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Abstract

A prime objective for welfare state activities is to take action to enhance population health and decrease mortality risks. Poverty has for several centuries been seen as a key social risk factor in these respects. Consequently, the fight against poverty has historically been at the forefront of public health and social policy. The relation between relative poverty rates and population health indicators is less self-evident, notwithstanding the obvious relation to the debated topic of the relation between population health and income inequality. In this study we make a comparative analysis on the relation between relative poverty and mortality across 26 countries over time with pooled cross-sectional time series analysis. We utilize data from the Luxembourg Income Study to construct age-related poverty rates across countries and time covering the period from around 1980 to 2005 merged with data on age- and gender-specific mortality data from the Human Mortality Database. Our results suggest an impact of relative poverty but also clear differences by welfare regimes that partly go beyond the well-known differences in poverty rates between welfare regimes.

Introduction

Fighting poverty has always been at the centre of welfare state activities. There are several important reasons for such a focus but a key issue is no doubt that poverty is associated with increasing risks for ill-health and also death. That at least extreme poverty and poor health go together seems instinctively obvious and historically one finds numerous classical examples of investigators highlighting the interrelation between scarce economic resources and poor health status. Friedrich Engels' *The condition of the Working Class in England*([1] and Seebohm Rowntree's [2] poverty investigations in York more than hundred years ago are the two classical examples. In the latter, Rowntree did not only show the high mortality risks among the poorest areas of the working class but also that York at that time had what is nowadays called a "social gradient" [3]. For example, the infant mortality rate in the area with "highest class labour" was close to double to that in the "servant-keeping class". Interesting enough, it was also then higher than currently in the nations that according to UN has the highest infant mortality in the world today, such as Sierra Leone [4].

The finding of the social gradient is also of interest when going from these historical studies to present discussions about poverty, inequality and population health since it indicates that not only the very poorest sections were hit but that relative poverty also was of importance. That countries with high absolute poverty rates today (e.g. World Bank indicators of 1 or 2 US dollars a day) also tend to be countries with low life expectancy and high mortality risks is well-known. But what is the relation between relative poverty rates and mortality risks among the richer countries of the world?

Assuming that the poorest people in rich countries do not live under absolute poverty, the relation between variations in relative poverty rates and variations in mortality rates may seem less self-evident. However, the relation has been at the centre of one of the most debated topics within the field of public health research and social epidemiology during the last decades, namely the health impact of income inequality. It is actually one foundation for the so-called Wilkinson hypothesis which basically states that it is not the level of affluence as such that matters among rich countries but rather how the pie of total economic resources is distributed [5]. Now this hypothesis is articulated in relation to the whole social structure, thus stating that it is income inequality as such that kills and not only poverty. However, most evidence, both on the macro-level of countries and on the micro-levels of individuals, suggests a curvilinear association between income and health which implies that health gains can be made by transferring money from richer to poorer. If this is so it means that not only income inequality, but also and even more evident variations in poverty rates should be associated with population health. But can we evidence that cross-national variation in relative poverty rates are related to cross-national variations in survival possibilities within relatively rich countries?

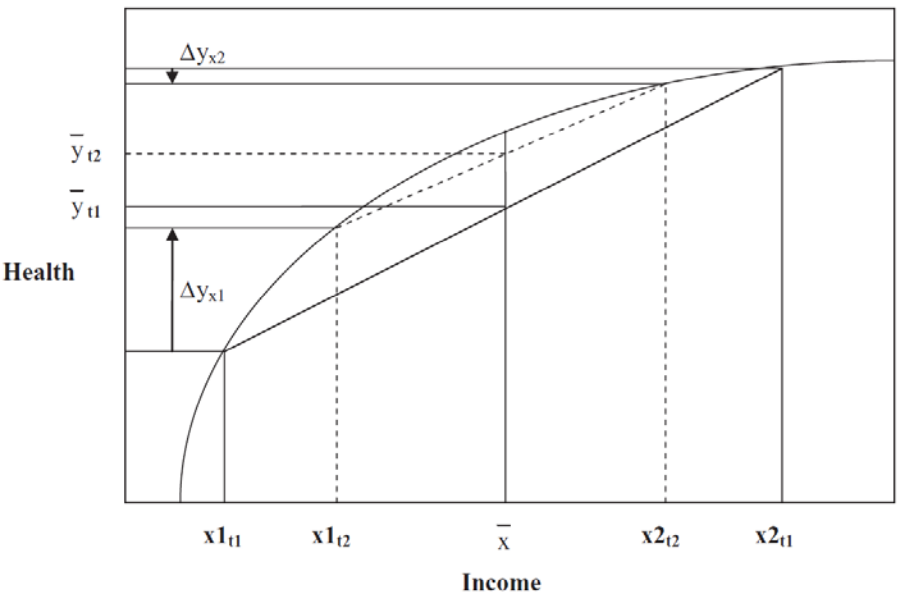
In this study we conduct a comparative analysis on the relation between poverty and mortality across 26 developed countries over time. We utilize data from the Luxembourg Income Study [6] to construct age-related poverty rates across countries and time covering the period from around 1980 to 2005 merged with data on age- and gender-specific mortality data from the Human Mortality Database [7].

