Socio-Economic Planning Sciences 93 (2024) 101905

Contents lists available at ScienceDirect

Socio-Economic Planning Sciences

journal homepage: www.elsevier.com/locate/seps

Health insurance and height inequality: Evidence from European health insurance expansions

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ARTICLE INFO

JEL classification:
I13
J15
N34

Keywords:
Health insurance expansions
Heights
Health inequality
Inequality
Economic development

ABSTRACT

Health insurance expansions can improve health outcomes by increasing access to healthcare. This is especially true among the poorer segments of the population, who may not be able to afford the cost of healthcare, or might lack the information about where to seek proper medical care. In this paper we examine whether increased access to health insurance has historically reduced height inequality by promoting body growth, particularly among poor individuals, and so enhanced their height, a widely used and well-established anthropometric health and well-being indicator. We draw on data from a large global panel of countries for which we could measure height inequality. Our evidence documents that indeed within-country differences in height inequality decreased following health insurance expansions towards near-universal coverage.

1. Introduction

The expansion of health insurance programs in the 19th and 20th centuries to provide coverage to larger segments of the population was critical for increasing access to medical care, and potentially for improving human health. Following Bismarck's lead on expanding the number of people being insured in Germany [1], the proliferation of state-funded health insurance in countries such as Denmark, Belgium, Norway, and the United Kingdom (UK) significantly reduced the costs of accessing a range of health technologies and preventive programs [2]. Before the introduction of comprehensive health insurance, physicians in many of those countries acted as information gatekeepers, restricting the provision of health information primarily to patients who paid substantial amounts (hence basic health informamtion was not accessible for many low-income groups). In contrast, in comprehensive health insurance systems the access to medical care was widened. This is expected to have influenced individuals' behaviour and health utilization, including preventive and curative care [3]. Such effects were especially important among unskilled, low-income, and near-elderly adults, who were otherwise uninsured [4,5].

So far, in other settings, it has been shown that *contemporary* insurance expansions have been followed by improvements in a variety of health outcomes: infant and child mortality has been demonstrated to fall; Currie and Gruber [6] document improvement in child health effects after the introduction of Medicaid in the United States (US). Similarly, Goodman-Bacon [7] comparing birth cohorts before and after the introduction of Medicaid across several US states, document that children eligible for Medicaid in the early years are both significantly healthier and financially better off as adults later in life. This is consistent with the fact that individual's health during childhood is largely determined by parental actions guided by medical improvements such as critical dietary recommendations, access to vaccination, recurring screenings, or treatments for specific conditions, all of which weigh heavily on a person's health later in life [8]. Furthermore, health insurance encompasses income effects and more financial stability, which in turn reduces stress from going bankrupt and improves well-being [9].

To date, however, the literature reveals ambiguous effects of insurance expansions - whether developed by the state, the market, mutual, or employment-based designs - on the health of both adults and children [10]. The ambiguity stems from the fact that, for example, in the Mexican case the public health insurance was dramatically expanded during the 2000s, while the inequality of health increased during the same period [10]. The authors argue that health insurance expansion was only one barrier in the access to health care, and other changes also

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https://doi.org/10.1016/j.seps.2024.101905
Received 20 November 2023; Received in revised form 4 April 2024; Accepted 19 April 2024
Available online 21 April 2024

need to be considered to understand trends in health inequality. This example motivates our study to consider the big picture of health insurance and health inequality.

The impact of insurance expansions on people who would otherwise face difficulties with healthcare access is particularly interesting. This is because, in addition to potentially improving health for the entire community, health insurance expansions are expected to alter health inequities by gradually incorporating portions of the population more in need. Therefore, improving the health of those with the worst health conditions can arguably give rise to a reduction in population health disparities if the marginal contribution of healthcare access and utilization to one's health is larger at lower levels of the health status distribution. If the intervention promotes mostly health care access to the lower income (and low health) group which is more likely to exhibit higher marginal gains, the overall effect should result in a reduction even in the case of equal access to the same resources.[1]

The main aim of this research is to examine the historical influence of the introduction of health insurance on a measure of health inequality, specifically the Gini coefficient of human height (Height-Gini). The advantage of human height as a proxy for health, is that it allows undertaking an analysis of health evolution over the past 200 years. Most insurance expansions across countries have taken place at a time when there was little access to health indicators to measure the effects of insurance expansions, which limited the analysis of insurance on some well-defined health measures such as mortality [11]. One way to circumvent the limited access to such data is the analysis of retrospective heights of individuals, a measure very sensitive to the improvement of standards of living and early-life health investments. In addition, once adult age has been reached, height is stable before people start to shrink around after the age of fifty [12,13]. Therefore, the distribution of adult peoples' heights within a country provides an estimate of health that is less subject to bias for omitted variables, which is often problematic with other health measures.

This paper exploits cross-country variation in health insurance expansions and examines its effect on height inequality, measured using height data for a large sample of countries. Health insurance coverage indicates both whether a country has public or private healthcare insurance, as well as the degree of coverage available to its citizens as defined by the World Health Organization. That is, the focus of the study is on determining the presence of Universal Health Coverage (UHC) in a specific country and year. We construct a binary indicator, the Universal Health Coverage (UHC) dummy indicating whether a country has jointly legislated for some form of social or collectively funded insurance and achieved coverage of more than 90% of the population, including privately insured people, when such an option is available. We report both baseline estimates alongside other estimates from an Instrumental Variable (IV) strategy which exploits the diffusion and establishment of communism in Russia at the beginning of the twentieth century, and thus assess whether health insurance expansion causally reduces height inequality. Our estimates document a positive and economically relevant reduction in height inequality, where UHC explains between 22 and 29 Gini points of height inequality's reduction (Table 4).

Our baseline results are robust to several checks and document a strong negative conditional correlation between the achievement of UHC and the Height-Gini. We thus contribute to the literature by examining the effect of major health insurance expansions using a large cross-country dataset covering up to 134 countries and almost two centuries from 1810 to 2000. Hence, we offer the analysis of a data set that reaches far back in time – this in itself presents a new contribution. Second, we focus on measuring the effect of health insurance expansion on inequalities in health, which have received limited attention in the literature, and primarily focus on average health effects ([14] for a recent survey). Third, we draw on height measures for health inequality, where the dispersion in the use of human stature is not affected by the traditional problems of self-reporting bias that health measures exhibit as it can be objectively assessed during in-person surveys or through administrative records, where height is measured independently on the subject, or at least can be assessed by third parties when self-reported in presence.

The rest of the paper is organised as follows. Section 2 reports the background literature on health insurance's effect on health and discusses potential mechanisms. Section 3 details the empirical strategy followed. Section 4 describes the data collection and processing. In section 5, we discuss the descriptive statistics and provide the results, including those obtained with IV-2SLS estimation. Section 6 reports a battery of additional robustness checks. Finally, section 7 concludes.

2. Related literature

2.1. Inequality and heights

Heights are commonly employed as a proxy for health and nutritional quality, and health determinants associated with living conditions in early life. Heights have been found to correlate with a series of health measures [15,16]. Like other measures of health, height can predict the economic performance of individuals, such as income or wages [17,18], which are also dependent on cognitive abilities [19]. However, socioeconomic circumstances can influence individual heights, and therefore height disparities in a population [20,21]. Consistently, Candela-Martınez et al. [22] already document evidence of a reduction of height differences by educational attainment in Spain, in the period 1940 to 1994, when healthcare was universalised, and the welfare state exhibited significant development.

