Nov 2014 No.210

Income Inequality, Redistribution and their Effect on Inequality in Longevity

Thomas Plümper and Eric Neumayer

WORKING PAPER SERIES

Centre for Competitive Advantage in the Global Economy

Department of Economics

Income Inequality, Redistribution and their Effect on Inequality in Longevity

Thomas Plümper[a] and Eric Neumayer[b]

[a] Department of Government, University of Essex, Wivenhoe Park, Colchester CO4 3SQ, UK, tpluem@essex.ac.uk

[b] Department of Geography and Environment, London School of Economics and Political Science (LSE), London WC2A 2AE, UK, e.neumayer@lse.ac.uk

Objectives. We examined the effects of market income inequality (income inequality before taxes and transfers) and income redistribution via taxes and transfers on inequality in longevity.

Methods. Life tables were used to compute Gini coefficients of longevity inequality for all individuals and for individuals that survived at least to the age of ten. Longevity inequality was regressed on market income inequality and income redistribution controlling for a range of potential confounders in a cross-sectional time-series sample of up to 29 predominantly Western developed countries and up to 37 years.

Results. Income inequality before taxes and transfers had a positive effect on inequality in the number of years lived, while income redistribution (the difference between market income inequality and income inequality after taxes and transfers have been accounted for) had a negative effect on longevity inequality.

Conclusions. Governments can reduce inequality in the number of years lived not only via public health policies, but also via their influence on market income inequality and the redistribution of incomes from the relatively rich to the relatively poor.

It is widely recognized that low income has multiple direct and indirect negative consequences for individual health (American Public Health Association 2001). It is therefore likely that higher inequality in incomes across the population of a country results in higher inequality in health outcomes at the population level. We analyze whether market income inequality (inequality of incomes before taxes and transfers are taken into account) and redistribution of incomes via taxes and transfers affect the inequality of longevity, both measured at the country level.

Of course, some inequality in longevity occurs naturally. Genetic predispositions, occupational risks, and heterogeneous lifestyles cause mortality risks to vary across different individuals in a population and thus cause inequality in the number of years lived. However, lifetime inequality varies strongly over time and moderately across seemingly similar countries. Much of these variations will also be caused by changes and differences in lifestyles and perhaps even genetic differences, but public policies not only affect health and mortality at the individual level, but also the inequality of longevity at the aggregate level. For example, higher tobacco (Chaloupka et al. 2002) and alcohol taxes (Wagenaar et al. 2009) reduce their consumption and should ultimately reduce avoidable and premature mortality from lung cancer and liver cirrhosis. More directly, governments install different health and safety regulations, they influence health spending and its allocation and regulate the coverage of health insurance across individuals.

While these pathways to more longevity equality are generally well understood, we focus here on a mechanism for which surprisingly no cross-country evidence exists: the influence of income inequality and income redistribution on lifetime inequality. Smaller market inequality in incomes and higher redistribution of incomes should give the poor access to activities, goods and services that prevent some premature deaths. For example, it should allow the poorer parts of the population to improve their nutrition, avoiding diseases such as diabetes and coronary heart disease that are related to poor diets, to afford better and more recreational activities, avoiding stress-related diseases, to invest more in education for themselves and their children, which will tend to result in healthier lifestyle choices, and to afford more additional private health care if that proves necessary. Though research has speculated that a relation between redistributive policies and longevity inequality exists at the country level (e.g., Smits and Monden 2009: 1122), we are the first to empirically study the effect of redistributive government policies on inequality in longevity in a pooled analysis of up to 28 countries over up to 37 years. We find that higher income inequality before taxes and transfers renders the years individuals live before they die more unequal, whereas redistribution of income via taxes and transfers reduces the inequality in longevity.

METHODS

As our measure of longevity inequality, we compute Gini coefficients from internationally comparable life tables from the highest quality data source, the Human Mortality Database.[1] It provides age-specific mortality data for 37 countries and, depending on the country, in part with very long time series of up to 200 years. However, our effective sample size is determined by the availability (or lack thereof) of data for our explanatory variables. In effect, our sample ranges from 1974 to 2011 at most and comprises 22 Western developed countries plus the Czech Republic, Estonia, Israel, Poland, the Slovak Republic and Slovenia.