In the next section we will shortly go through some of the arguments and empirical evidence of relevance to our study. Thereafter we will present our data, methods and analytical design. We then present our results and the paper ends by a concluding discussion about our findings.

As already mentioned, the idea that income inequality could influence population health was something noted already by the typical curvilinear association of the so called Rodgers curve. Partly based on empirical data, Rodgers [8] presented a model of how smaller income disparities and relative poverty at societal level are linked to better public health through differential impacts on individual health status among both low- and high-income earners. He argues that the health returns of income are diminishing at higher income levels, implying that this relation is curvilinear [8, 9]. In the Rodgers example (Figure 1) health of the low-income person x1 is much poorer than that of the high-income person x2 at t1. Redistributing income from x2 to x1 at t2 will result in an unchanged average income ($\overline{x}$), while average health ($\overline{y}_{t2}$) improves. This is simply the result of the health gain among the poor (Δy_{x1}) being larger than the health loss among the rich (Δy_{x2}) as a consequence of this income redistribution. Rodgers also presented results from cross-national, cross-sectional analysis supporting the specification that countries with lower inequality had higher life expectancy.

Although Rodgers, and later Wilkinson [10], articulated how the whole income distribution could make a difference, it is evident following from the hypothesis that what should particularly make a difference is how the relatively poor fare and how large a fraction of the population is at risk of poverty.

Figure 1. Theoretical connection between individual and aggregate level relationships between income and health (From (Lundberg et al. [11], adapted from Rodgers [8])



The topic of income inequality and health has become a little research industry within social epidemiology, with some influences from economics and sociology, and numerous studies have been published especially on the relation between income inequality across American states and various health outcomes [12]. One major review [13] was by and large in favour of the hypothesis, whereas another one [14] was sceptical. A meta-analysis of multi-level studies linking income inequality to mortality and self-rated health gave support to the idea [15]. A recent global study investigating 140 countries give support to the hypothesis, but only so in low- and middle-income countries [16].

Contrary to the many studies on income inequality, few studies have directly investigated the role of relative poverty. The role of welfare state programmes in population health has recently been highlighted. Not least within the NEWS-project [11], initiated in collaboration with the WHO Commission on Social Determinants of Health, a number of studies were produced linking specific designs, generosity and coverage of social policy programmes on the one hand, to overall and age-specific mortality, and on the other, to morbidity [17-21]. These studies focused on the cash side of the welfare state and gave support to the idea that cash programmes of the welfare state have been of importance to public health during the second half of the 20th century. These studies did not investigate the role of welfare services, nor did they study any specific mechanisms behind the found associations. However, the ability of these programmes in poverty alleviation was often referred to as a key factor for cross-national variations in mortality rates. Of course, the programmes of the welfare state are likely to also influence other more proximal health-related factors that could influence mortality risks. In this study we will explore the relative poverty argument directly by making use of the best sources for comparative studies on poverty and mortality over a 25-year period. As the small-N problem occurs in most cross-national studies, we partly overcome this problem by making use of multiple waves of data for each country included.