2.2. Insurance, health, and inequality

Health insurance minimises the risk of unexpected medical costs that individuals or households would instead have to bear if they had to pay out of pocket. When costs are unaffordable to households, people are expected forego healthcare, which can have detrimental consequences for their health. Thus, increasing health insurance coverage encompasses large utility gains for households through the reduction of uncertainty and variable health-related expenditures [23]. However, the effect of health insurance on health is not clear from the literature: Finkelstein et al. [4] document causal evidence that public health insurance expansions improve self-reported health and mental healthcare among those low-income individuals in the US who randomly qualified for a Medicaid expansion in Oregon. The effect on other objective measures of health, however, was not significant. Costa-Font et al. [10] document that the expansion of public insurance in Mexico has failed to reduce health inequality and mobility of individuals across the health-states distribution. Nevertheless, several related studies report findings that are highly context-dependent and incremental compared to earlier reforms. The effects of these reforms cannot be measured in such a straightforward manner with existing evidence. A study on China suggests that, while health insurance is linked to reduced health disparities, this effect is mainly due to circumstances which are not related to the healthcare system [24]. The exception is Bauernschuster et al. [11], who show that the introduction of health insurance in 1884 in Bismarck's Germany accounts for a decrease in mortality ranging between 24% and 45% across blue-collar occupations affected by the reform.

2.3. Information and preventive effects

Insurance expansion can be important in promoting the uptake of some preventable behaviours. Individuals are more likely to adopt highly valuable health behaviours when they receive health information

[1] This reasoning is based on the concavity of the production function of health, which is arguably a quite widely accepted assumption.

from a source they trust, such as from healthcare providers [25]. Insurance can in turn reduce the impact of cognitive biases that lead to negative behavioural risks [26], and the underuse of health care. Hence, so far, the literature indicates that access to affordable insurance, combined with the provision of high-value health information, improves health outcomes, especially for those who were in poorer health before the expansions. However, health insurance expansions earlier in time were different from recent ones, and heights are more sensitive to improvement in specific periods of one's life course. This study will provide evidence that will help understand this question.

3. Methods

3.1. Estimating inequality using the Gini coefficient of height

Our main variable of interest is the variable $Height\_Gini_{it}$ which depicts the value of the Gini index in a country *i* and period *t*. The temporal indication *t* does not refer to a specific year but covers the Height-Gini coefficient measured using the available data on the height level for a certain country from year j = 0 to year j+9 for each decade. The Gini coefficient is typically used to measure income inequality. However, before the 1980s, evidence on income inequality was not available for many lower-income countries. Recent studies have instead used the coefficient of variation (CV) of height as a proxy indicator, or the Height-Gini coefficient, which can be derived from the CV itself by following a consolidated procedure exposed in Baten [27], Baten and Blum [28], Moradi and Baten [29], and Baten and Mumme [30]. Adult height is commonly accepted as a retrospective indicator of biological well-being and adaptation [16,31–33] given that human stature grows at the fastest rate during the first three to five years of life, and presents a second growth spurt around adolescence years occurring earlier for young females (12–14), and about two years later (14–16) for the young males [12,34]. Hence, we focus on heights measured in adult age and we aggregate them by birth cohorts [27,35]. From the well-established studies in auxology and the literature on anthropometric evolution, the exploration of human heights and their distribution moved to economics and other social sciences, and has nowadays become widely used [16,27,32,36]. According to these studies, genetic factors have a distinct impact on height at the *individual level*, whereas *population* averages of height are influenced by social status, environmental conditions, and diet quality [13].

Taller parents tend to have taller children for genetic reasons, but the genetic influence is attenuated at the population level because *individual genetic differences average out* [37]. Similarly, average population height is far less driven by genetic factors than individual level heights. For example, during a period of severe protein deficiency in mid-nineteenth-century Holland, Dutch people were very short by European standards, whereas today they are frequently regarded as the tallest people on the planet [38,39]. While anthropologists during the early 20th century attributed many size patterns (e.g., tall Tutsi and Masai) to genetics, these *patterns of growth*, were later identified to be the result of dietary quality and a healthy environment [40–43]. If average stature is an indicator of average dietary quality and health, *inequalities* in health can be measured using the heights' coefficient of variation or Gini indexes of a population within a given birth decade. Baten ([27,44] argues that the CV is also a good indicator of income inequality within society (see also [29,45]), the two measures are correlated with the distribution of nutrition and standards of living. To understand the influence of inequality on height, we compare outcomes of a hypothetical situation, where a population is subject to the alternative distribution of resources, (A) and (B), after birth [29]:

A. Every individual is endowed with the same amount and quality of resources (e.g., nutrition and health services). This setting constitutes a condition of perfect equality.
B. The resources are unequally distributed, yet independent of the genetics of an individual.

Case (A) reflects the *biological variance* in a normally distributed stature since the size distribution should only reflect genetics. But what happens to the distribution of heights as inequality increases from (A) to (B) is that some people benefit and grow taller, while other individuals grow smaller as they endure poor nutrition and standards of living. As a result, when compared to the scenario of perfect equality, the richer classes' height shifts to the right, while the poorer classes shift to the left. Therefore, increasing inequality of resources will result in greater inequality in height. If resource endowments differ greatly between groups, it may even result in a bimodal size distribution. Even though biological variance still accounts for a large proportion of total variance, most size distributions tend towards a normal distribution, albeit with a larger standard deviation than in theory (A).

Finally, given the biological variance is found to increase with average stature, mere standard deviation of stature will lack temporal comparability as a measure of inequality [46]. This effect is accounted for by the CV, which is divided by the average height, making it a more reliable and consistent measure of height inequality. Our data contain ten-year birth-decade *t* and country *i* observations, averaged for the adult population (22–50 years old), where the CV is defined as follows:

$$CV_{it} = \frac{\sigma_{it}}{\mu_{it}} \times 100 \qquad \text{(Eq.1)}$$

Baten ([27,36] uses the CV measure to compare size differences between social groups in the early 19th century in the southern region of Germany, Bavaria. Moreover, Moradi and Baten [29] apply a formula, transforming the CV values in Height-Gini coefficients, which has been already widely used as an inequality indicator in empirical studies [45,47], and which we are using here as well. This final step, namely the transformation of the CV index into a Height-Gini, is motivated by the fact that the Gini units are easier to read and interpret (See Appendix A.4).

4. Data

4.1. Height data

Our sample of adult heights is based on the data collection of a global project, which was originally organised and published by Baten and Blum [28]. Their data is publicly available on the website of Clio Infra[2] and was recently extended in 2023.[3] Height and height-inequality sources at the country level include several national surveys for the early decades, and data from international household surveys such as the Demographic and Health Surveys (DHS), especially for developing countries and more recent years. The result of the data collection refers the Height-Gini indexes for 193 countries covering birth decades from 1810 to 2000, where each decade includes the average of the following 10 years, i.e., 1990 represents those born in the years between 1990 and the end of 1999. Such a large dataset encompasses a strong overlap of 134 countries for which both height inequality and universal health coverage evidence is available and discussed more in depth in the following sections.

4.2. Universal health coverage data

The World Health Organization (WHO) distinguishes between two

[2] Data on Height and Gini-Height is publicly available on the website of Clio infra: https://clio-infra.eu/. However, the updated version is unavailable yet on ClioInfra (as of 04/04/2023).

[3] A more detailed overview of countries and respective sources can be found on the Clio Infra website or in Radatz and Baten [67,68].

levels of care. Primary Health Care (PHC) is the first stage, and Universal Health Care (UHC) is the second stage of public health.[4] UHC is defined as access to the national health system for (almost) all people living in the country. This includes providing essential health services of high quality and without imposing an economic burden on those seeking to access these services. Note that such health system may be publicly and/or privately funded (WHO, 2010). To the best of our knowledge, there is no official list of countries fulfilling the WHO definition of UHC based on explicit criteria [48]. However, there does exist an official indicator from the WHO, namely the *UHC service coverage index*, for the percentage of the population covered [49], and an *indicator for social health protection* from the International Labour Organization [50]. Both indicators provide us with important, but limited, data for the period 2000–2019 in the case of the UHC index, alongside a snapshot of the year 2020 for the ILO index. As an additional source, we use evidence from the Organization for Economic Co-operation and Development [51,52], which provides a dataset on social protection for OECD countries from 1960 onwards and calculates the percentage of the population covered by both public and private healthcare systems within a country. Another data source we consider is the Varieties of Democracy (V-Dem) dataset, which provides measures of health resource distribution as an important component of a democratic state. More specifically, the database includes two categorical indicators on the equality of access to basic health care and economic resources for the population from 1900 to 2022 [53]. We use these measures to check the robustness of our results (see Section 6).