We use the Gini coefficient as our preferred measure of inequality but different inequality measures tend to produce similar results in the analysis of longevity (Wilmoth and Horiuchi 1999). Since infant mortality has a relatively strong effect on longevity inequality, most demographers analyze not the entire range of life tables, but typically left-truncated ones of those who have survived beyond the age of 5, 10 or 15 (Edwards and Tuljapurkar 2005;

[1] www.mortality.org.

Edwards 2011). We report analyses of Gini coefficients over the entire life tables (0-110 years) and of Gini coefficients for those who have survived to the age of 10 (10-110 years), but our findings also hold for other thresholds. As always with Gini coefficients, higher values represent larger inequality. The sample means of the two Gini coefficients of longevity are, respectively, 0.100 and 0.094 (standard deviations (s.d.) of 0.0098 and 0.0076).

Longevity inequality has dramatically declined in all countries of our sample over the last two centuries. This development was paralleled by a large increase in life expectancy. The strong association between both trends prompts some to argue that one should only analyze inequality in longevity controlling for life expectancy (Wilmoth and Horiuchi 1999; Smits and Monden 2009). However, rather than increases in life expectancy causing more equality in longevity, both trends are likely being determined by the same factors: the sharp decline in infant mortality and the somewhat less pronounced decline in premature mortality. We include average life expectancy in our estimation models, but all estimation results hold regardless of whether we include life expectancy or not.

Despite the dramatic decline in longevity inequality over the last two centuries, substantial differences in longevity inequality across countries persist. Figure 1 compares the mortality by age of Sweden, one of the most equal, and the USA, one of the most unequal countries, in 1975.

Figure 1: Mortality by Age, Sweden and USA 1975

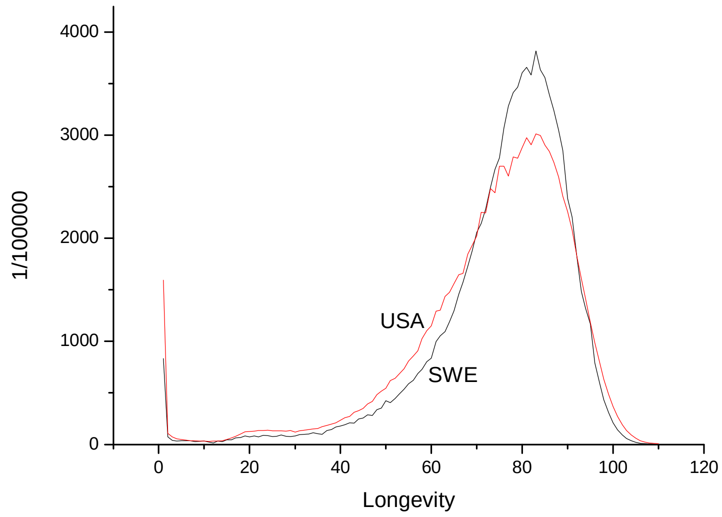

Figure 1 reveals four important differences between these two countries: The USA has a higher child mortality rate than Sweden (1.59 to 0.83 percent) and the death rate in the age group of the 20 to 65 year old is considerably higher (22.60 to 17.67 percent). On the other hand, the USA has a moderately higher share of individuals aged 100+ years (1.20 to 0.57 percent). As a consequence, Sweden has much higher mortality rates in the age group of the 65 to 90 year old (72.38 to 64.17 percent). The Gini coefficient for these two distributions is 0.107 for Sweden and 0.133 for the USA. Interestingly, the USA eventually reached a Gini of 0.107 in 2010. In other words: The USA lags behind the development in lifetime inequality in Sweden by 35 years. Moreover, differences in lifetime inequality decline but do not disappear if we suppress child mortality from the calculation. In 1975 Sweden had a Gini coefficient of 0.097 for the part of population that survived at least to the age of 10, while the USA had a Gini for the same age cohort of 0.115.

Figure 2 contrasts changes in longevity inequality within a country over the recent past. We use Italy as an example here, since the country experienced a comparably large decline in lifespan inequality, but other countries would basically reveal the same pattern of change.

