Appendix

The Gini index derived from the Lorenz Curve

The Lorenz curve plots the cumulative share of the global disease burden for each country against the cumulative share of the world population, ordered by ascending DALY rates. The Gini index is calculated as twice the area bounded by the Lorenz curve and the theoretical egalitarian distribution represented as f(x) = x.

Figure 1 displays the distribution of the disease burden due to all causes for the year 1990 and 2017. Figure 2 shows the curves of the distribution of the disease burden for CMNNs, NCDs and Injuries for 1990 and 2017, illustrating that, in 2017, countries in the top fifth in terms of disease burden experienced 70% of CMNN disease burden, 26% of injury burden, and 37% of NCD burden.
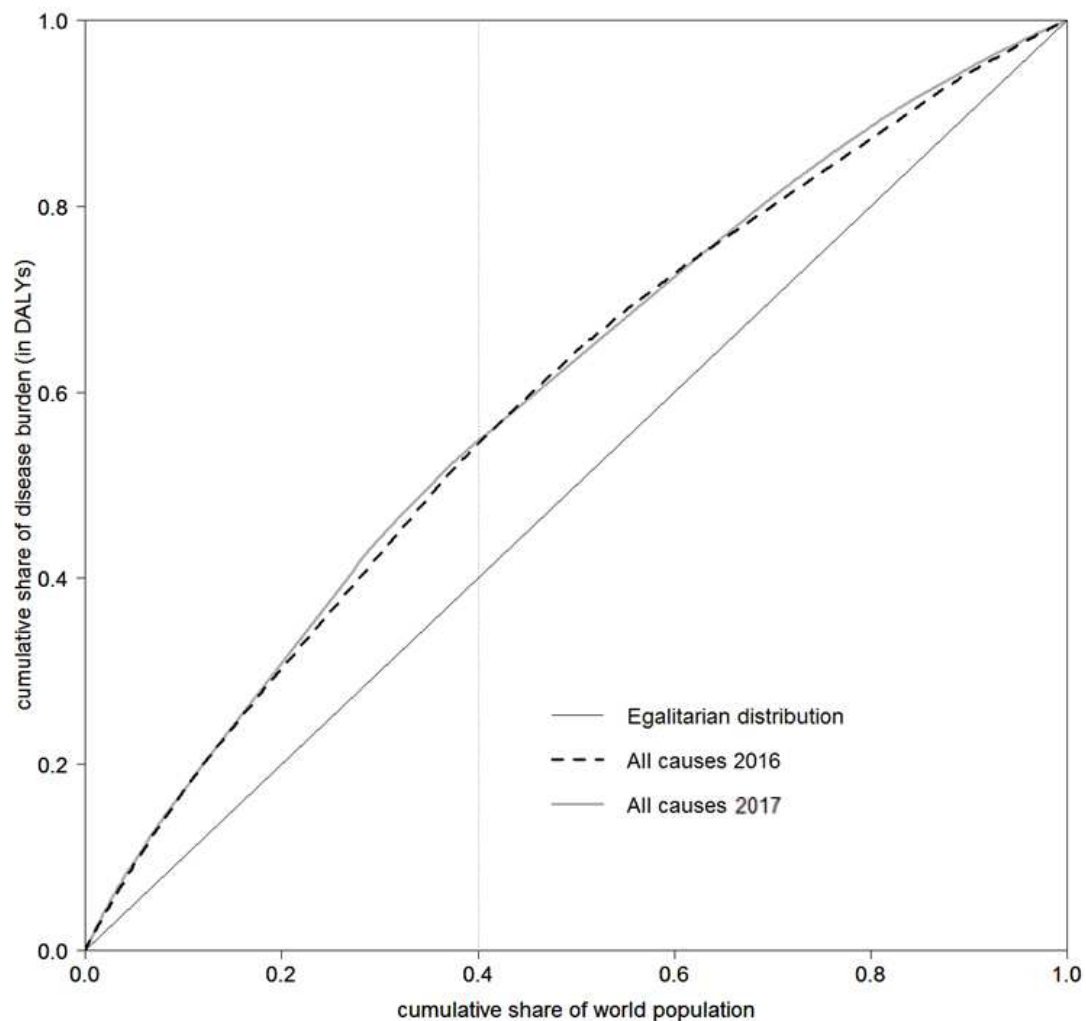
Figure 1. Lorenz curves showing the global distribution of disease burden in1990 and 2017, based on the age-adjusted DALY-rate of 195 countries. The grey line represents a theoretical perfect egalitarian distribution of the disease burden.
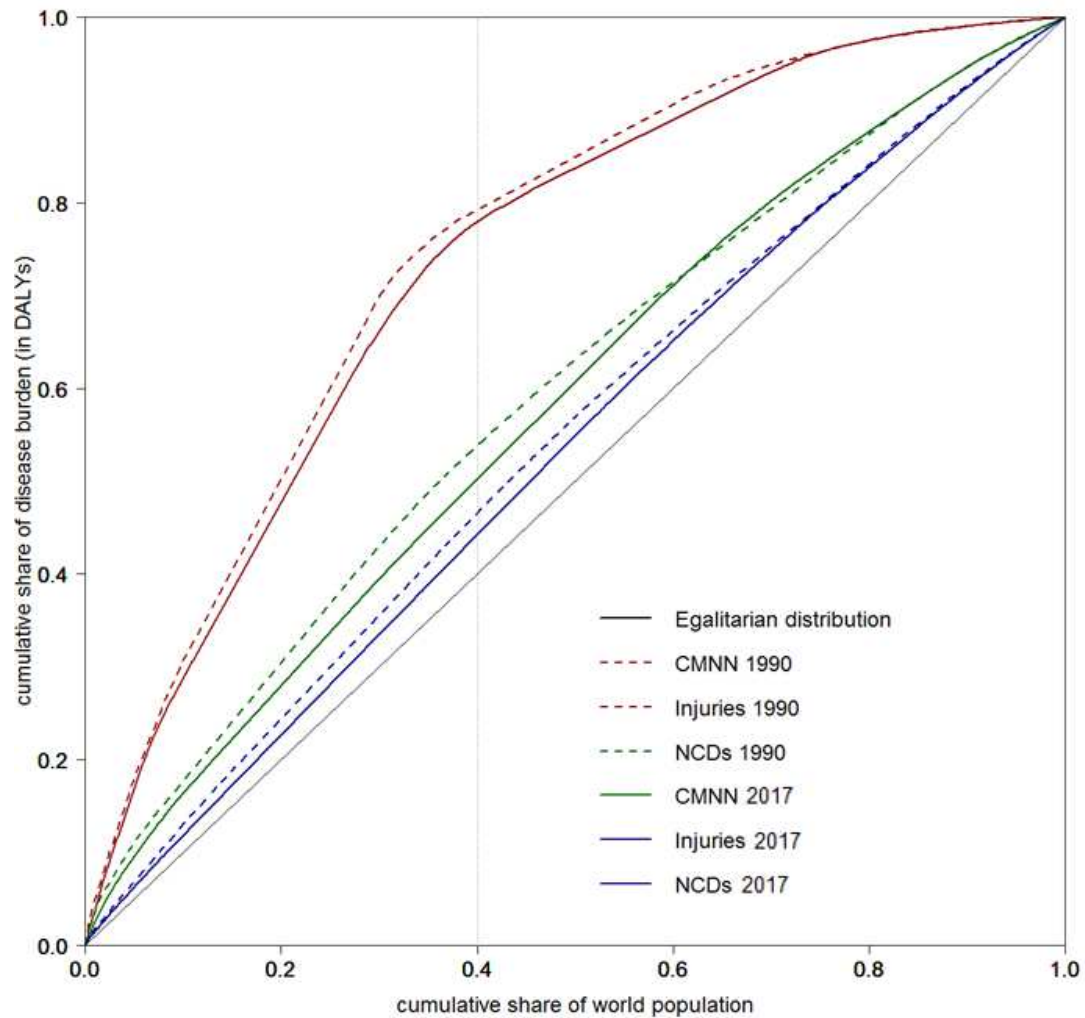

