Global inequality in length of life: 1950-2015

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Inequality in length of life

Paper's objective

- This paper provides an **analysis of national, regional and global trends of inequality in length of life over the period 1950-2015**.
- We use data on life tables from the **World Population Prospects** to construct a database of a battery of inequality measures for 201 countries at five-year intervals over the period under analysis.
- **We estimate both absolute and relative inequality measures** which have the property of being additively decomposable.

Results in a nutshell

Main findings:

- Our estimates indicate that **inequality in length of life has decreased sharply since 1950**, a reduction that can be largely attributed to the**substantial progress made in reducing child mortality worldwide**.

- The decomposition analysis reveals that **differences in life expectancy between countries account for a very small portion of the observed changes in global inequality in length of life**, evolution of which is mainly driven by *within* country variation.

- We also observe a degree of **heterogeneity in the distributional patters of inequality in length of life across world regions**

Background

- The unequal distribution of well-being among members of society is an enduring concern that have preoccupied social scientists for centuries.
- Despite long-standing debates about its measurement, **health is regarded as a fundamental aspect of well-being**. **The capabilities approach makes emphasis on the functional capabilities of individuals, such as fulfilling a long and healthy life as a fundamental factor in enlarging people's freedoms** (Sen 2000, Nussbaum and Sen 1993).
- The recognition of long life as a catalystic human dimension for measuring well-being has prompted **a renewed interest in the distribution of lifespan indicators, such as life expectancy and mortality rates**.

Background

- **Most studies have focused on differences across social groups within societies** (Wilkinson and Marmot 2003), and those which investigate inequalities in length of life among individuals have generally restricted the analysis to a few countries (Peltzman 2009, Tranvåg and Norheim 2013).
- **At the global level, most previous work have focused on differences in life expectancy between countries** (Becker et al. 2005, Ram 2006)
- While differences in lifespan within countries are the main drivers of global inequality, **empirical research on within-country variation is surprisingly scarce and the evidence available relates only to a few years** (Smits and Monden 2009, Edwards 2011, Strømme and Norheim 2016).

What do we do?

- **We estimate the evolution of the global distribution of length of life between 1950 and 2015**. To do so, **we use data on life tables from World Population Prospects** to build a database of length of life inequality measures for 201 countries at five-year intervals.

- **We focus on additively decomposable inequality measures**, which allows us to assess the extent to which disparities are explained by within-country variation and differences in average lifespan between countries.

- **We provide a detailed analysis of the evolution of inequality in lifespan using both, absolute and relative measures**, to see whether different concepts of inequality present diverging trends over time.

- **We disaggregate inequality patterns by sex** because distributional patterns of length of life have been different across gender. **We also opt for separating adult and infant mortality** because the underlining factors that determine these two phenomena are etiologically different.

- **We provide insights into the evolution of disparities in different world regions**, which are expected to show fairly different paths.

Data

- **We use period life tables from the World Population Prospects** (UN Population Division, UN-DESA 2017). Life tables contain data from 201 countries on the number of deaths for every five-year age group up to 95 years for a synthetic cohort of 100,000 individuals.
- **Period life tables are constructed using data on the number of deaths in that particular year**, whereas mortality rates capture the current mortality pattern of a country.
- We use period life tables to perform the analysis, as they **provide an indication of the mortality situation at a particular point in time**.

The world distribution of length of life

Let Y be a random variable representing the life time of an individual until death. Consider J realizations of that variable, $y_1, \ldots, y_J$, grouped in K age intervals, $[x_0, x_1), \ldots, [x_{K-1}, x_K)$.

Period life tables provide information on the survivals (l_k) of a hypothetical birth cohort of a synthetic population of 100,000 individuals. **Dividing these figures by the size of this hypothetical population we obtain the proportion of survivals at the beginning of each interval x_{k-1}**, which is known as the **survival function** $(s_k = Pr[Y > x_{k-1}])$.

The survival function relates to the cumulative distribution function (CDF) as follows:

$$F_k = 1 - s_k = Pr[Y \leq x_{k-1}],$$

which gives the **probability of dying aged x_{k-1} or younger**.

The world distribution of length of life

We denote by f_k the proportion of observations in each interval, i.e. **the proportion of people who died aged between x_{k-1} and x_k. This proportion measures the mortality rate of the age interval k** and can be derived from the CDF by first differencing it:

$$f_k = F_k - F_{k-1}.$$

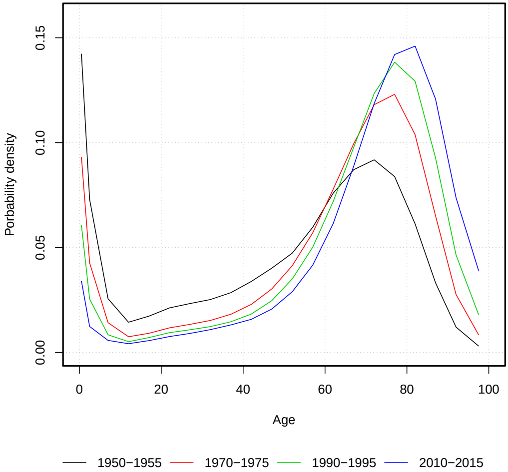
Mortality rates are points of the probability density function (PDF), which gives the probability of dying at the age interval k.