Figure 2: A Mortality-by-Age Comparison of Italy 1975 and Italy 2009

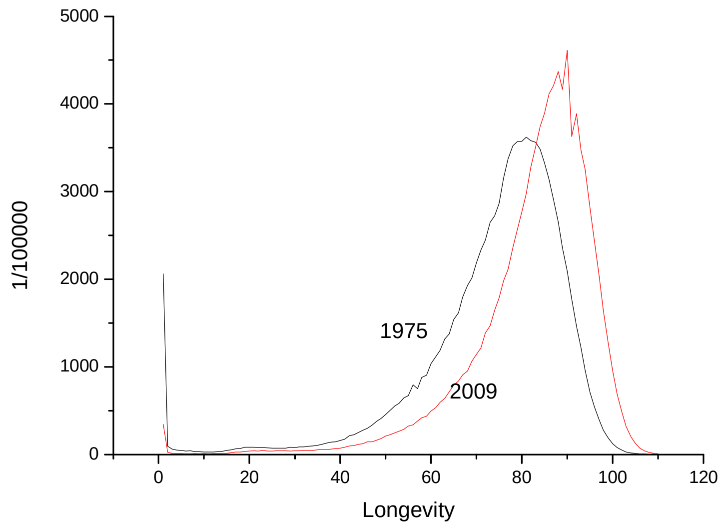

Figure 2 reveals that two factors are 'responsible' for the decline in lifespan inequality in Italy: first, the drastic decline in child mortality from 2 percent to below 0.4 percent, and second, the squeeze of the distribution around the peak, which also shifted to the right by almost 10 years over this period and thus increased life expectancy.

Note that whilst avoiding deaths at any age unambiguously increases life expectancy, the same is not true for reducing inequality. Instead, reducing premature deaths at ages approximately just before the longevity mean will decrease inequality, whereas reducing deaths at ages beyond will increase inequality (see also Vaupel, Zhang and van Raalte 2011). The very strong negative correlation between life expectancy and longevity inequality is due to countries having achieved life expectancy gains predominantly by focusing on averting premature deaths and reducing mortality is increasingly difficult at very high ages, rendering the right side of the distribution quasi-bounded (Smits and Monden 2009). As a consequence, higher longevity inequality almost always represents greater disparity in the left tail of the mortality distribution.

Explanatory Variables

As our measures of market income inequality and income redistribution we use, firstly, the Gini coefficient of incomes before taxes and transfers (mean 0.451, s.d. 0.041), which for simplicity we call pre-tax income inequality, and, secondly, the absolute difference between the Gini coefficient of incomes *before* taxes and transfers and the Gini coefficient of incomes *after* taxes and transfers (mean 0.016, s.d. 0.041). Note that a higher absolute difference does not necessarily imply that more income in absolute amounts is redistributed. Rather, it implies that income was redistributed in a way that resulted in a larger reduction in income inequality. For example, redistributing income from upper middle income brackets to lower middle income brackets has a smaller influence on our measure of income redistribution than the redistribution of an equally sized sum from high income to low income brackets. This feature makes this operationalization so attractive for our research. We source data from the OECD.[2]

As control variables, we include life expectancy at birth (mean 77.9, s.d. 2.3), computed from the life tables. All findings are robust to the exclusion of this variable. Further, we source data on GDP per capita in thousand constant purchasing power parity Dollars (mean 28.6 with s.d. 8.2) and total health expenditures per capita in thousand constant Dollars (mean 2.50 with s.d. 1.08) from the OECD and the WHO's European Health for All database.[3] Lastly, we account for cross-country differences in lifestyle and health and safety regulations that impact on longevity inequality. We thus include average alcohol per capita consumption in liters of pure alcohol (mean 9.54, s.d. 2.48). Since we have no data with comprehensive coverage on tobacco consumption and on lifestyle choices and health and safety regulations

[2] http://stats.oecd.org/

[3] http://www.euro.who.int/en/data-and-evidence/databases/european-health-for-all-database-hfa-db)

that result in death due to external causes, we account instead for the mortality consequences of these by including mortality rates from lung cancer (mean 48.4, s.d. 12.4) and from external causes (mean 54.4, s.d. 16.3) per 100,000 inhabitants (all data sourced from the OECD and WHO). We interpolate (but not extrapolate) missing observations on the explanatory variables.

Estimation Strategy

Our data has some properties that require attention in specifying an estimation model. The data is temporally dependent and would exhibit serially correlated errors if we did not control for temporal dependency. We therefore include the lagged dependent variable. Note that with the lagged dependent variable included, β represent their short-run marginal effects, whereas their long-run marginal effects are $\beta/(1-\rho)$, with ρ the estimated coefficient of the lagged dependent variable.