Historically, the first introduction of a health insurance scheme took place in Germany, in 1883. Germany was swiftly followed by other Western European countries in the 1880s like the Habsburg Empire that included entire territories of today's Austria, the Czech Republic, Hungary, and Slovakia (alongside parts of the current territory of other countries). Many countries implemented similar health insurance schemes in the decades that followed, primarily during the 1940s. The introduction of comparable health insurance schemes in developing world regions such as Africa occurred much later and with concerns about the stability and robustness of these systems. In South Sudan, for example, there is a government health service that is supposed to be free and accessible. However, only 32% of the population results to be covered in 2019 according to official statistics [54]. A similar observation can be made for Nigeria, where the National Health Insurance Scheme (NHIS), introduced in 1999, was supposed to provide universal coverage, but where free access and good quality are still quite limited [55]. These examples show that the mere formal introduction of health insurance may not be sufficient to produce observable positive effects on population health. Therefore, to establish the presence of a *factual UHC* in a country we checked on a case-by-case basis if the introduction of UHC was effectively covering a large proportion of the population. We are interested in both the timing of the legal introduction of health insurance in a country and whether this health care system covers a *substantial* portion of the population. To construct the UHC variable we manually collected data for the legal implementation of health insurance in a country from a variety of sources, the main being Cutler and Johnson [56], Kangas [57], and the 'Social Security Programs Throughout the World' publication series, published by the Social Security Administration (SSA) (see Appendix for more details). We also consider whether there is an actual implementation of a country's population by the UHC by consulting country reports and the OECD indicator on social protection. We include countries that have legally mandated UHC and have already completed the transition to nearly complete population coverage by both public and private channels of financing. While technically "universal coverage" should refer to 100% of the population, we define the threshold as population coverage of 90%. We coded UHC taking value one beginning with the year of the first legal implementation of health insurance - given this country achieved UHC in the meanwhile - and zero otherwise. As of 2010, we can find evidence of UHC in 43 countries around the world that meet the criteria for classification we described above.

5. Estimation and results

5.1. Descriptive statistics

Table 1 reports the summary statistics of the sample used in our long-run analysis.

The panel is made of 134 countries potentially observed for 18 decadal periods spanning from 1810 to 2000. The panel is unbalanced and contains 1191 observations for our main variables of interest, measured at the country-*birth-decade* level. Controlling only for urbanization (with missing values for 7 cases), we will present a regression analysis below with 1184 cases (Table 1, panel A). However, as we also include democracy scores and GDP per capita (with more missing values), a "core" data set of 722 observations is used. We also report the descriptive statistics for the 722 observations in panel B of Table 1. The values are quite similar, only UHC and democracy values are slightly higher.

The world maps in Figs. 1 and 2 exhibit the within-country height inequality for the earliest and latest available observation in our sample.

Fig. 1 displays the sample of country observations used to examine height inequality for the earliest observations available in each country, starting with the birth decade of 1810, with the 1900 birth decade providing the latest observations for this graph. Height inequality was high in African and Latin American countries in the 19th century, and much lower for countries located in Europe and Asia. Fig. 2 maps the most recent estimates for Height-Gini available per country, ranging from the birth decades 1960 to 2000. Again, European, and Asian countries show the lowest levels of height inequality. The highest levels of inequality today are mostly found in the world regions of sub-Saharan

Table 1
Summary statistics.

Panel (A)	Observations	Mean	SD	Min	Max
Height inequality	1191	43.74	7.637	23.67	81.33
UHC	1191	0.171	0.38	0	1
Population (log)	1183	15.795	1.57	11.89	20.96
Urbanisation	1184	0.269	0.21	0.00	0.96
GDP per capita (log)	864	8.195	1.05	6.26	11.10
Democracy	796	0.683	6.83	−10	10
Panel (B) Summary statistics using reduced sample conditioned on all control variables (722 observations)					
	Observations	Mean	SD	Min	Max
Height inequality	722	44.13	7.65	23.67	81.33
UHC	722	0.26	0.44	0	1
Population (log)	722	16.22	1.48	12.35	20.96
Urbanisation	722	0.34	0.21	0.02	0.96
GDP per capita (log)	722	8.28	1.04	6.36	11.10
Democracy	722	1.19	6.77	−10	10

Notes. All variables are measured on a country-decade unit. Height inequality is measured as the Gini coefficient. UHC is coded as one if a country achieved UHC, indicating the years after the first implementation, zero otherwise. UHC is coded as one if a country achieved 90% coverage of the population, indicating the years after the first implementation, and zero otherwise. For interpretation, GDP per capita is divided by 1000 before running the regression. Urbanization and Population see Appendix A.3. Democracy is the Polity index from the polity IV database. Marginal effects were reported.

[4] Primary health care (PHC) is a WHO [79] definition of health care that proclaims the right to health for all. Within a society, health care is seen as providing essential tools for everyone to achieve better health. PHC is based on three components: integrated health services, multi-sectoral policies and actions, and empowerment of individuals and members of society. PHC is seen as the foundation and first step towards universal health coverage (UHC).

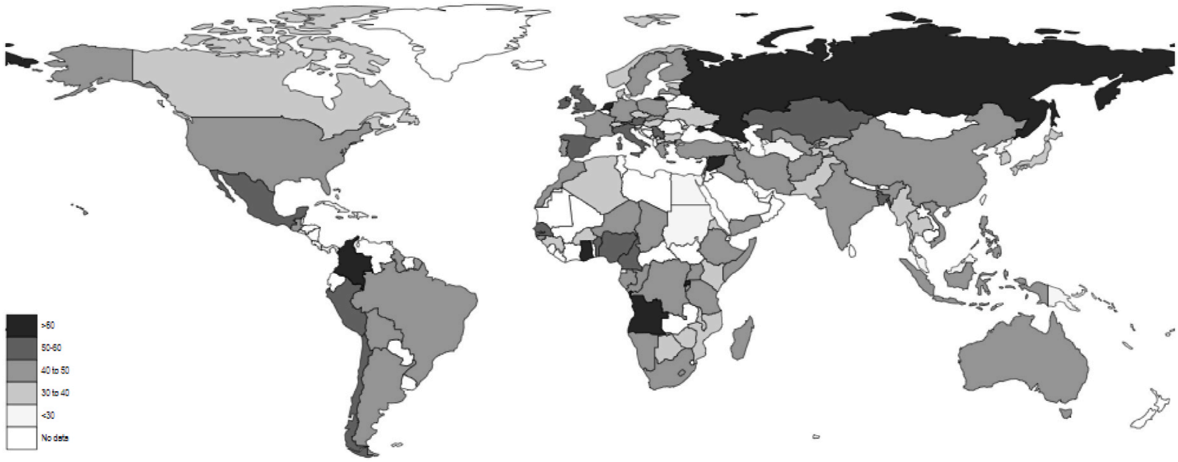

Fig. 1. Height inequality worldwide: 1810–1900
Notes. Darker shades indicate higher inequality levels, and lighter shades lower levels of height inequality. We display the earliest data available for each country beginning with birth decade 1810.