We computed the distribution of length of life of groups of countries as a mixture of their national distributions, weighted by their population shares. Let $Y^{(i)}$ be the length of life in the county $i, i = 1, ..., N$, and $f_k^{(i)}$ be the mortality rate of the age group k in the country i. Then, **the regional mortality rates are given by**:

$$f_k^{(R)} = \sum_{i=1}^{N} \lambda_i f_k^{(i)}, k = 1, \ldots, K,$$

where λ_i stands for the population weights of the countries.

Evolution of the global distribution of length of life: 1950-2015



Inequality measures

- Inequality measures can be classified into **relative** and **absolute** measures.
- There is an open debate about which of the two approaches is more appropriate to evaluate disparities in health (Anand et al. anand2001).
- Relative indicators seem to be an appealing choice for income variables, but **for bounded variables, such as length of life, absolute changes might be the better alternative to measure health inequality** (Atkinson 2013).
- Demographers often prefer absolute measures, among which variance and standard deviation are the most widely used (Edwards 2011, Edwards and Tuljapurkar 2005).

Inequality measures

For life tables, with data in grouped form in K age intervals, **the variance can be expressed as follows**:

$$Var(Y) = \sum_{k=1}^{K} (y_k - \bar{y})^2 f_k,$$

where y_k is the average age of the age group $k, k = 1, ..., K$, f_k is the dead rate of the age group k and $\bar{y}$ is life expectancy at birth.

The variance can be decomposed by its within- and between-country inequality components as follows:

$$Var(Y) = \sum_{i=1}^{N} \lambda_i Var(Y_i) + \sum_{i=1}^{N} (\bar{y}_i)^2 \lambda_i - \bar{y}^2,$$

where λ_i stands for the population weights of the countries, $\bar{y}_i$ is the life expectancy of the country i and $\bar{y}$ denotes the regional life expectancy.

Inequality measures

For relative inequality measures, we compute the Gini index, which is computed as follows:

$$G(Y) = \frac{1}{2\bar{y}} \sum_{k=1}^{K} \sum_{j=1}^{K} |y_k - y_j| f_k f_j.$$

The Gini index is nonetheless problematic: First, **it is not additively decomposable in within- and between-country inequality**. Second **it is sensitive to the middle of the distribution**, but **it does not allow us to change the weight given to differences in specific parts of the distribution**.

For this reason, **we compute an alternative set of inequality measures belonging to the Generalized Entropy (GE) family**, which includes a sensitivity parameter (θ) to account for differences in length of life among the oldest.

Inequality measures

The mean log deviation (MLD) corresponds to the GE index when the parameter (θ) set to 0, which is **more sensitive to infant mortality**.

The Theil's entropy measure is equally sensitive to all parts of the distribution, being characterized by a parameter (θ) equal to 1.

We also compute the GE measure when the sensitivity parameter (θ) is equal to 2, to analyze the evolution of lifespan inequality when more importance is given to the differences in **length of life among the oldest population**.

The general expression of the GE measure is given by,

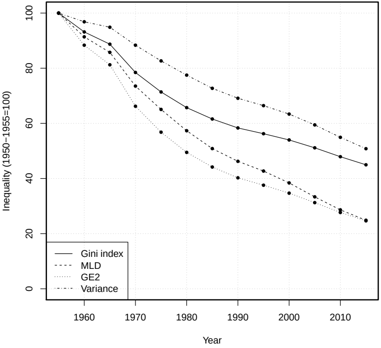
$$GE(Y;\theta) = \frac{1}{\theta(\theta-1)}\left(\sum_{k=1}^{K} f_k\left(\frac{y_k}{\bar{y}}\right)^{\theta} - 1\right), \theta \neq 0, 1,$$

Results

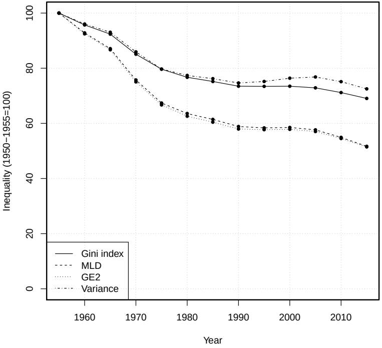
Decomposition of global inequality in length of life - global population