Figure 2. Lorenz curves showing the global distribution of disease burden for 1990 vs. 2017, based on the age-adjusted DALY-rate of 195 countries. The red curve represents the distribution of the disease burden attributed to Communicable, Maternal, Neonatal and Nutritional (CMNN)-disorders, the green dotted curve represents the disease burden due to injuries and the blue curve represents the disease burden attributed to Non-Communicable Diseases (NCDs). The dotted curves display the distribution of the year 1990, while the solid line displays the data distribution in 2017.

Derivation of slope inequality index from the Pen's Parade

The Pen's Parade ranks global disease burden from the lowest-burden countries to highest-burden countries. The disease burden is based one DALY-rates per 100,000 with the length of the segments along the x-axis displaying the population size of the country through the cumulative share of the world population. The dotted lines are linear regressions through the Pen's Parade, which are used to calculate the slope inequality index.
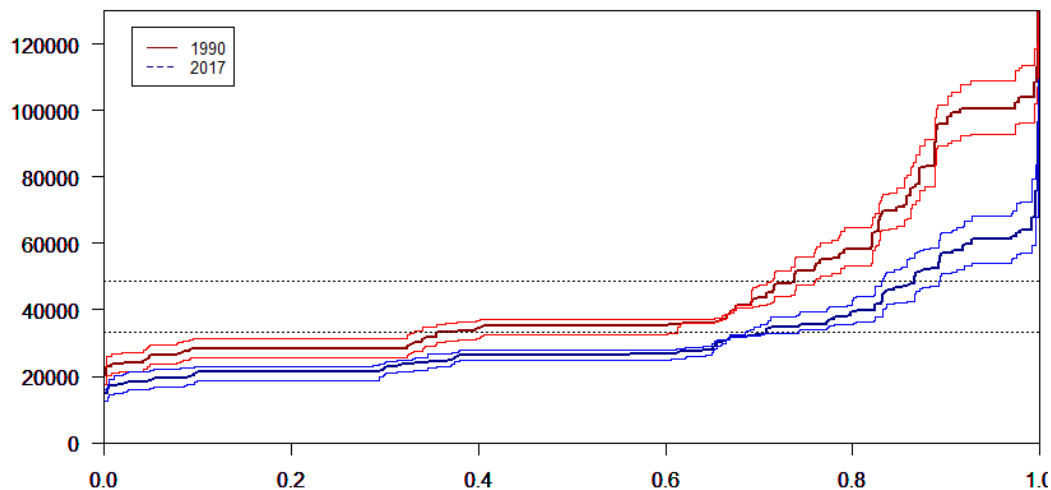

Figure 3. *Pen's Parade of disease burden due to all causes for 2017 (black curve) and 1990 (grey curve). The DALY-rates per 100,000 for 195 countries are used to calculate the disease burden. Each segment along the x-axis represents one country, with the length of the segment along the x-axis displaying the country's share of the world population.*
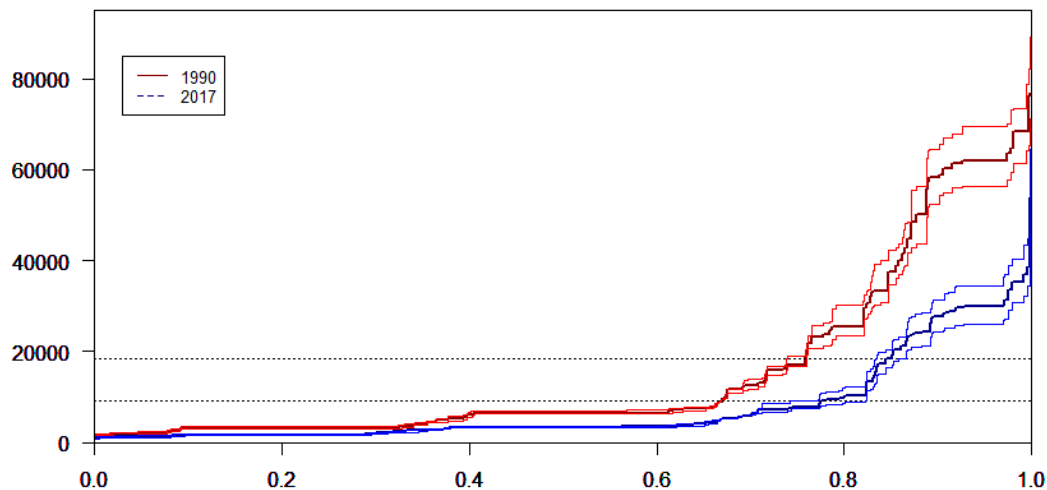

Figure 4A. *Pen's Parade of disease burden due to Communicable, Maternal, Neonatal and Nutritional (CMMNs) disorders for the year 2017 (dark blue) and 1990 (dark red), including the upper and lower bounds calculated based on the 95% confidence interval of the countries in each year (red lines / blue lines).*

Figure 4B. *Pen's Parade of disease burden due to Non-Communicable Diseases (NCDs) for the year 2017 (dark blue) and 1990 (dark red), including the upper and lower bounds calculated based on the 95% confidence interval of the countries in each year (red lines / blue lines).*