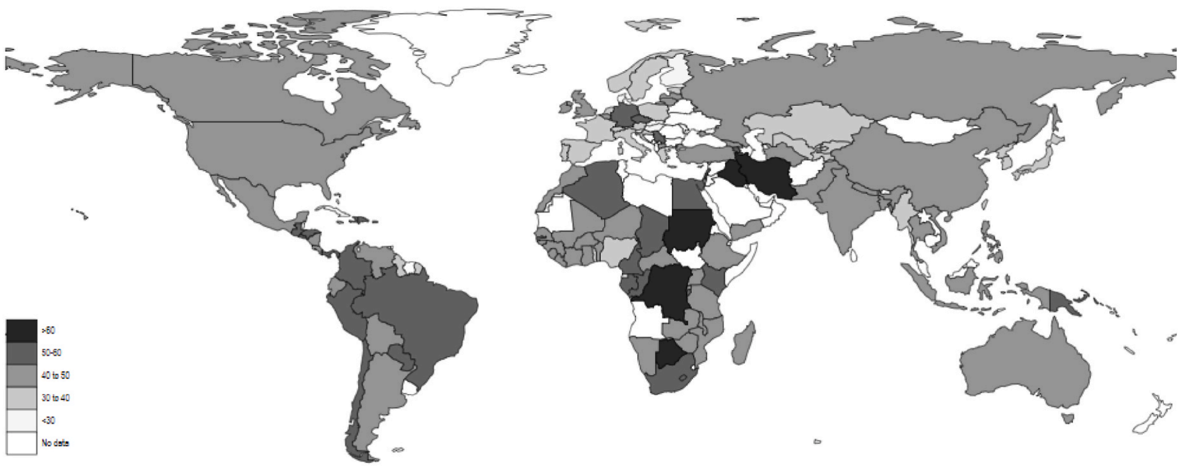

Fig. 2. Height inequality worldwide: 1960–2000
Notes. Darker shades indicate higher inequality levels, and lighter shades lower levels of height inequality. We display the most recent data available for each country beginning with the birth decade 1960 until 2000.

Africa and the Middle East, with the highest inequality levels in countries such as the Democratic Republic of the Congo, Iraq, and Sudan.

Fig. 3 reveals a trend of rising gap in height inequality between different world regions despite having a similar starting point in the birth decades of around 1870–1880, before the Bismarckian social insurance system was introduced in Germany.

The early 20th century was also the period when, after an initial worsening before WWI, substantial achievements were obtained in improving health conditions across many societies and in reducing inequalities in health [58,59]. Especially after the birth decade labelled as 1920 (referring to the 1920–1929 period), we observe a reduction in the Height-Gini indicator. In Europe, inequality began to fall following the birth decade of the 1920s. In contrast, in Africa and North America, we see rising height discrepancies from the birth decades of the 1930s–1960s. According to our data, during the birth decade of 2000–2009, inequality levels are the highest in South America and Africa. One important explanation for the difference in the development of height inequality might be the introduction of different welfare programs, especially UHC. As of the decade 2000–2009, out of the 43 countries we find to have a 90% or higher coverage of health insurance for their population, we can include 37 countries in our sample where we do have additional data for height inequality. Over 67% of these countries are in Western and Eastern Europe. In Fig. 4 we do observe that those countries having UHC show lower height inequality on average for the birth decade 2000–2009 of 10.93 Gini points. For the whole sample period, starting in the 1810s, such difference decreases to 6.27 Gini points for each combination of country and decade of birth.

To explore this relationship in more detail, we divide the inequality estimates into five different sequences, ranging from low (<30), moderate (30–40), medium (40–50), high (50–60), and very high (>60) inequality. In Fig. 5 we display the percentage of the different inequality sequences.

For countries and birth decades with no UHC available (at least not for the vast majority of the population, UHC = 0), we observe that almost 25% of those observations (out of 965 country-birth decade combinations) show high to very high Gini coefficients. Moreover, it appears that there is a much higher prevalence of very high inequality in height compared to countries and birth decades where health insurance was already fully implemented.

5.2. Regression analysis

Our baseline regression analysis uses a two-way fixed effects OLS in the form of equation (2):

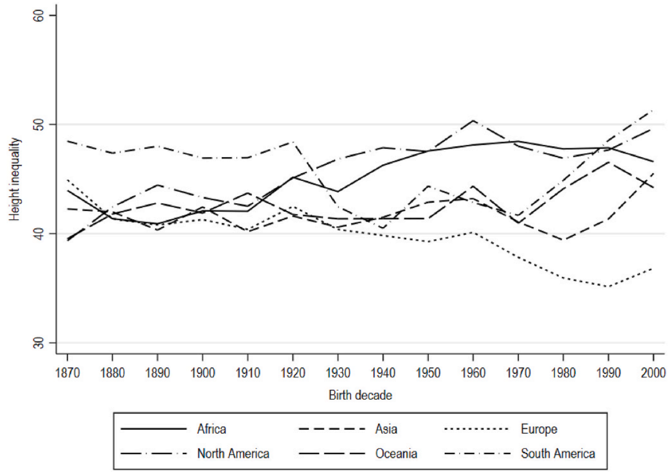

Fig. 3. Development of height inequality by world region
Notes. We show the difference in height inequality by countries with (=1) and without (=0) UHC, for the whole period 1810–2000 on the left, and for the birth decade 2000 on the right. Height inequality is measured as the Gini coefficient.

$$HeightGini_{ijt} = \beta_0 + \beta_1 \times UHC_{ijt} + \gamma' \mathbf{Z}_{it} + \tau_t + \mu_j + \varepsilon_{it} \quad \text{(Eq.2)}$$

Where the outcome $HeightGini_{it}$ is the Gini coefficient of height distribution in *adult age* in country *i*, in region *j*, and *birth* decade *t*. The main independent variable is the dummy UHC_{it}. Z_{it} is a vector of control variables, capturing country characteristics. Here we control for a country's population and the degree of urbanisation. In a larger country, public resources may be more unequally distributed across the population, and in more rural societies, the availability of health infrastructure may be more fragmented. We also include GDP per capita as a control variable to take account of a country's economic development and health spending (as health spending is known to be highly correlated with GDP per capita).[5] Hence, we include GDP per capita in our analysis to avoid potential omitted variable bias. However, to address the concern that GDP per capita, or any other control variable included in this model, might be a bad control, we report our regression results as a (stepwise) sequence, including each control variable at a time. Similar considerations apply to the democracy index. Finally, we control for the level of democratisation as measured by the polity2 index. Democratic states are expected to grant more (health) rights to the population and to provide higher social transfers [60,61]. Democratisation accounts for other institutional changes that could have affected both UHC progression as well as lowering health inequalities. We further include time-fixed effects τ_t for the birth decades and u_j, world region fixed effects. Including world region-fixed effects instead of country-fixed

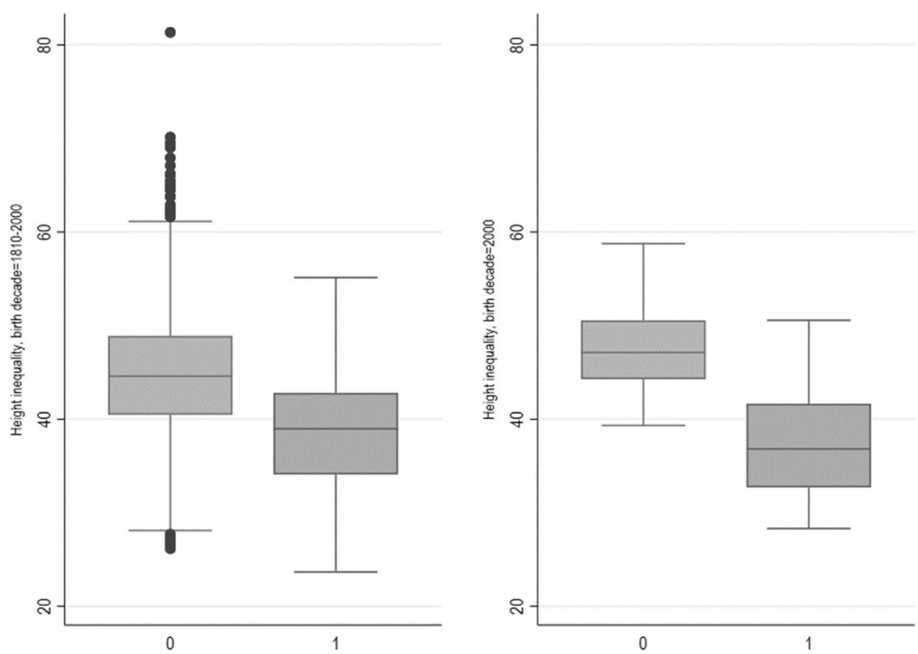

Fig. 4. Differences in Height Inequality by Universal Health Coverage
Notes. We show the difference in height inequality by countries with (=1) and without (=0) UHC, for the whole period 1810–2000 on the left, and for the birth decade 2000 on the right. Height inequality is measured as the Gini coefficient.