	1950-1955	1960-1965	1970-1975	1980-1985	1990-1995	2000-2005	2010-2015
Life expectancy	49.088	53.043	59.216	62.987	65.270	67.705	70.486
Gini index	0.335	0.297	0.236	0.201	0.183	0.166	0.144
Theil index	0.257	0.215	0.154	0.118	0.100	0.081	0.062
Between	0.031	0.027	0.014	0.010	0.009	0.008	0.006
Within	0.226	0.188	0.139	0.108	0.091	0.073	0.056
MLD	0.671	0.578	0.434	0.337	0.283	0.221	0.162
Between	0.031	0.027	0.015	0.011	0.009	0.009	0.006
Within	0.640	0.551	0.419	0.326	0.274	0.212	0.156
GE2	0.181	0.148	0.102	0.078	0.066	0.055	0.042
Between	0.032	0.027	0.014	0.010	0.009	0.008	0.006
Within	0.149	0.121	0.088	0.068	0.057	0.047	0.037
Variance	928.601	883.335	759.807	660.628	601.241	533.909	445.938
Between	162.531	162.276	105.097	85.795	78.411	78.159	58.050
Within	766.070	721.058	654.711	574.833	522.830	455.750	387.888

Evolution of global inequality in length of life (1950-1955=100)



Total population

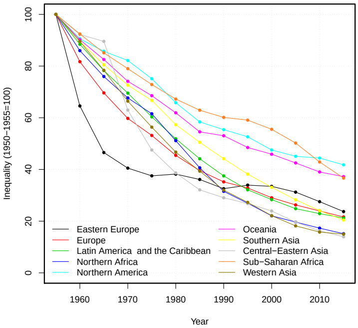


Population aged over 15

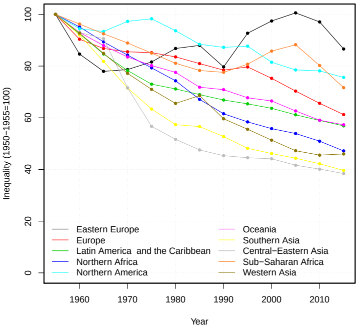
Regional length of life inequality

- We also looked at **regional inequality trends**, following the classification proposed by the UN Population Division.
- We observe a **decrease in disparities in length of life in all world regions for both relative and absolute measures**.
- **In 1950, SSA and Northern Africa presented the highest level of relative inequality**. **By 2015, SSA was still the region with the largest disparities**, while Northern Africa saw major reductions in length of life inequality.
- **We find contrasting results when looking at absolute inequality measures**. **Northern Africa and Western Asia were the regions with the highest levels of absolute inequality**, whereas **Latin America, Southern Asia and Central and Eastern Asia show similar levels of absolute inequality to SSA**.

Evolution of regional inequality in length of life (1950-1955=100)

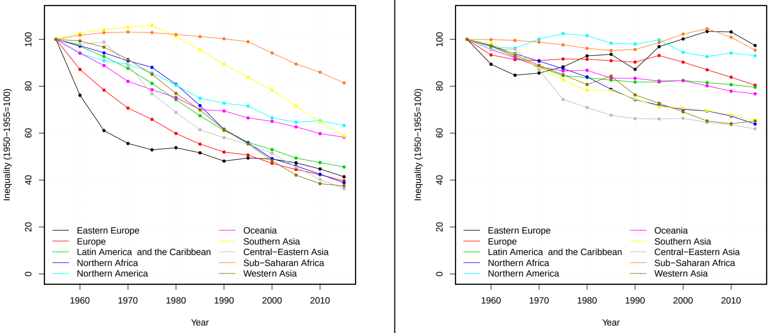


Theil index, total population



Theil index, adult population

Evolution of regional inequality in length of life (1950-1955=100)



Variance, total population

Variance, adult population

Conclusion

- Our analysis shows a **substantial reduction in disparities in length of life worldwide**.
- Our decomposition analysis indicates that **within-country variation represents over 90% of global inequality in lifespan**.
- **The fundamental factor behind the decrease of global inequality is the reduction in infant mortality**. Key factors are:
  - **The combating of measles, pneumonia and diarrhoea with cheap and easy-to-administer treatment**, such as antibiotics and oral rehydration (Liu et al. 2012).
  - **Less deaths due to HIV/AIDS and malaria**, although at a **slower rate because of limited access to, and utilisation of, anti-retroviral drugs and insecticide-impregnated bed-nets** in countries where these diseases are endemic.
  - **Progress in women's education** (Cutler et al. 2006, Gakidou et al. 2010)


That's all Folks!