Although we will not examine the mechanisms, it is still necessary to shortly mention some of the possible multiple pathways linking relative poverty and mortality. Overall mortality has decreased over the recent decades in developed countries (with Russia as the only exception). The question is whether incidence of relative poverty has delayed or hindered a fall in mortality in the countries included in our analysis. The experience of living in relative poverty may be connected both to unhealthy habits, continuous stress, as well as negative consequences more or less directly stemming from lack of resources, e.g. not being able to consume healthy food or live in adequate housing, or to move to a neighbourhood with more safety, better primary health care or better schools and other services. We believe many of these factors may work rather in a causal chain than as contradictory mechanisms [22]. In so far as the psycho-social processes are at work, it seems more reasonable to assume that they have a material base than to see the material and psycho-social as representing two opposite and mutually exclusive poles.

Materials and Methods

Our two main data sources are the Luxembourg Income Study (LIS) and the Human Mortality Database (HMD). LIS is a cross-national harmonized database that includes multiple waves of micro-data for a number of countries. It has a focus on income inequality and poverty but also includes a lot of information on for example family situation and employment status. The first wave started around 1980 having approximately five-year intervals so that wave six of the data is around 2005 (for a thorough presentation of the database, see [23]. LIS is commonly regarded as the best source for cross-national comparisons of poverty and income inequality. The Human Mortality Database (HMD), maintained by the University of California, Berkeley and the Max Planck Institute of Demographic

Research, provides detailed open access mortality and population data for a number of countries for years reaching from the 1800's to around 2010. Currently, the HMD includes information for 37 countries, which are partly the same and partly different than those in the LIS database.

In our study, we include all countries from LIS that have at least two waves of data from the same original survey source, and for these countries, all LIS waves for which also mortality data were available in the HMD for corresponding years. These principles lead to a country sample of 26 rich countries with 2 to 6 waves, a total of 122 data points (see table 1). LIS data accessed and analysed in January to February 2011. Countries that are included are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Luxembourg, the Netherlands, Norway, Poland, Russia, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Taiwan, the United Kingdom and the United States.

Table 1. Countries and LIS waves included in the analysis, grouped by welfare state regimes

Country	**LIS Waves**						**Country**	**LIS Waves**					
	1	2	3	4	5	6		1	2	3	4	5	6
Nordic model							*South-European model*						
Denmark		1987	1992	1995	2000	2004	Italy		1986	1991	1995	2000	2004
Finland		1987	1991	1995	2000	2004	Spain	1980		1990	1995	2000	2004
Norway	1979	1986	1991	1995	2000	2004	*Post-Socialist model*						
Sweden	1981	1987	1992	1995	2000	2005	Czech Republic			1992	1996		2004
Central European model							Hungary			1991	1994	1999	2005
Austria		1987		1994	2000	2004	Poland		1986	1992	1995	1999	2004
Belgium		1985	1988	1995	2000		Russia			1992	1995	2000	
France	1979	1984	1989	1994	2000		Slovak Republic			1992	1996		
Germany			1989	1994	2000	2004	Slovenia				1997	1999	2004
Luxembourg		1985	1991	1994	2000	2004	*Other*						
Netherlands		1987	1991	1994	1999	2004	Israel		1986	1992	1997	2001	2005
Switzerland	1982		1992		2000	2004	Taiwan	1981	1986	1991	1995	2000	2005
Liberal model													
Australia	1981	1985	1989	1995	2001	2003							
Canada	1981	1987	1991	1994	2000	2004	*Number of countries per wave*	10	18	23	25	24	22
Ireland		1987		1995	2000	2004							
United Kingdom	1979	1986	1991	1995	1999	2004							
United States	1979	1986	1991	1994	2000	2004							

Key measurement variables

Poverty rates: We use a standard income poverty head-count measurement in which those individuals living in households with equivalent disposable income lower than a certain percentage of median income are regarded as poor. Accordingly we measure income after taking into account welfare state transfers and taxes. In order to be able to compare households of different sizes we make use of a standard one-parametric equivalence scale which simultaneously tries to handle economies of scale and the fact that costs increase so each household's disposable income is divided by the square root of the number of persons in the household. The proportion poor households will of course be partly determined by where we put the threshold. Evidently, the nature of poverty in terms of both the size of income and, for the countries analysed here, its consequences will become more severe the further away from the national median we get. In our analyses we have employed a more severe definition than the usual 60% threshold, and thus set the poverty threshold to 40% of national median. Poverty rates in each country and each wave were calculated separately for children (<18) and working-age adults (aged 25–65).