In addition to being temporally dependent, the data also exhibit strong trends over time. Medical and other progress that reduces infant mortality and premature deaths over time will exert a strong influence on longevity inequality, but this progress is impossible to observe and measure. However, this progress should lead to an upward trend in life expectancy and a downward trend in longevity inequality which is common to all countries included in our sample. We deal with this complication by adding year-specific fixed effects to the lagged dependent variable in our model specification and by controlling for life expectancy.

Finally, we account for remaining cross-sectional heterogeneity by including healthcare system fixed effects. We rely on Böhm et al.'s (2013) classification, which groups countries into types of healthcare systems according to the private, societal or state organization of the regulation, financing and provision of health care. With not all combinations in effect, countries can be grouped into those adopting systems of national health service (Denmark, Finland, Iceland, Norway, Portugal, Spain, Sweden, and the UK), national health insurance (Australia, Canada, Ireland, New Zealand, Italy), social health insurance (Austria, Germany, Luxembourg, and Switzerland), social-based mixed-type (Slovenia), etatist social health insurance, which we subdivide into Western (Belgium, France, Netherlands, Israel, and Japan) and Eastern (Czech Republic, Estonia, Poland and Slovakia), and private health (USA). Our estimator is ordinary least squares with standard errors clustered on countries.

RESULTS

Table 1 presents estimation results for the Gini coefficient of longevity over the entire life tables as dependent variable, table 2 the corresponding results for the Gini coefficient calculated conditional on survival to the age of 10. As one would expect, results are very similar for the two measures of longevity inequality, which suggests that results are not driven by changes in child mortality across countries and time. Models 1 and 4 cover the entire sample with available data; models 2 and 5 restrict the sample to the more homogeneous 22 Western developed countries to check whether the results are driven by the presence of Eastern European countries and Israel in the sample; models 3 and 6 further drop the USA from the sample to check whether this country alone determines the results. As tables 1 and 2 show, results on our variables of principal interest are very robust across these different samples.

The estimated coefficients of the lagged dependent variables of between 0.82 and 0.86 suggest substantial auto-correlation in the data, which, however, is safely below the unit root threshold of one. Life expectancy has the expected negative effect on inequality. So does GDP per capita, but it is only statistically significant once the USA is dropped from the sample. Total health expenditures have no statistically significant effect on longevity inequality, except in model 6. It might be surprising that we find total health spending to either have no statistically significant or a positive effect on longevity inequality, when higher total health spending will reduce longevity inequality if it is focused on reducing premature mortality. However, in relatively developed countries additional resources for health care often go into cutting-edge medical treatment, which prolongs the lives of some, often the already elderly, but it does not systematically prevent premature deaths. In other words, moving from high to even higher per capita spending on health care does not necessarily reduce inequality in longevity. Even the contrary is possible: if additional health care benefits mainly those who would otherwise not receive it because they are considered to be too old for some treatments, then additional health spending may actually increase longevity inequality. Neither average alcohol consumption nor the lung cancer mortality rate have a statistically significant impact on longevity mortality, whereas a higher mortality rate from external causes is predicted to increase longevity inequality, as expected.

Higher pre-tax income inequality is statistically significantly related to higher longevity inequality, whereas the opposite holds for higher income redistribution. The estimated substantive effects are similar, but in the opposite direction. An additional percentage point in the Gini coefficient of pre-tax income inequality is predicted to increase the Gini coefficient of longevity by between 0.0049 (model 2) and 0.0080 (model 6) in the short run and, correspondingly, by between 0.035 and 0.044 in the long run. An additional percentage point reduction from the Gini coefficient of pre-tax income inequality to the Gini coefficient of post-tax income inequality is predicted to decrease the Gini coefficient of longevity by between 0.0056 (models 1 and 5) and 0.0081 (model 3) in the short run and by between 0.04 and 0.05 in the long run. These effects are substantively important given that the standard deviations in both market income inequality and income redistribution are about 4.4 and 5.6 times larger than the standard deviations in, respectively, longevity inequality over the entire life tables and longevity inequality conditional on survival to the age of 10. In model 4, for example, varying pre-tax income inequality or income redistribution by one standard deviation would result in a long run change in longevity inequality by almost 21 per cent of its standard deviation. In model 1, the corresponding effects would be 16 per cent for pre-tax income inequality and 17 per cent for income redistribution.

Table 1. Estimation results for Gini coefficient of longevity (entire life tables).