Figure 4C. *Pen's Parade of disease burden due to Injuries for the year 2017 (dark blue) and 1990 (dark red), including the upper and lower bounds calculated based on the 95% confidence interval of the countries in each year (red lines / blue lines).*
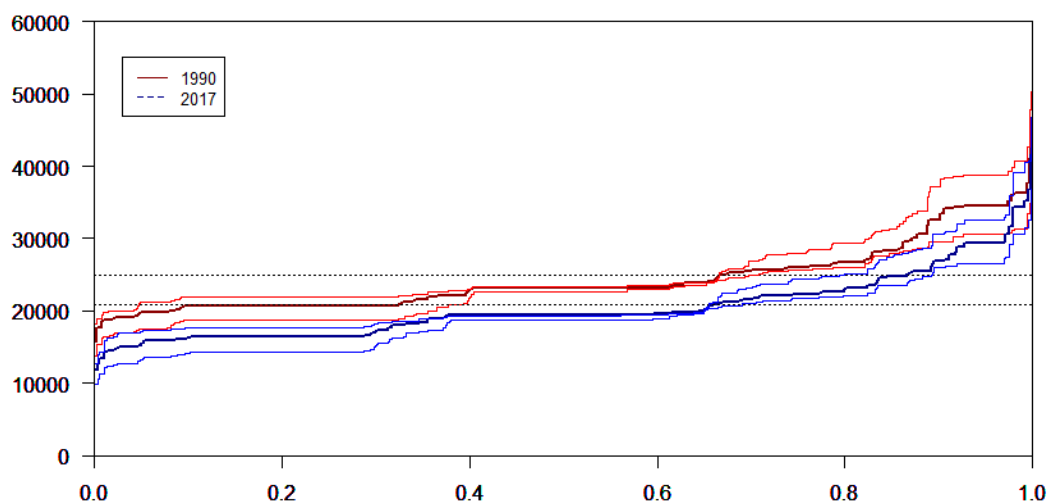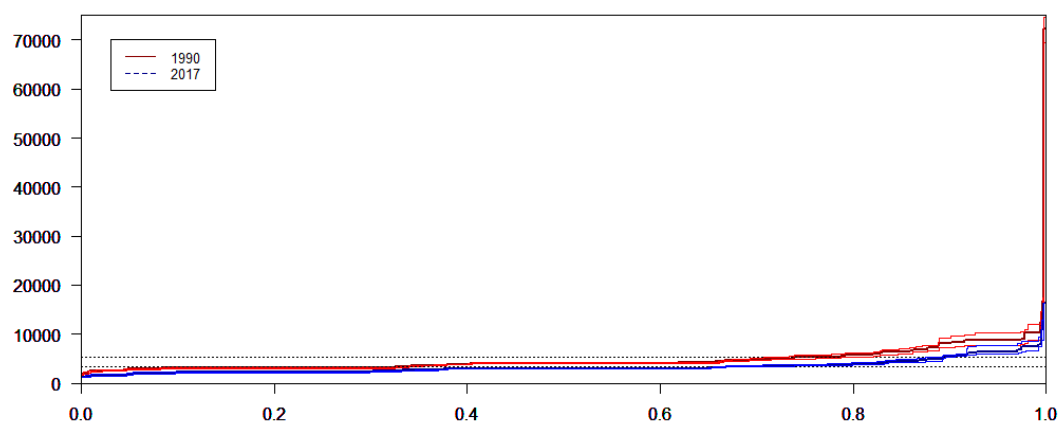
Boxplots on inequality between countries

The following figures display the distribution of countries according to their disease burden (measured as DALY-rate per 100,000) for the years 1990 to 2016. The all cause DALY-rate per 100,000 is displayed in figure 5, while the disease burden of the 195 countries which can be attributed to CMNN, Injuries, and NCDs is displayed in Figure 6 A-C.

The boxplot graphically depicts groups of numerical data – in this case the DALY-rate per 100,000 of 195 countries – through their quartiles. The spacings between the different parts of the box and the whiskers indicate the degree of dispersion (spread) and skewness in the data.