Mortality rates: We study deaths in three different gender specific age groups: infants (<1 year), children aged 0–17 years and adults in the age bracket 25 to 64 years of age. Data on deaths and populations at risk were collected for 1-year age bands for each country from the HMD for all LIS waves and for three following years of each wave. While infant mortality rates were used as such, age-standardized mortality rates for the 0–17 and 25–64 years of age were calculated to adjust for the different age structures of the countries. In these calculations, we used the direct method and the European standard population [24]. The age-standardized rates thus represent what the crude rates would have been if the populations of the countries had the same age distribution as the European standard population. The age-standardized mortality rates were calculated as deaths per 1000 person years. To allow for exposure time on mortality after our poverty measurements we calculated mortality rates as the average of the age-standardized mortality rate of the LIS year plus that of the three following years. However for infant mortality we only took the immediate year into account. The calculated rates were, in the multivariate regressions, logged in order to normalize the skewed mortality data.

Control variables: LIS wave number was used in all analyses to allow for time-related changes in poverty and mortality rates. The wave number also is an indicator variable pertaining to the more or less automatic decline in mortality that takes place in all countries.

GDP per capita/1000 US dollars data were derived from Penn's world tables [25] that contain information on the GDP per capita levels for all the countries included in our analyses. The GDP levels are adjusted to changes in cost of living across time and space and they are given in 2005 US dollars.

Data on *social spending* are from OECD databases[1] and are expressed as a percentage of GDP. Russia and Taiwan are not included in this database; therefore, data for these countries are derived from other sources [26, 27].[2]

[1] The social spending measure includes both benefits in cash and in kind. In addition, there are administrative costs included but the inclusion of the costs for running the schemes is not a major problem since these costs comprise 2-4% of all expenditure. A more nuanced way of studying the impact of welfare spending would have been to use disaggregate spending data, i.e. to separate cash and in kind benefits used for children, elderly,

An additional welfare state measure is a dummy for the *welfare state regime* that each country belongs to (see Table 1). [3] The classification follows the more or less standard classifications: Nordic model (Denmark, Finland, Norway and Sweden); Central European model (Austria, Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland);Liberal model (Australia, Canada, Ireland, the United Kingdom and the United States); South-European model (Italy, Spain); Post-Socialist model (Chez Republic, Hungary, Poland, Russia, Slovakia, Slovenia) and the category of 'Other' (Israel and Taiwan), for a closer discussion on the welfare state regimes, see Castles et al. [28].

Methods and methodological approach

In the first part of the analysis, we inspect bivariate plots to see the general pattern of the relationship between mortality rates and the background variables. We start by looking at developmental pattern in mortality over cross-sections and welfare regimes. Thereafter we proceed to multivariate analyses to see how the bivariate relationships will change when other variables are included in the regression models. For regression analyses we used pooled cross-sectional time-series methods. By using cross-sectional analyses and combining them with pooled regression data, we want to shed some light on the debate on the relationships between poverty, economic growth, the characteristics of the welfare state and mortality.

These methods take advantage of the panel structure of the data while taking care of the correlations of data points between waves using panel-corrected standard errors [29-31]. When partially solving the small N-problems, the pooled cross-sectional time-series method ends up in problems of spatial and longitudinal autocorrelation and heterogeneity. There is a number of regression techniques available to deal with the special problems of analyzing pooled data and each of them has its weaknesses and results seem to be highly sensitive to the specific method applied [32-36]. Pooled regressions were run by the STATA 12 cross-sectional time-series package using Prais-Winsten regressions. Here we tested two possible ways to model the autocorrelation. 1) The PSAR(1) model uses autoregressive (AR1) autocorrelation that is panel-specifically calculated. The good side is that it is tailored for each panel separately and the flip side is that it may be unstable if there are few cross-sections. 2) The AR(1) model uses an autocorrelation structure that is common for all panels. In order to further test robustness of our results we ran separately both AR(1) and PSAR(1) models. In practice, the results were robust for different method applied, and although the standard errors varied, the interpretations of the results did not.

An obvious option would have been to use fixed effect regression models, but then we would have lost the effect of the level variables and our results would have been more dependent on the short-

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health care, various income maintenance programs etc. However, that kind of analysis falls beyond this particular paper and is a task for future studies. Here we simply assume that the overall social spending level reflects the state's commitment to citizens' welfare.