	(1)		(2)		(3)	
	Coeff	95% CI	Coeff	95% CI	Coeff	95% CI
Lagged dependent variable	0.854964**	(0.779657, 0.930272)	0.855363**	(0.793882, 0.916844)	0.844090**	(0.774647, 0.913532)
GDP per capita	-0.000021	(-0.000041, 0.000000)	-0.000017	(-0.000040, 0.000005)	-0.000027*	(-0.000048, -0.000005)
Life expectancy	-0.000335*	(-0.000638, -0.000032)	-0.000290*	(-0.000553, -0.000026)	-0.000345*	(-0.000668, -0.000022)
Health expenditures per capita	0.000121	(-0.000121, 0.000362)	0.000140	(-0.000109, 0.000390)	0.000396	(-0.000006, 0.000797)
Alcohol per capita consumption	0.000017	(-0.000042, 0.000076)	0.000050	(-0.000008, 0.000109)	0.000044	(-0.000013, 0.000102)
Lung cancer mortality rate	0.000010	(-0.000006, 0.000027)	0.000009	(-0.000005, 0.000024)	0.000008	(-0.000008, 0.000024)
External cause mortality rate	0.000028**	(0.000015, 0.000040)	0.000030**	(0.000018, 0.000042)	0.000033**	(0.000020, 0.000047)
Pre-tax income inequality	0.005184**	(0.001581, 0.008786)	0.004934*	(0.001010, 0.008858)	0.007564**	(0.002511, 0.012618)
Income redistribution	-0.005583**	(-0.009552, -0.001615)	-0.005729**	(-0.009784, -0.001674)	-0.008113**	(-0.013526, -0.002699)
Observations	476		422		385	
Countries	28		22		21	

** p<0.01, * p<0.05. Year and healthcare system fixed effects included (coefficients not shown).

Model 2 restricts sample to Western developed countries, model 3 further excludes the USA.

Table 2. Estimation results for Gini coefficient of longevity (conditional on survival to age of 10).

	(4)		(5)		(6)	
	Coeff	95% CI	Coeff	95% CI	Coeff	95% CI
Lagged dependent variable	0.837078**	(0.749391, 0.924765)	0.839776**	(0.755611, 0.923941)	0.824390**	(0.728761, 0.920018)
GDP per capita	-0.000016	(-0.000034, 0.000002)	-0.000013	(-0.000033, 0.000006)	-0.000023*	(-0.000042, -0.000004)
Life expectancy	-0.000295*	(-0.000555, -0.000035)	-0.000251*	(-0.000492, -0.000011)	-0.000309*	(-0.000605, -0.000013)
Health expenditures per capita	0.000119	(-0.000113, 0.000352)	0.000144	(-0.000100, 0.000389)	0.000405*	(0.000001, 0.000808)
Alcohol per capita consumption	0.000031	(-0.000024, 0.000086)	0.000061*	(0.000003, 0.000120)	0.000056	(-0.000003, 0.000116)
Lung cancer mortality rate	0.000008	(-0.000007, 0.000022)	0.000006	(-0.000007, 0.000019)	0.000005	(-0.000009, 0.000018)
External cause mortality rate	0.000035**	(0.000018, 0.000051)	0.000035**	(0.000019, 0.000051)	0.000039**	(0.000021, 0.000057)
Pre-tax income inequality	0.006057**	(0.002694, 0.009420)	0.005336**	(0.001933, 0.008739)	0.008036**	(0.003218, 0.012855)
Income redistribution	-0.006057**	(-0.009600, -0.002513)	-0.005561**	(-0.009000, -0.002121)	-0.007951**	(-0.012770, -0.003132)
Observations	476		422		385	
Countries	28		22		21	

** p<0.01, * p<0.05. Year and healthcare system fixed effects included (coefficients not shown).

Model 5 restricts sample to Western developed countries, model 6 further excludes the USA.

DISCUSSION

Previous studies have focused on analyzing the effect of income inequality on health outcomes in single countries, predominantly in the USA (e.g., Singh 2003; Wilkinson and Pickett 2008) but also in Brazil (Pabayo et al. 2013), Italy (Materia et al. 2005), Norway (Elstad et al. 2006), and a few others. Whilst results have been somewhat mixed, a meta-analysis found income inequality to be associated with a modest excess risk of premature mortality (Kondo et al. 2009). Our analysis differs from these existing studies by analyzing the effect of economic inequality on longevity inequality, both measured at the country level, across a large cross-section of countries, namely up to 28 countries over the period 1974 to 2011. We have found substantively important effects of market income inequality and of income redistribution on longevity inequality.