Median all-cause DALY rates (Figure 5), as well as the median DALY-rates attributed to CMNN-disorders, Injuries and NCDs (Figure 6) decreased between 1990 and 2016. The absolute range of country-level DALY rates widened between 1990 and 2005, narrowing again after this (Figure 5). This widening and narrowing of the range was mostly attributable to changes in the CMNN disorders cause group (Figure 6A) and to a smaller extend to the NCD group (Figure 6C). Haiti, an outlier, was excluded from the 2010 set in figure 5 and figure 6B (outliers defined as values more than 6 times the interquartile range above the median).
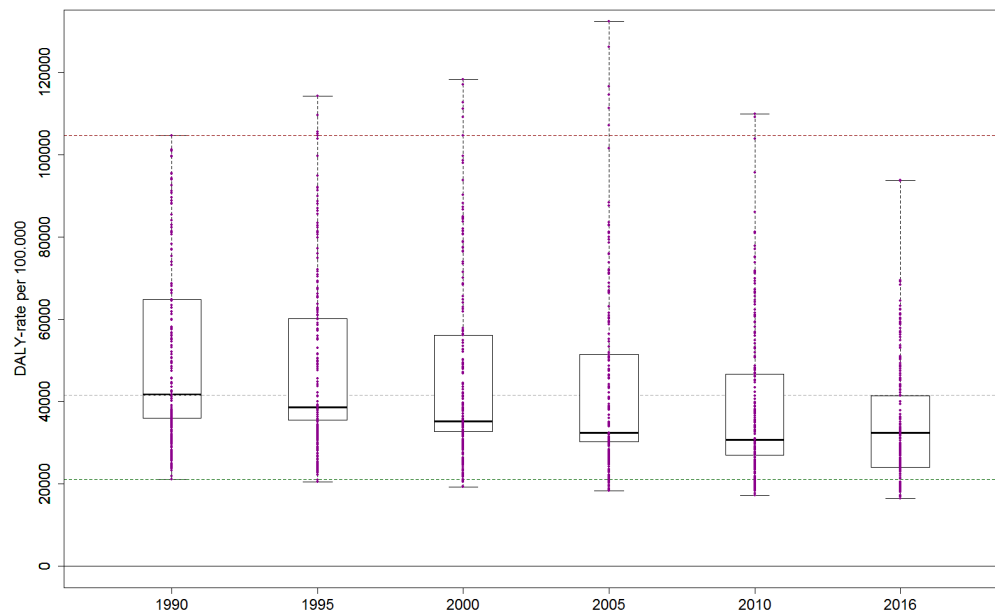
Figure 5. All cause DALY rate per 100,000 of 195 countries shown as population-weighted box-plots
The burden of disease for 195 countries in the form of population-weighted box-plots (relative rate per 100,000), showing an improvement at the upper quartile, median, lower quartile and lower whisker for the period 1990 to 2016. In contrast, the upper whisker increased for the period of 1990 and 2005, followed by decrease in the period 2005 to 2016. The year 2010 excludes the outlier Haiti.

Figure 6(A). DALY rate per 100,000 attributed to CMNN disorders of 195 countries shown as population-weighted box-plots. *The burden of disease for 195 countries in the form of population-weighted box-plots (relative rate per 100,000), showing an improvement at the upper quartile, median, lower quartile and lower whisker for the period 1990 to 2016. In contrast, the upper whisker increased for the period of 1990 and 2005, followed by decrease in the period 2005 to 2016.*
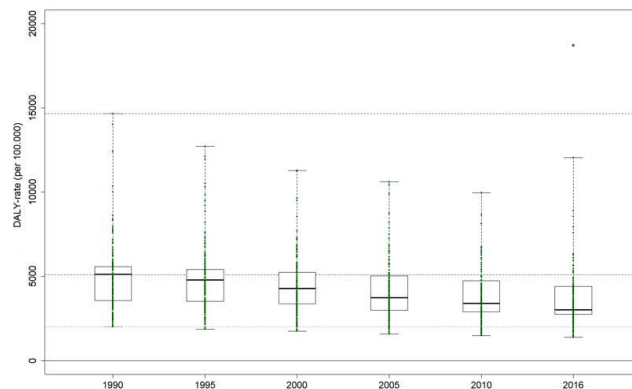
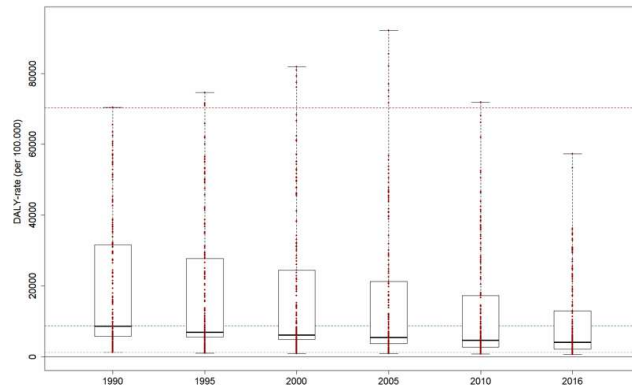***Figure 6 (B). DALY rate per 100,000 attributed to Injuries of 195 countries shown as population-weighted box-plots*** *The burden of disease for 195 countries in the form of population-weighted box-plots (relative rate per 100,000), showing an improvement at the upper whisker, upper quartile, median, lower quartile and lower whisker for the period 1990 to 2010. In contrast, the upper whisker increased between 1990 and 2016, which can be attributed to the development in the two countries Syria and Afghanistan. The year 2010 excludes the outlier Haiti.*
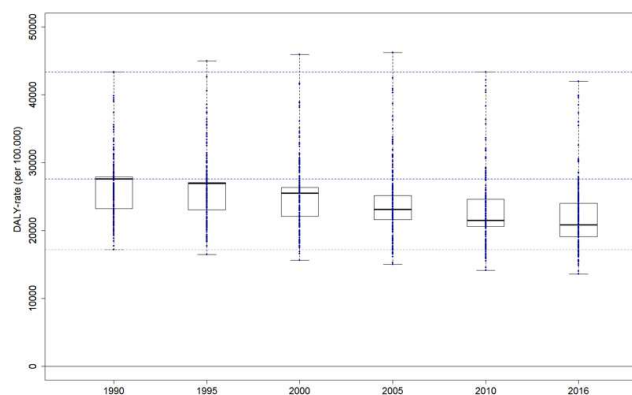
Figure 6 (C). DALY rate per 100,000 attributed to NCDs of 195 countries shown as population-weighted box-plots. *The burden of disease for 195 countries in the form of population-weighted box-plots (relative rate per 100,000), showing an improvement at the upper quartile, median, lower quartile and lower whisker for the period 1990 to 2016. In contrast, the upper whisker increased for the period of 1990 and 2005, followed by decrease in the period 2005 to 2016.*