[5] Countries with higher GDP per capita invest a higher proportion of their government expenditure in health services such as hospitals and medicines and can afford the provision of UHC to their population. The WHO (2010) notes that as a country's income rises, government spending on health tends to increase. However, there are still large differences in the share of government spending on health between low-income and high-income countries [79]. Therefore, GDP per capita can provide important insights into variations in height inequality, as even poor people in high-income countries have adequate access to basic needs and health care compared to low-income countries.

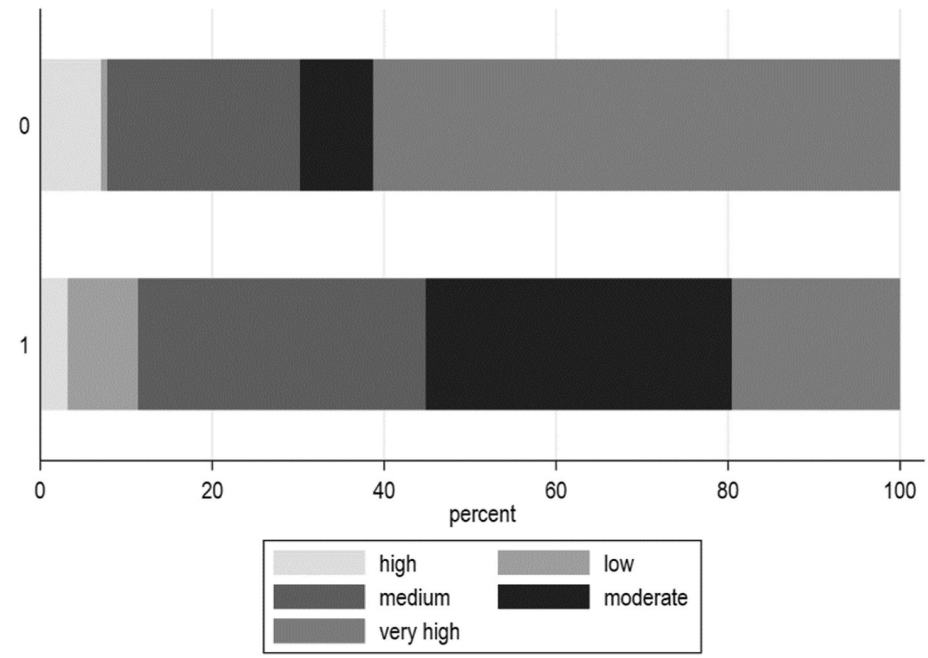

Fig. 5. Percentage of different levels of height inequality by the (non-) presence of Universal Health Coverage
Notes. The percentage of country-decade combination are displayed depending on their inequality level. Height inequality is hereby divided into five sequences: low inequality (<30 Gini points), moderate (30–39 Gini points), medium (40–49 Gini points), high (50–59 Gini points), and very high inequality (>60 Gini points). We further distinguish between the presence and fulfilment of UHC (=1) compared to no UHC (=0).

effects allows us to exploit countries' *between-variability* and helps us to identify the relationship between social policies such as UHC and inequality more precisely [62]. Finally, to account for the possibility that the introduction of UHC and the implementation of reforms to achieve a wider coverage of the population is driven by high height inequality, we use an IV approach below exploiting the capital's distance from the geographical centre of Russia as an instrument.

Table 2 (panels A and B) displays the regression results using the long run (1810–2000) country-year panel. All models perform pooled OLS regressions with Height-Gini as the dependent variable.

Regression results reveal a consistently significant coefficient for UHC at a 1% level of significance. As expected, the coefficients for UHC are negatively correlated with the Height-Gini, showing that exposure to UHC during the birth decade decreases the inequality in the distribution of heights achieved in adult age. In the specification (1), we run the regression analysis without time- or region-fixed effects which are included in the following models. Specifically, we include time-fixed effects in (2) and (3) jointly time and world-region fixed effects. In (4), we include country-fixed effects. The statistically significant correlation between height inequality and UHC is robust to these specifications. Regressions (5) to (8) in panel B reproduce the same model using the smallest sample conditional on all-variable availability. Results are consistent throughout, and do not depend on sample selection induced by control-variables availability. In Table 3 we study the relationship between health insurance and height inequality, including control variables step by step.

The coefficients remain statistically significant across all regressions. Our results suggest a statistically significant negative correlation between GDP per capita and height inequality in all models, but the UHC effects remain significant. The coefficient for urbanisation is mostly significant, whereas population size and the level of democratisation do not seem to be significantly correlated with height inequality.

Table 2
OLS regressions: relationship between height inequality and Universal Health Coverage.

Panel (A)	(1)	(2)	(3)	(4)
UHC	−6.27***	−6.88***	−4.73***	−4.46***
	(0.84)	(0.90)	(1.16)	(1.42)
Observations	1191	1191	1191	1191
Adjusted R-squared	0.10	0.14	0.19	0.41
Time FE	×	✓	✓	✓
Region FE	×	×	✓	×
Country FE	×	×	×	✓
Panel (B) – Fixed sample	(5)	(6)	(7)	(8)
UHC	−6.75***	−6.73***	−4.14***	−3.72**
	(1.00)	(1.05)	(1.54)	(1.82)
Observations	722	722	722	722
Adjusted R-squared	0.15	0.15	0.20	0.56
Time FE	×	✓	✓	✓
Region FE	×	×	✓	×
Country FE	×	×	×	✓

Notes. Country-clustered robust standard errors in parentheses, ***, **, *, significant on the 1, 5, and 10%-level, respectively. In every model, the dependent variable is height inequality measured by the Gini index of height distribution across the 00-09 decade. UHC is a dummy coded as one if a country achieved UHC, indicating the years after the first implementation, and 0 otherwise. For variable definitions see also Tables 1A and 1B

5.3. Instrumental variable estimates

Our previous results using OLS regressions could be affected by some potential threats to the identification including reverse causality, measurement error, or omitted variable issues. Causality might have run from height inequality to the introduction of health insurance: regions with relatively low height inequality could have reached an easier consensus about introducing costly health insurance. Moreover, measurement error or omitted variable issues could bias our estimates, especially for the richest countries during the last few decades, height inequality might be less informative about health inequality, as basic needs are already covered even for the poorer parts of the population. To correct for such potential endogeneity, we use an instrumental variable estimation where the first stage of the two-stage-least-square (2SLS) estimate is displayed in equation (3):

Table 3
OLS regression including controls: potential correlates of height inequality.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
UHC	−5.04***	−3.88**	−3.86**	−5.47***	−5.35***	−3.56**	−4.54***	−3.78**	−3.77**
	(1.29)	(1.52)	(1.50)	(1.24)	(1.39)	(1.56)	(1.67)	(1.65)	(1.62)
Urbanisation	4.82*	9.85***	9.86***	7.54***	9.84**	10.02**	3.97	10.31**	10.42**
	(2.84)	(3.70)	(3.70)	(2.68)	(4.09)	(3.97)	(3.47)	(4.11)	(4.11)
GDP per capita (log)		−1.91**	−1.90**	−1.57*	−2.15**	−1.92**		−2.30***	−2.25***
		(0.74)	(0.75)	(0.84)	(0.95)	(0.86)		(0.77)	(0.79)
Population (log)			−0.07	−0.56	−0.59	−0.22			−0.21
			(0.35)	(0.42)	(0.43)	(0.43)			(0.43)
Democracy				−0.05	−0.03	−0.06			
				(0.08)	(0.09)	(0.09)			
Democracy Squared				−0.55	−0.74	−0.30			
				(1.23)	(1.28)	(1.30)			
Observations	1184	857	857	722	722	722	722	722	722
Adjusted R-squared	0.19	0.23	0.23	0.18	0.19	0.23	0.21	0.23	0.23
Decadal FE	✓	✓	✓	×	✓	✓	✓	✓	✓
Regional FE	✓	✓	✓	×	×	✓	✓	✓	✓