Where existing studies have explicitly focused on longevity inequality measured at the country level, they have decomposed longevity inequality by inequality in educational achievement or socio-economic status. Van Raalte et al. (2010) find that educational inequalities can explain a substantial part of lifespan variation in 11 European countries. Edwards and Tuljapurkar (2005) find socioeconomic inequality to be important for accounting for the variance in adult life span in the United States. In a panel of countries, based on bivariate plots they find no clear relationship between income inequality or inequality in educational achievement and inequality in longevity, both measured at the country level. However, such bivariate plots fail to control for important confounding variables and exogenous trends. To our knowledge, ours is the first cross-country study that estimates the effects of economic inequality on longevity inequality with a multivariate statistical model.

CONCLUSION

Traditionally, scholarship in public health has focused on the effects of healthcare spending and its allocation as well as the effects of healthcare systems on health inequalities. We have shown that income inequality and policies that reduce it have a strong association with longevity inequality in a cross-country study. Societies that are more unequal in terms of income are also more unequal in terms of the number of years lived. We believe that this is an important argument for income redistribution, and one that is left out in the recent public debate about the rise and the consequences of income inequality. Governments can indirectly influence income inequality before taxes and transfers via, for example, investment in education and infrastructure and the regulation of markets. They can redistribute incomes directly via taxes and transfers. Governments can thus affect longevity inequality well beyond any specific healthcare policies.

REFERENCES

American Public Health Association. 2001. Raising Income to Protect Health. American Journal of Public Health 91(3):504-505.

Böhm, K, Schmid A, Götze R, Landwehr C, Rothgang H. 2013. Five Types of OECD Healthcare Systems: Empirical Results of a Deductive Classification. Health Policy 113:258-269.

Chaloupka FJ, Cummings KM, Morley CP, Horan JK. 2002. Tax, price and cigarette smoking: evidence from the tobacco documents and implications for tobacco company marketing strategies. Tobacco Control 11(1):I62–72.

Edwards, RD. 2011. Changes in world inequality in length of life: 1970-2000. Population and Development Review 37(3):499-528.

Edwards, RD, Tuljapurkar S. 2005. Inequality in life spans and a new perspective on mortality convergence across industrialized countries. Population and Development Review 31(4):645-674.

Elstad, J.I., Dahl E, Hofoss D. 2006. Associations Between Income and Mortality in Norway: a Register-based Study. European Journal of International Health 16(6):640-644.

Kondo N, Sembajwe G, Kawachi I, van Dam RM, Subramanian SV, Yamagata Z. 2009. Income inequality, mortality, and self-rated health: meta-analysis of multilevel studies. BMJ 339:1178-1181.

Materia, E, Cacciani L, Bugarini G, Cesaroni G, Davoli M, Mirale MP, Vergine L, Baglio G, Simeone G, Perucci CA. 2005. Income Inequality and Mortality in Italy. European Journal of International Health 15(4):411-417.

Pabayo, R., Chiavegatto Filho ADP, Lebrão ML, Kawachi I. 2013. Income Inequality and Mortality: Results from a Longitudinal Study of Older Residents of São Paulo, Brazil. American Journal of Public Health 103(9):43-49.

Singh, GK. 2003. Area Deprivation and Widening Inequalities in US Mortality, 1969-1998. American Journal of Public Health 93(7):1137-1143.

Smits, J, Monden C. 2009. Length of life inequality around the globe. Social Science & Medicine 68(6):1114-1123.

van Raalte, AA, Kunst AE, Deboosere P, Leinsalu M, Lundberg O, Martikainen P, Strand BH, Artnik B, Wojtyniak B, Mackenbach JP. 2011. More variation in lifespan in lower educated groups: evidence from 10 European countries. International Journal of Epidemiology 40(6):1703-1714.

Vaupel, JW, Zhang Z, van Raalte AA. 2011. Life expectancy and disparity: an international comparison of life table data. BMJ open 1(1):e000128.

Wagenaar AC, Salois MJ, Komor KA. 2009. Effects of beverage alcohol price and tax levels on drinking: a meta-analysis of 1003 Estimates from 112 Studies. Addiction 104:179–90.

Wilkinson, R, Pickett KE. 2008. Income Inequality and Socioeconomic Gradients in Mortality. American Journal of Public Health 98(4):699-704.

Wilmoth, JR, Horiuchi S. 1999. Rectangularization revisited: Variability of age at death within human populations. Demography 36(4):475-495.