Figure 7. Trends in age-standardized DALY rate by World Bank income category.

Chart from the GBD Compare tool:

Institute for Health Metrics and Evaluation (IHME). GBD Compare Data Visualization. Seattle, WA: IHME, University of Washington, 2016. Available from http:// vizhub. healthdata.org/gbd-compare. (Accessed 2 Jul 2018).

Summary of Gini index and SII index for all causes, CMNNs, Injuries and NCDs between 1990 and 2017.

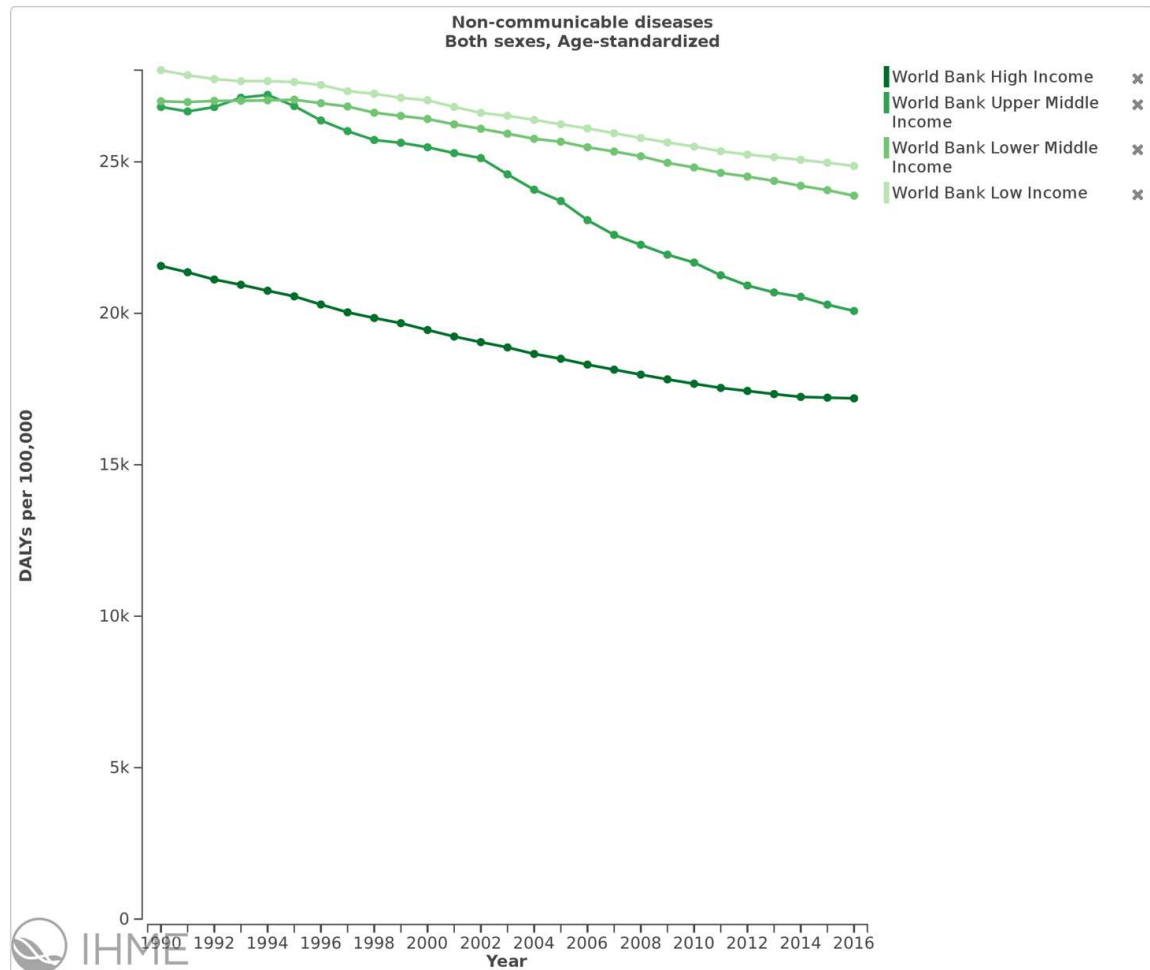| year	All causes			NCDs			CMNN			Injuries		
	Value	lower bound	upper bound	Value	lower bound	upper bound	Value	lower bound	upper bound	Value	lower bound	upper bound
1990	0.21	0.18	0.24	0.07	0.05	0.11	0.47	0.45	0.49	0.15	0.14	0.18
1991	0.21	0.18	0.24	0.07	0.05	0.11	0.47	0.45	0.49	0.17	0.15	0.19
1992	0.21	0.18	0.24	0.07	0.05	0.11	0.47	0.45	0.49	0.15	0.13	0.17
1993	0.21	0.18	0.24	0.08	0.05	0.11	0.47	0.45	0.49	0.16	0.15	0.18
1994	0.22	0.19	0.25	0.08	0.06	0.12	0.47	0.46	0.49	0.25	0.24	0.26
1995	0.21	0.18	0.24	0.08	0.06	0.12	0.48	0.46	0.49	0.16	0.15	0.18
1996	0.22	0.19	0.25	0.08	0.06	0.12	0.48	0.46	0.50	0.16	0.15	0.18
1997	0.22	0.19	0.25	0.08	0.06	0.12	0.49	0.47	0.50	0.17	0.15	0.19
1998	0.22	0.19	0.25	0.08	0.06	0.12	0.49	0.48	0.51	0.17	0.15	0.19