[2] Since data for Russia and Taiwan are adapted from non-standard OECD sources they are not totally comparable. Therefore, we have run sensitivity tests with and without these countries. The omission of Taiwan did not change the results, while the exclusion of Russia had a strong impact. Our data set is unbalanced, i.e. data are not available for all countries and all years, therefore, we also run control analyses for the balanced data. Whereas the omission of Russia had the strongest impact, the omission of other was not that significant (see further discussion below).

[3] In principle, it would have also been possible to use country dummies but in practice it was not a viable strategy given the high number of countries and the relatively small number of waves.

term changes and fluctuations in variables used [34, 37]. Our motive is that it seems reasonable to assume that it is the level of poverty rather than fluctuating yearly changes that has an effect on mortality. Thus, we assume that the magnitude of poverty is lethal, not that much annual fluctuations. The issue here is about in which kind of circumstances people live or die, not that much how minor changes affect their health. However, it should be noted that some of the fixed effects still are included by the used dummies for the LIS-wave and welfare state regime. The underpinning idea in the welfare regime thinking is that some countries, due to learning from their closest neighbours and due to other historical legacies, have a high degree of family resemblance in their welfare state policies, and consequently, not only are the institutional set-ups of welfare state policy but also consequences e.g. in terms of poverty similar in countries belonging to the same welfare state regime [38-40].

We begin our analyses by looking at the infant mortality rates and then proceed to study mortality in the age-groups 0-17 and 25-64 respectively.

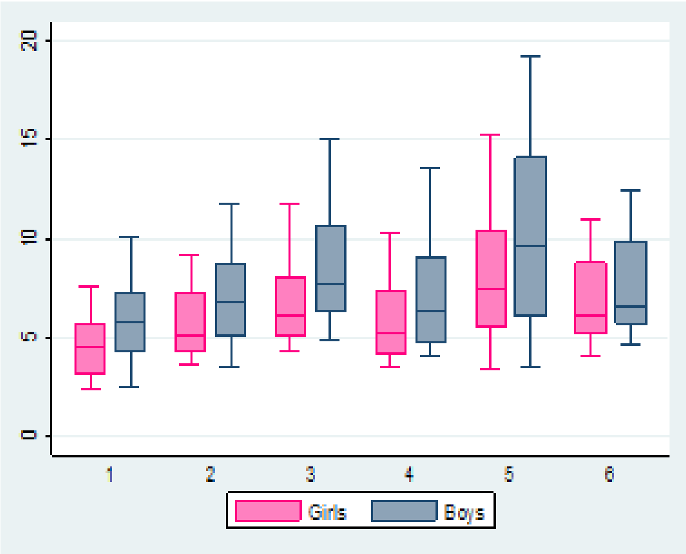
Results and Discussion

Infant mortality rates

In figures 2A and 2B we study the magnitude and variability of infant mortality rates in different welfare state regimes and over time. In the latter regressions we will use logged mortality for girls and boys together but in these more descriptive figures we show the raw figures for each sex. The box-plots display medians and distributions of country-based and wave-based observations around the median values. The interpretation of the box-plot presentation is as follows: the upper boundary of the box represents the 75th percentile and the lower boundary pertains to the 25th percentile of cases. The minimum and maximum cases that are not outliers – i.e. not further than 1.5 times the box length from the upper or lower box boundary – are indicated by small horizontal lines in "whiskers". Dots outside these short horizontal lines indicate an outlier.