Notes. Country-clustered robust standard errors in parentheses, ***, **, * significant at the 1, 5, and 10%-level, respectively. The dependent variable is height inequality measured with the Gini-Index of inequality in every model. For variable definitions and descriptives statistics, please see also Tables 1A and 1B Columns (7), (8), and (9) rerun respectively regressions (1), (2), and (3) using the smallest sample available conditional on all control variables' availability.

$$UHC_{it} = \beta_1 + \beta_2 DistanceSovietUnion_i + \gamma' X_{it} + \varepsilon_{it} \tag{Eq.3}$$

In Eq. (3), $DistanceSovietUnion_i$ is a cross-sectional spatial instrumental variable of the logged distance of each country's capital from the geographical centre of the Soviet Union. The Soviet Union, as a socialist state, was perceived as a potential threat after its creation in 1922 (de jure), and Western market economies introduced health insurance partly as a measure to keep workers from striving for socialism. $\boldsymbol{X}$ is a vector of other control variables.

The results of the 2SLS regressions confirm that the distance to the Soviet Union fulfils the requirements to be a reasonable instrument for the introduction of UHC. First, it correlates negatively with the existence of UHC, as is documented by the 'first stage' section of Tables 4A and 4B, and the F-Test is above 10 (see Ref. [63]).

We expect the instrument to influence the dependent variable only through the potentially endogenous variable, universal health insurance converage (UHC). More specifically, the validity of our instrument lies in that counties under the socialist and communist influence provided a quite comprehensive health insurance system. This system gave also poorer parts of the society access to medical services and healthy nutrition. Communist states emerged not only in Russia but also in other countries around the globe. Hence, we expect that the expansion of communism in the Soviet Union would have seen by neighbouring non-communist states as the greatest threat to their political system. Hence, they also introduced comparable health insurance schemes, especially if they were geographically close to the epicentre of communism, the Soviet Union.

Arguably, the advantage of using the distance to the Soviet Union as an instrument is its exogenous nature. This is because communism was introduced in countries that were not even considered a potential candidate by Marxists around 1900. They believed that more industrialised and capitalist countries, like England or Belgium, were primary candidates for the socialist revolution, while Russia at the time was mainly an agricultural Empire. The quite inadvertent WWI outcome was

Table 4A
Instrumental variable (2SLS) using all observations.

	(1)	(2)	(3)	(4)	(5)
First stage (Controls included)					
Distance from Soviet Union	−0.22***	−0.22***	−0.22***	−0.24***	−0.27***
	(0.021)	(0.023)	(0.021)	(0.027)	(0.029)
Second stage					
UHC	−24.11***	−26.58***	−28.63***	−25.49***	−22.37***
	(2.665)	(3.157)	(3.628)	(13.646)	(3.185)
Population (log)		0.47**	0.16*	−0.19	−0.49**
		(0.220)	(0.192)	(0.204)	(0.214)
Urbanization			24.82***	13.08***	13.72***
			(4.509)	(3.180)	(3.305)
GDP per capita (log)				2.28**	0.95
				(0.948)	(0.855)
Democracy					0.07
					(0.076)
Democracy squared					1.55
					(1.189)
Observations	1191	1183	1176	857	722
Adj. R-squared	0.178	0.176	0.369	0.472	0.509
Time FE	✓	✓	✓	✓	✓
Region FE	×	×	×	×	×
F-statistic	109.90	91.43	87.91	76.97	81.10

Notes. Robust standard errors in parentheses, ***, **, *, are significant on the 1, 5, and 10%-level, respectively. Kleinbergen-Paap rk-LM statistic, and the Hansen J statistic are exactly identified across all regressions. The dependent variable in the first stage is UHC and height inequality in the second stage. UHC is coded as one if a country achieved UHC, indicating the years after the first implementation, zero otherwise. We take the natural logarithm for the variables *DistSovietUnion*, Population, and GDP per capita. For interpretation, we divided *DistSovietUnion* by 1000 before running the regression. This is the log distance between the country capital from the geographical center of Russia. For variable definitions see also Tables 1A and 1B

Table 4B
Instrumental variable (2SLS) using a constant sample (N = 722).

	(1)	(2)	(3)	(4)	(5)
First stage					
Distance from Soviet Union	−0.290***	−0.316***	−0.317***	−0.264***	−0.267***
	(0.0318)	(0.0341)	(0.0295)	(0.0288)	(0.0295)
R-squared	0.201	0.205	0.448	0.513	0.526
F-stat	82.81	86.94	116.64	84.45	82.1
Second stage					
UHC	−21.86***	−20.77***	−20.69***	−22.02***	−22.37***
	(2.749)	(2.648)	(2.536)	(3.180)	(3.185)
Population (log)		−0.246	−0.492**	−0.506**	−0.492**
		(0.242)	(0.209)	(0.213)	(0.214)
Urbanization			17.86***	12.59***	13.72***
			(3.711)	(3.149)	(3.305)
GDP per capita (log)				1.644*	0.953
				(0.936)	(0.855)
Democracy					0.0709
					(0.0764)
Democracy squared					1.547
					(1.189)
Observations	722	722	722	722	722
Adjusted R-squared	0.201	0.205	0.448	0.513	0.526
Time FE	✓	✓	✓	✓	✓
Region FE	×	×	×	×	×
F-Stat	82.8	86.9	116.6	84.5	82.1

Notes. Robust standard errors in parentheses, ***, **, *, are significant on the 1, 5, and 10%-level, respectively. Kleinbergen-Paap rk-LM statistic, and the Hansen J statistic are exactly identified across all regressions. The dependent variable in the first stage is UHC and height inequality in the second stage. UHC is coded as one if a country achieved UHC, indicating the years after the first implementation, zero otherwise. We take the natural logarithm for the variables *DistSovietUnion*, Population, and GDP per capita. For interpretation, we divided *DistSovietUnion* by 1000 before running the regression. This is the log distance between the country capital from the geographical center of Russia. For variable definitions see also Tables 1A and 1B

disastrous for the political hold of the Russian Czar Nicholas II; Lenin and his party comrades were convincing leaders and determined personalities who took advantage of the social and economic upheaval in the aftermath of the Great War and of the indecisiveness of the provisional government established after the Czar's abdication. The Bolshevik Party seized power during the October Revolution in 1917, then diffused throughout the country, and from 1922 onwards consolidated a communist state in its native country, holding power in Russia for many decades after [64]. A violation of the exclusion restriction might result if health inequality is influenced by geographical characteristics. Geography is considered relevant in explaining health inequalities within countries, but only through the prevailing socioeconomic circumstances [65]. Our spatial instrument should therefore be valid if height inequality was not affected by the distance to Russia decades before the emergence of socialism and the expansion of the Soviet Union.

Table 5 shows the correlations between early and later height inequality and the distance to the Soviet Union.

In particular, column (2) of the table displays the correlation between height inequality and the IV, which is the distance to the Soviet Union, with the exception of the sample selected before 1880, where we find no statistically significant correlation. We have chosen 1880 as a cut-off date because most participants of the October Revolution 1917 were born after 1880. We therefore conclude that the geographic location itself has no direct correlation with our dependent variable height inequality, but such correlation only appeared after the creation of the Soviet Union and the corresponding threat, which, in turn, inspired Universal Health Coverage set up as a countermeasure in neighbouring countries.

Table 5
Correlation between early and later height inequality and the distance to the Soviet Union.

