attenuation bias in the OLS estimates caused by measurement error. Our empirical analysis based on IV-2SLS revealed that, on average, higher income inequality leads to poor health outcomes. At the same time, higher income redistribution leads to better health outcomes. Apart from the statistically significant relationship, we observed that the relationship between income inequality and health outcomes is also economically significant. The estimated elasticities (size of the coefficients) of income inequality are relatively larger than those of key determinants of health outcomes such as GDP per capita, health expenditure, trade openness, urbanization, education and electrification. Also, apart from the life expectancy model, where the estimated coefficient on inequality is less than unity (fairly inelastic), in the mortalities' models, the size of the estimated coefficients on income inequality is greater than unity (fairly elastic).

Our results further showed that the established relationship between income inequality and health outcomes is even more robust after further controlling for confounding variables such as remittance, carbon emissions, mobile phone penetration and foreign direct investment in our analysis. Further robustness checks based on the Lewbel 2SLS supported our results that income inequality is associated with poorer health outcomes. The established relationship between income inequality and health outcomes can be interpreted as causal since our mediation analysis indicated that GDP per capita, education, health expenditure and carbon emissions (only when maternal mortality is considered) are some of the main channels through which income inequality affects health outcomes. The negative effect of income inequality on health outcomes is consistent, even if we exclude these mediating variables from our empirical models. Our results also established that the impact of income inequality on health outcomes differs among geographical regions. While our results showed that the effect of income inequality on health outcomes is statistically insignificant in Asia-Pacific, Europe and Central Asia, we found that income inequality strongly worsens health outcomes in South Asia, the Middle East and North Africa, sub-Saharan Africa and the Caribbean and Latin America. The underdeveloped nature of these regions, with seemingly high-income inequality and relatively low government support and functioning public health systems in a chunk of the countries making up these regions, may explain this outcome. As a result, the wider the income inequality gap, the less those at the bottom of the income ladder can afford health care services.

Apart from these findings' novelty and scholarly contributions, our results have significant implications for global and regional health policies. The evidence that income inequality hinders the attainment of better health outcomes suggests that policymakers should not overlook income inequality during the design of health policies. While investing in health infrastructure generates positive outcomes on population health, we argue that the failure of policymakers to consider and address income inequality could impede efforts to enhance global and regional health outcomes. Our findings imply that reducing income inequality or increasing income redistribution would complement other global health policies to attain better health outcomes. Policymakers could develop and implement safety-net programs to generate employment and income to support lower-income groups. Given that the estimated effect of income inequality on health outcomes, especially mortalities, is fairly elastic, any policy measures that would significantly address income inequality would substantially improve global and regional health outcomes.

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CONFLICT OF INTEREST STATEMENT

The authors declare no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDIX

TABLE A1 List of countries.

South Asia countries
Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka
Europe and central Asia countries
Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Kazakhstan, Kosovo, Latvia, Lithuania, Luxembourg, Moldova, Montenegro, The Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Serbia, Slovenia, Spain, Sweden, Switzerland, Tajikistan, Turkmenistan, Ukraine, United Kingdom and Uzbekistan.
Middle East and North African countries
Algeria, Bahrain, Djibouti, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Malta, Morocco, Oman, Qatar, Saudi Arabia, Tunisia and the United Arab Emirates
East Asia and Pacific countries
Australia, Cambodia, China, Fiji, Indonesia, Japan, Malaysia, Mongolia, New Zealand, Papua, New Guinea, Philippines, Samoa, Singapore, Thailand, Timor-Leste, Tonga, Tuvalu, Vanuatu and Vietnam
Sub-Saharan African countries
Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Eswatini, Ethiopia, Gabon, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe
Latin America and the Caribbean countries
Argentina, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago and Uruguay

Note: Countries are classified based on World Bank regional classification.

TABLE A2 Descriptive statistics.

Variable	Proxies	Mean	Std. Dev.	Min	Max	Sources
Life expectancy	Life expectancy at birth, total (years)	4.212	0.157	2.646	4.438	WDI
Neonatal mortality	Number of neonatal deaths	7.374	2.482	0	14.286	
Under-five mortality	Number of under-five deaths	8.137	2.617	0.693	15.068	
Infant mortality	Number of infant deaths	7.888	2.544	0.693	14.691	
Maternal mortality	Maternal mortality ratio (modelled estimate per 100,000 live births)	4.116	1.74	0.693	7.816	
Income inequality	Post-tax Gini coefficient	3.633	0.228	2.991	4.181	SWIID
Income redistribution	Absolute income redistribution*	2.19	0.972	−2.303	3.246	
Egalitarian democracy	Egalitarian democracy index	0.404	0.244	0.037	0.885	V-DEM
GDP per capita	GDP per capita (constant 2015 US$)	8.393	1.449	5.248	11.63	WDI
Trade openness	Trade (% of GDP)	4.268	0.598	−3.863	6.081	
Urbanization	Urban population	14.966	1.934	8.225	20.584	
Health expenditure	Domestic general government health expenditure (% of GDP)	0.926	0.754	−2.475	3.183	
Electrification	Access to electricity (% of population)	4.179	0.772	−0.628	4.605	
Education	School enrolment, secondary (% gross)	4.197	0.635	1.653	5.099	
Remittances	Personal remittances received (% of GDP)	0.192	1.845	−10.448	5.121	
Carbon emissions	CO2 emissions (kt)	9.277	2.376	2.303	16.213	
Mobile phone penetration	Mobile cellular subscriptions (per 100 people)	2.728	2.635	−8.971	5.4	
Foreign direct investment	Foreign direct investment, net inflows (% of GDP)	0.753	1.542	−14.987	6.107	

Note: All the variables in the Appendix Table are log-transformed.

Abbreviations: SWIID, Standardized Word Income Inequality Database; V-DEM, Varieties of Democracy; WDI, World Development Indicators.