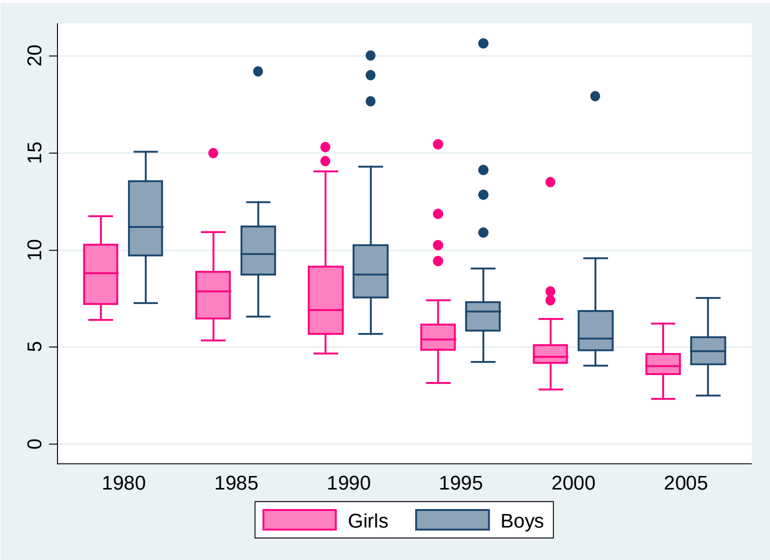
The first observation from the box-plot figure is that infant mortality rates among boys are higher than among girls (8,99 per 1000 among boys and 6,43 per 1000 among girls, on average across countries and time points). While this holds for all welfare regimes, there is regime and country-based variation in the width of the gap. While the gap is the smallest in Israel and Luxembourg, it is widest in the post-socialist countries as is also evident in the figure. As can be seen, the mortality rates are the lowest in the Nordic group (4.56 for girls and 5.92 for boys) and there is not much variation between the four countries included into this cluster, and also the variation between the years under inspection is relatively low. Already the starting levels are low and there is a modest absolute, decline in infant mortality. In the other end of the continuum we find the former socialist countries show both the highest mortality rates and the highest variation between nations but also the highest absolute decline in infant mortality. There is substantial variation also over time, and as is evident in figure 2B, there is a downward trend over the waves both concerning levels and the cross-national variation.

Figure 2A. Infant mortality rates (per 1000), 1980 to 2005, among girls and boys in different welfare state regimes



1=Nordic; 2=Central European; 3=Liberal; 4=South-European; 5=Post-Socialist; 6=Other

Figure 2B. Infant mortality rates (per 1000) among girls and boys, 1980 to 2005



In figure 3 we present bivariate scatter plots between infant mortality rates and those background variables that we later on will use in our multivariate models. In pooled data, i.e. where all cross-sections are merged into one, the relations between predictors and infant mortality rates are in the expected direction but not always convincingly high. The overall correlation in the pooled data is the highest between infant mortality rate and GDP, indicating that infant mortality is conditioned by the wealth of the nation and all those factors that are linked to GDP. However, GDP is not only an indicator of economic prosperity but it also represents a more general modernization trend that includes better food, better health care, better sanitation, access to clean water etc. – factors that are regarded as important to combat infant mortality.

The negative association holds for each cross-section. While the relationship between infant mortality and GDP per capita is lowest in the first wave, it is strongest in the fourth wave. In line with earlier research we can also note the curvilinearity in the association between economic prosperity and infant mortality.

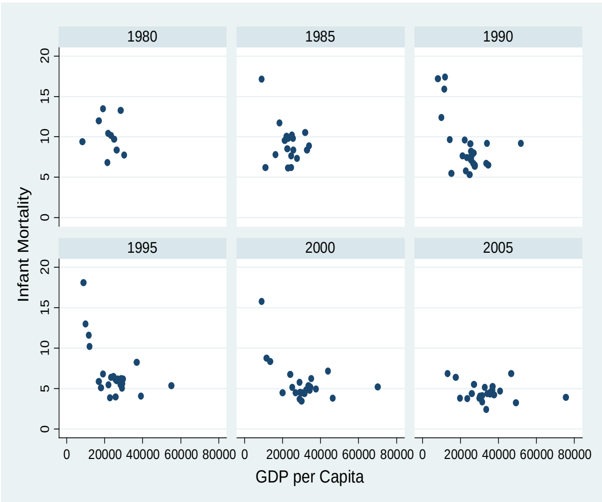
What this kind of inspection does not reveal is that the decline in GDP as a consequence of the severe economic crisis in Finland, Sweden and Switzerland did not result in an increase in infant mortality rates in the 1990s. This indicates that GDP is a necessary but not a sufficient condition for the decline in child mortality. There are also other forces in play. Moreover, as noted earlier [19, 20], nowadays the relation does not hold if we restrict the sample to the rich traditional OECD-countries.

The second strongest correlation in the pooled data is that between mortality and social spending that represents the magnitude of the public commitment to the social protection of the populace. Also here the pattern is rather constant over cross-sections (figure 3): the larger the share of GDP is made up of social spending, the lower the infant mortality rate. The association tends to be stronger in later periods of observation.