	(1)	(2)	(3)
	Full Sample	*Omitted birth decades If ≤ 1880*	*Omitted birth decades If > 1880*
Distance from Soviet Union	6.766***	5.831	6.322***
	(4.18)	(1.35)	(4.38)
Constant	53.34***	53.01***	47.44***
	(27.92)	(18.16)	(37.98)
Observations	1191	185	1006
R-squared	0.2048	0.134	0.218
Decade Fixed Effects	✓	✓	✓
Regional Fixed Effects	✓	✓	✓

Notes. Robust standard errors in parentheses, ***, **, *, are significant on the 1, 5, and 10%-level, respectively. The dependent variable is height inequality measured with the Gini index. We take the natural logarithm of *DistSovietUnion* and divide it by 1000 before running the regression. For variable definitions see also Table 1A.

6. Robustness checks

6.1. Measure, period, and subsample sensitivity

To test the robustness of our results, we exclude communist states from the regression analysis in Table 6.

For baseline comparison, we consider our results from the main analysis as displayed in Table 3, relative to the different specifications in Table 6. One robustness check is to exclude socialist countries (Table 6 column (1)). As argued in the previous section, the emergence of socialist parties was seen as a threat to political stability, especially after the Russian October Revolution of 1917 and the creation of the Soviet Union. It is therefore seen as a motivating force for social reforms in neighbouring countries, such as the introduction of health insurance [11]. As a further robustness check, we therefore exclude countries for the periods in which they are socialist states. This puts the focus on countries which faced the socialist "threat". Our results in Table 6 are thus robust to the exclusion of communist countries. The literature is ambiguous about this effect. Although the 'welfare regime theory' suggests that health inequalities are lower in socialist regimes, a review of

Table 6
Robustness check for height inequality and healthcare measurements.

Panel (A)	(1)	(2)	(3)	(4)
UHC (communist states omitted)	−4.829***			
	(1.185)			
Formal UHC x Equal Access to Health Resources (V-Dem)		−1.369***		
		(0.457)		
Equal Access to Health Resources (V-Dem)			−1.024***	
			(0.321)	
Alternative UHC Index, WHO				−0.157***
				(0.042)
Observations	1059	804	804	55
R-squared	0.227	0.238	0.239	0.173
Time FE	✓	✓	✓	×
Region FE	✓	✓	✓	×
Controls	×	×	×	×

Notes. Results to be compared to baseline results in column (1), Table 3 [-4.73 (1.158)]. Country-clustered robust standard errors in parentheses, ***, **, *, significant on the 1, 5, and 10%-level, respectively. The dependent variable is height inequality in every model. Our measurement of UHC is used in column (1), and communist countries are excluded. The variable equal access to health services is derived from the V-DEM project and refers to the v2pehealth indicator, ranging from zero to four, where four indicates the equal access of all citizens to the health system resources. The alternative UHC index in column (4) is provided by the WHO. For variable definitions see also Tables 1A and 1B

Table 7
Rank regressions of deciles of inequality.

	(1)	(2)	(3)	(4)
	Height-Gini Deciles		Height-Gini Deciles by Year	
	OLS	OPROBIT	OLS	OPROBIT
UHC	−1.20**	−0.50**	−1.21**	−0.52**
	(0.59)	(0.24)	(0.61)	(0.25)
Urbanization	3.42**	1.41**	3.54***	1.46***
	(1.41)	(0.57)	(1.35)	(0.55)
GDP per capita (log)	−0.79***	−0.33***	−0.93***	−0.38***
	(0.29)	(0.12)	(0.29)	(0.12)
Population (log)	−0.05	−0.01	−0.08	−0.02
	(0.15)	(0.06)	(0.14)	(0.06)
Observations	722	722	722	722
R-squared	0.22	0.06	0.26	0.07
	adj R2	pseudo R2	adj R2	pseudo R2
Time FE	✓	✓	✓	✓
Region FE	✓	✓	✓	✓

Notes: Country-clustered robust standard errors in parentheses, ***, **, *, significant on the 1, 5, and 10%-level, respectively. The dependent variable is height inequality expressed as a rank from 1 to 9. In column 2 and 4 we run an ordered probit using the inequality ranks 1 to 9 for the first (lowest 10%) to the highest decile of inequality range. In column 1 and 3 we do this regression with OLS. In column 1 and 2, we arrange the deciles for the whole dataset, while for column 3 and 4 we arrange the deciles by year, i.e., we calculate them separately for each time period. For variable definitions see also Table 1B.

the empirical evidence does not support this theory [66].

We also control for other definitions of UHC. For example, we include the measurement of health care access equality (and more specifically the variable 'v2pehealth') from the Varieties of Democracy (V-Dem). This variable classifies the level of access to health services by the population on a scale from zero to four, where zero indicates unequal access to health services and the highest number indicates equal access for everyone [53]. Specifically in column (2) we interact the UHC formal (or de jure) measure used in the baselines with this indicator and use the multicategorical variable from the V-Dem by itself (column 3). We further include the UHC service coverage index (2.8.1) from the WHO in Table 6 column (4), even though it substantially reduces the number of observations as we are just able to include the birth decade of 2000. In sum, all models using these alternative definitions of UHC result in negative and statistically significant coefficients.

6.2. *Size of inequality effects: rank-regressions, ordered probit, and quantile estimates*

To have a more precise understanding of the size effects deriving from our baselines we rank the Height-Gini variable by deciles of its distribution, where the first decile (q1) consists of the 10% countries with lowest Height-Gini. Results in Table 7 show that on average, UHC achievement has the effect of moving down the country of about 1.2 ranks, while the ordered probit shows the marginal effect of reducing the Height-Gini when achieving UHC (columns 1 and 2).

Results are not very different when the ranking is stratified by decade (columns 3 and 4).

A related exercise is conducted in Table 8, showing quantile regressions when using the original Height-Gini measure.

Overall, the effects show their significance at higher inequality level of the quantile's distribution, suggesting the introduction of UHC has an effect of reducing inequality at relatively higher levels than lower ones.

7. Conclusion

This paper has examined the influence of the extension of health insurance on health inequality using human heights as a measure of health. The historical data collection undertaken for this paper allowed to examine the effects of a major institutional reform, namely the introduction of comprehensive health insurance, over a sweep of world history for the last 200 years and from more than 130 countries. By doing so, we have drawn on novel evidence for an unprecedented historical country profile. Our results suggest that insurance inception reducing financial barriers to access health care reduce the inequality in the health status (heights) in a country. Although evidence about the effects of insurance on health inequality is still contentious, we examine evidence of a period where there were large expansions of health insurance in several countries on the Gini-measure of height inequality, which is not sensitive to self-reporting bias. We draw on a unique data set of countries where we can measure individuals' heights retrospectively for several birth decades. We study whether inequalities in heights decline with the introduction of healthcare insurance schemes, controlling for several relevant control variables, and we consider an IV estimation strategy to adress some concerns to the identification, and finally we have proposed alternative tests to verify the robustness of our baseline results. Our estimates of the cross-country comparison suggest robust evidence that within-country differences in height inequality declined with the introduction of health insurance schemes. An alternative IV specification confirms that the likely causal effect of UHC was a reduction height inequality. As expected, we document a positive and economically relevant reduction in height inequality, where UHC explains between 22 and 29 Gini points of height inequality.

These results indicate that the strategy of pursuing substantial universal health insurance coverage adopted by several international organisation not only exerted an effect on access to health alone, but was a pathway to reduce health inequality by extending health care access to neglected segments of the population, which more likely benefited in terms of height gains from insurance expansions.

CRediT authorship contribution statement

Jörg Baten: Writing – review & editing, Writing – original draft. **Alberto Batinti:** Writing – review & editing, Writing – original draft. **Joan Costa-Font:** Writing – review & editing, Writing – original draft. **Laura Radatz:** Writing – review & editing, Writing – original draft.

Table 8
Quantile Regressions (q1: lowest 10% of health inequality, q9: highest).