1999	0.22	0.19	0.26	0.08	0.06	0.12	0.50	0.48	0.51	0.18	0.17	0.20
2000	0.23	0.20	0.26	0.09	0.06	0.13	0.50	0.48	0.52	0.18	0.17	0.20
2001	0.23	0.20	0.26	0.09	0.06	0.13	0.51	0.49	0.52	0.18	0.16	0.20
2002	0.23	0.20	0.26	0.09	0.06	0.13	0.51	0.49	0.52	0.18	0.16	0.20
2003	0.23	0.20	0.26	0.09	0.07	0.13	0.51	0.50	0.53	0.18	0.16	0.20
2004	0.23	0.20	0.26	0.09	0.07	0.13	0.52	0.50	0.53	0.19	0.17	0.21
2005	0.23	0.20	0.26	0.10	0.07	0.13	0.52	0.50	0.54	0.19	0.17	0.21
2006	0.23	0.20	0.26	0.10	0.07	0.14	0.52	0.50	0.54	0.18	0.16	0.20
2007	0.23	0.20	0.26	0.10	0.07	0.14	0.52	0.50	0.54	0.18	0.16	0.20
2008	0.23	0.19	0.26	0.10	0.07	0.14	0.52	0.50	0.54	0.19	0.17	0.21
2009	0.22	0.19	0.26	0.10	0.07	0.14	0.52	0.50	0.53	0.17	0.15	0.20
2010	0.22	0.19	0.26	0.10	0.07	0.14	0.52	0.50	0.53	0.21	0.20	0.23
2011	0.21	0.18	0.25	0.10	0.07	0.14	0.51	0.49	0.53	0.18	0.16	0.20
2012	0.21	0.18	0.25	0.10	0.07	0.14	0.51	0.49	0.53	0.18	0.16	0.21
2013	0.21	0.17	0.24	0.10	0.07	0.14	0.51	0.49	0.52	0.18	0.16	0.20
2014	0.20	0.17	0.24	0.10	0.07	0.14	0.50	0.48	0.52	0.19	0.17	0.21
2015	0.20	0.16	0.23	0.10	0.07	0.14	0.50	0.47	0.52	0.18	0.16	0.21
2016	0.20	0.16	0.23	0.10	0.07	0.14	0.49	0.47	0.52	0.18	0.16	0.21
2017	0.19	0.16	0.23	0.10	0.07	0.14	0.49	0.47	0.52	0.18	0.16	0.20