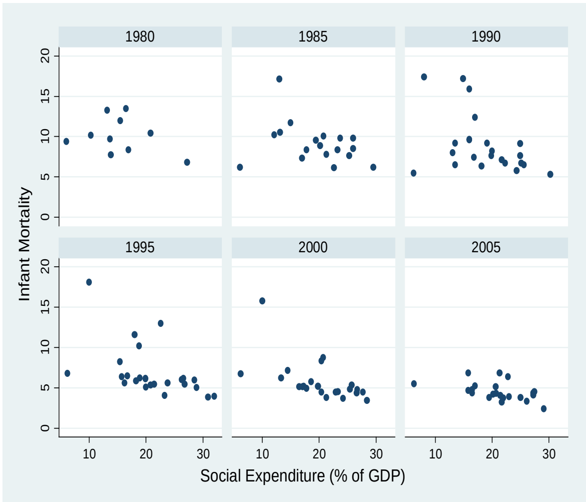
Contrary to our initial expectations, the link between infant mortality and child poverty rates is relatively low also in the merged data. Whereas relative poverty is rather strongly correlated with mortality in the first and last waves, the correlations in waves 2 and 3 are rather weak. Our interim conclusion is that the level of prosperity of the country and the magnitude of the welfare state matter and the impact of the welfare state is mirrored in the lower levels of child poverty and inequality, which in turn, partially combat deaths of the new-borns.

Figure 3. Relationships between infant mortality rates and explanatory factors (GDP; Social spending; Relative child poverty), 1980-2005

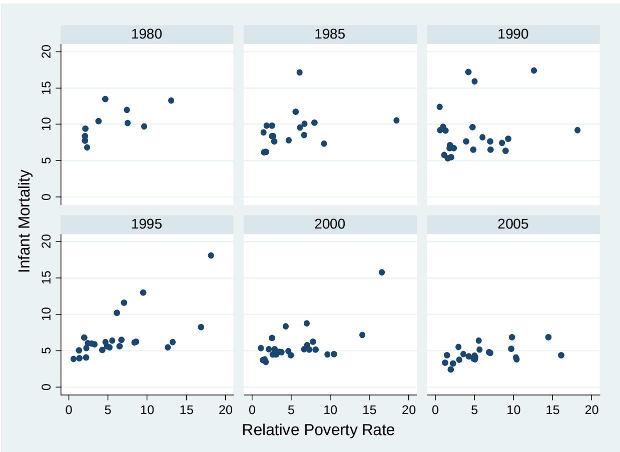
GDP



Social spending



Child poverty



An intriguing question is to what extent, if any, these bivariate relationships are robust when they are analysed simultaneously. In Table 2a and 2b we present results from gender specific regression analyses where we step-wise include additional variables as trend (wave), GDP per capita (1000 US dollars in 2005 values), social spending and finally, the welfare state regimes as dummies. In the last model (4) the Nordic welfare regime is used as a reference and left out from the models.

Table 2a and 2b. Associations between logged infant mortality rates (age 0–1) and explanatory factors for girls(a) and boys(b), respectively. Results from pooled cross-sectional time series analyses. N (countries): 26, N (observations): 122

a) Girls 0-1

	Model 1		Model 2		Model 3		Model 4	
	Coef.	p-values	Coef.	p-values	Coef.	p-values	Coef.	p-values
Constant	2,328	0,000	2,493	0,000	2,828	0,000	2,257	0,000
Child poverty (40%)	0,020	0,022	0,021	0,001	0,013	0,076	0,014	0,104
Wave	-0,176	0,000	-0,148	0,000	-0,136	0,000	-0,182	0,000
GDP /1000 US dollars			-0,010	0,003	-0,009	0,007	0,002	0,681
Social spending					-0,019	0,000	-0,009	0,247
Welfare Regime:								
Central European							0,236	0,000
Liberal							0,225	0,002
South-European							0,180	0,067
Post-Socialist							0,581	0,000
Other							0,295	0,007
R Squared		0,92		0,93		0,94		0,94

b) Boys 0-1

	Model 1		Model 2		Model 3		Model 4	
	Coef.	p-values	Coef.	p-values	Coef.	p-values	Coef.	p-values
Constant	2,583	0,000	2,732	0,000	3,088	0,000	2,814	0,000
Child poverty (40%)	0,023	0,002	0,022	0,000	0,014	0,066	0,016	0,054
Wave	-0,192	0,000	-0,164	0,000	-0,151	0,000	-0,172	0,000
GDP /1000 US dollars			-0,009	0,001	-0,008	0,001	-0,004	0,064
Social spending					-0,019	0,000	-0,016	0,016
Welfare Regime:								
Central European							0,194	0,000
Liberal							0,131	0,088
South-European							0,049	0,674
Post-Socialist							0,380	0,025
Other							-0,009	0,927
R Squared		0,95		0,95		0,95		0,95