Height Gini deciles:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	q1	q2	q3	q4	q5	q6	q7	q8	q9
Univ. Health Insur.	−2.80	−2.81	−1.88	−2.08	−2.40	−2.41*	−2.53**	−2.70*	−5.75***
	(2.32)	(2.02)	(1.64)	(1.51)	(1.47)	(1.35)	(1.16)	(1.46)	(1.77)
Urbanization	−2.36	4.31	3.79	5.26	6.17	8.24*	10.46**	15.18***	20.69**
	(3.75)	(4.25)	(3.78)	(3.96)	(4.04)	(4.27)	(4.89)	(5.44)	(8.52)
GDP per capita (log)	−1.73	−2.60***	−2.44**	−2.14**	−2.31**	−2.22**	−2.04*	−2.31*	−2.42
	(1.25)	(0.98)	(0.95)	(0.84)	(0.95)	(1.06)	(1.22)	(1.20)	(1.53)
Population (log)	0.27	0.37	0.32	0.05	−0.03	−0.25	−0.22	−0.15	−0.09
	(0.66)	(0.43)	(0.58)	(0.53)	(0.48)	(0.46)	(0.41)	(0.41)	(0.45)
Observations	722	722	722	722	722	722	722	722	722
R-squared	0.18	0.19	0.20	0.22	0.23	0.23	0.23	0.21	0.20
Time FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Region FE	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes: Country-clustered robust standard errors in parentheses, ***, **, *, significant on the 1, 5, and 10%-level, respectively. The dependent variable is height inequality in every model. For variable definitions see also Table 1B.

Data availability

Data will be made available on request.

Appendix

1.1. Height inequality

Height inequality is measured as the Gini coefficient using the coefficient of variation (CV) of height. Data is derived from Clio Infra and updated by the extension done by Radatz and Baten [67,68]. The compiled dataset is based on several sources such as household surveys, for example, the Demographic and Health Surveys (DHS), and individual authors. For more details see the collection of data from Baten and Blum [69] and Radatz and Baten [67,68]. Data on height inequality is based on the birth cohort approach, therefore providing data by birth decade, starting from 1810 to the birth decade of 2000. In total, data is offered for 193 countries worldwide (though the overlap with health coverage date reduces the number of countries).

1.2. Universal Health Coverage: measurement and sources

Universal Health Coverage (UHC) is our main independent variable and is coded as a dummy variable. It takes on the value of one after the decade of the first legal implementation of health insurance, given that coverage for 90% of the population was achieved by 2010. To construct our variable UHC, first, we collected data on the timing of the implementation from different sources. We mainly rely on Cutler and Johnson [56] and the report series 'Social Security Programs Throughout the World' of the Social Security Administration (SSA), which is provided for the Americas, Asia and the Pacific, and Europe (see Social Security Administration [70–72]. Moreover, we obtained data from Goudima and Rybalko [73], Rosen et al. [74], and WHO et al. [75] for some individual countries. A detailed overview of the sources used for each country can be found in Table A1. By rounding off the years, we refer to the respective decade for the year of the introduction of health insurance. For example, we refer to an implementation of health insurance for the decade 1910, if the legal implementation took place in a year between 1910 and 1915, for example in Ireland in 1911 [70]. If the introduction took place in the years 1916–1919, we add this observation to the decade 1920. Second, we checked if a country achieved UHC. For 43 countries, we find a full achievement of UHC. For each country included we display the birth decade and our sources in Table A1. However, our sample is limited to 37 countries, as we just include country-birth decades for which all our main variables are available. The coverage of the population is measured based on the indicators provided by the OECD [51,52], for the percentage of the population covered by public or private health insurance, and the social protection indicator from ILOSTAT [51] for non-OECD countries. The reference year is 2010.

1.3. Controls

We include the following control variables in our regression analysis:

- *Population (log)*. We control the size of a country's population. Population size is measured by the natural logarithm of a country's population at the start of each decade. Source: Fink-Jensen [76], available via Clio Infra.
- *Urbanization.* The variable urbanisation shows the ratio of the urban population to the total population (incl. rural) within a country and for a specific decade. Source: Fink-Jensen [76], available via Clio Infra.
- *GDP* per capita *(log)*. Based on a country-birth decade unit we consider GDP per capita as a control variable, taking the natural logarithm. Source: Bolt and Van Zanden [77].
- *Democracy.* Our democracy variable is derived from the Polity5 project. It measures the degree of democratisation within a country. It ranges from −10 points for a full autocracy to +10 points for a fully consolidated democracy [78].

A.4. How to convert height CV values into Gini coefficients of height inequality

The Gini coefficient is the most widely used measure for inequality, hence it is practical to also scale the height dispersion in this metric. Moradi and Baten [29] suggested a formula based on the study of a substantial number of developing countries in Subsaharan Africa:

Moradi and Baten's formula: $Gini\_Height_{it} = -33.5 + 20.5 \times CV_{it}$.

This allows to transform the CV values in Height-Gini coefficients, which has been already widely used as an inequality indicator in empirical studies [45,47], and which we are using here as well. This conversion was assessed intensively in the following literature that used height inequality, such as van Zanden et al. [45]. They confirmed this formula broadly, although for their specific purpose, they suggested to add a time fixed effect (which increased the explanatory share for their sample, but had the disadvantage to make the formula time-specific. As we need a general formula for our purpose, we use the original Moradi-Baten formula). This final step, namely the transformation of the CV index into a Height-Gini, is motivated by the fact that the Gini units are easier to read and interpret.

Table A1
Sources for health insurance legislation

COUNTRY	CODE	BIRTH DECADE	SOURCE
Australia	AU	1970	Cutler and Johnson [56]
Austria	AT	1890	Cutler and Johnson [56]
Belgium	BE	1940	Cutler and Johnson [56]
Canada	CA	1970	Cutler and Johnson [56]
Chile	CL	1980	SSA [72]
Colombia	CO	1960	SSA [72]
Costa Rica	CR	1940	SSA [72]
Czech Republic	CZ	1890	SSA [70]
Denmark	DK	1930	Cutler and Johnson [56]
Estonia	EE	1920	SSA [70]
Finland	FI	1960	Cutler and Johnson [56]
France	FR	1930	Cutler and Johnson [56]
Germany	DE	1880	Cutler and Johnson [56]
Greece	GR	1920	SSA [70]
Guyana	BY	1970	SSA [72]
Hungary	HU	1890	SSA [70]
Iceland*	IS	1940	SSA [70]
Ireland	IE	1910	SSA [70]
Israel	IL	1950	Rosen et al. [74]
Italy	IT	1940	Cutler and Johnson [56]
Japan	JP	1930	Cutler and Johnson [56]
Kazakhstan	KZ	1910	Goudima and Rybalko [73]
Latvia	LV	1920	SSA [70]
Lithuania	LT	1990	WHO et al. [75]
Luxembourg*	LU	1900	SSA [70]
Netherlands	NL	1940	Cutler and Johnson [56]
New Zealand*	NZ	1940	Cutler and Johnson [56]
Norway	NO	1910	Cutler and Johnson [56]
Poland	PL	1920	SSA [70]
Portugal	PT	1930	Cutler and Johnson [56]
Romania*	RO	1930	SSA [70]
Russia	RU	1910	Goudima and Rybalko [73]
Singapore*	SG	1950	SSA [71]
Slovakia	SK	1990	SSA [70]
Slovenia	SI	1920	SSA [70]
South Korea	KR	1980	SSA [71]
Spain	ES	1940	Cutler and Johnson [56]
Sweden	SE	1930	SSA [70]
Switzerland	CH	1990	Cutler and Johnson [56]
Taiwan	TW	1950	SSA [71]
Turkey	TR	1950	SSA [70]
United Kingdom	UK	1910	Cutler and Johnson [56]
Uruguay*	UY	1970	SSA [72]

Notes. Countries marked with a star * are not included in the regression analysis due to missing data for height Gini.

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