Table 1: Development of Gini index between 1990 and 2017

year	All causes			NCDs			CMNN			Injuries		
	Value	lower bound	upper bound	Value	lower bound	upper bound	Value	lower bound	upper bound	Value	lower bound	upper bound
1990	0.68	0.56	0.79	0.12	0.08	0.19	0.55	0.51	0.62	0.07	0.06	0.07
1991	0.67	0.56	0.78	0.13	0.08	0.19	0.55	0.50	0.62	0.06	0.05	0.07
1992	0.65	0.55	0.76	0.13	0.08	0.19	0.55	0.50	0.61	0.05	0.04	0.06
1993	0.66	0.55	0.77	0.13	0.09	0.20	0.54	0.50	0.60	0.06	0.05	0.06
1994	0.80	0.70	0.91	0.13	0.09	0.20	0.54	0.49	0.60	0.19	0.18	0.20
1995	0.65	0.55	0.76	0.13	0.09	0.20	0.54	0.49	0.59	0.06	0.05	0.06
1996	0.66	0.55	0.77	0.13	0.09	0.20	0.53	0.48	0.60	0.05	0.05	0.06
1997	0.66	0.56	0.78	0.14	0.09	0.20	0.53	0.49	0.60	0.06	0.05	0.07
1998	0.67	0.56	0.78	0.13	0.09	0.20	0.54	0.48	0.60	0.06	0.05	0.07
1999	0.67	0.56	0.79	0.13	0.09	0.20	0.53	0.48	0.60	0.07	0.06	0.08
2000	0.66	0.56	0.78	0.14	0.09	0.20	0.53	0.48	0.60	0.05	0.04	0.06
2001	0.66	0.56	0.77	0.14	0.09	0.20	0.53	0.48	0.59	0.05	0.04	0.06
2002	0.65	0.55	0.77	0.13	0.09	0.20	0.52	0.46	0.59	0.05	0.04	0.06
2003	0.65	0.55	0.76	0.14	0.09	0.20	0.52	0.46	0.58	0.05	0.04	0.06
2004	0.64	0.55	0.76	0.14	0.09	0.20	0.51	0.45	0.57	0.05	0.04	0.06
2005	0.63	0.54	0.74	0.14	0.10	0.20	0.49	0.44	0.55	0.05	0.04	0.05
2006	0.62	0.53	0.73	0.14	0.10	0.20	0.48	0.43	0.53	0.04	0.04	0.05
2007	0.61	0.53	0.71	0.14	0.11	0.20	0.46	0.41	0.51	0.04	0.04	0.05
2008	0.59	0.51	0.69	0.14	0.11	0.20	0.44	0.39	0.49	0.05	0.04	0.05
2009	0.57	0.49	0.67	0.14	0.10	0.20	0.42	0.38	0.48	0.04	0.04	0.05
2010	0.58	0.50	0.68	0.14	0.10	0.20	0.40	0.36	0.45	0.07	0.06	0.08
2011	0.53	0.44	0.62	0.14	0.10	0.20	0.38	0.33	0.43	0.05	0.04	0.06
2012	0.50	0.41	0.60	0.14	0.10	0.20	0.36	0.32	0.41	0.05	0.04	0.05
2013	0.49	0.40	0.58	0.14	0.10	0.20	0.34	0.30	0.39	0.04	0.04	0.05
2014	0.47	0.38	0.57	0.14	0.10	0.20	0.32	0.29	0.37	0.05	0.04	0.06
2015	0.45	0.36	0.54	0.14	0.10	0.19	0.31	0.27	0.35	0.04	0.04	0.05
2016	0.43	0.35	0.53	0.14	0.10	0.19	0.29	0.26	0.34	0.04	0.04	0.05
2017	0.42	0.35	0.51	0.13	0.10	0.19	0.28	0.24	0.32	0.04	0.03	0.05

Table 2: Development of Slope Inequality index between 1990 and 2017