By and large the results for infant girls and boys turn out to be very similar so we can discuss the results together. In the first model including only the poverty rate and the wave variable– that is to capture the overall, non-observed transformation of societies, which transformation also leads to lower infant mortality rates – the coefficients for poverty are significant. Furthermore, the Wald χ^2 for the total model turns out to be highly significant. The coefficient of the association between poverty and logged mortality rates from this model can be statistically interpreted as follows: a one percentage-point increase in child poverty corresponds to about 2 per cent (slightly more for boys) increase in infant mortality. The introduction of GDP per capita/1000US dollars (model 2) does not change the picture. The inclusion of social spending (model 3) leads as expected to an attenuation of the poverty estimate – with close to 40 per cent. The statistical explanation for the strong attenuation of the poverty estimate when adding social spending is of course the strong association between social spending and poverty rates. So it seems as if the welfare state matters for relative poverty and relative poverty matters for infant mortality.

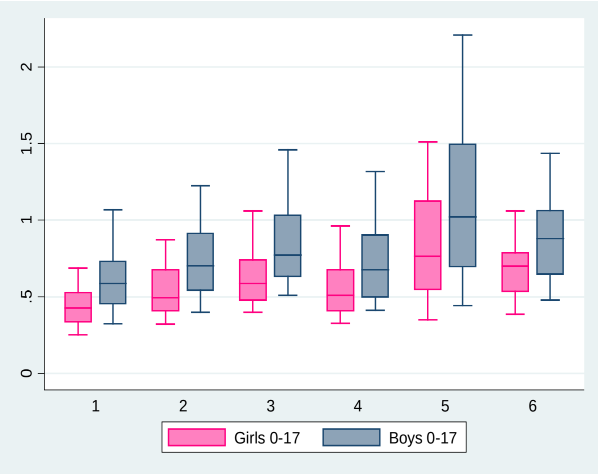
Finally when introducing welfare regimes (model 4) the poverty estimate remains about the same. The welfare regimes do obviously not only capture different welfare state characteristics but also different levels of economic prosperity since the coefficient for GDP totally disappears. In model 4, controlling for poverty, wave, GDP, social spending and welfare regime, infant mortality rates are significantly higher in Central-European, liberal and especially post-socialist regime types compared to the benchmarking Nordic regime (the reference category), while the Southern European and "other" regimes do not significantly deviate from the Nordic one .[4] These regime differences are notable, especially if you bear in mind that they are not captured by differences in poverty, economic prosperity or social spending. This evident variation between the regime types highlight that the causes to differences in population health statistics are multifactorial and we are not able to fully capture that by the variables in our regression models.

Mortality rates among children 0 to 17 years of age

When we move from the new-borns to older children the risk of death radically diminishes. This is also reflected in the age-standardized mortality rates in the age group 0 to 17 which are about one tenth of the corresponding infant mortality rates. Figure 4A and B give the variability in these crude rates by welfare state regime type and across waves in the same way as Figure 2A and B. Again there is an over-representation of boys in the death toll (the average age-standardized mortality rate over countries and time points is 0,60 per 1000 for girls and 0,81 per 1000 for boys under 18 years of age). In Post-Socialist regime the death rate is almost two-fold compared to the low Nordic numbers. As can be seen in Figure 4B also here there is a clear trend towards lower death rates in time. The fact that we have an unbalanced panel can of course influence the magnitude of this downward trend but the overall trend is general within all countries.

[4] We have also tested to do these runs on children under five. The estimates then become very similar to those reported in table 1 with somewhat lower p-values.

Figure 4A. Age-standardized mortality rates (per 1000) among 0-17, girls and boys in different welfare state regimes



1=Nordic; 2=Central European; 3=Liberal; 4=South-European; 5=Post-Socialist; 6=Other

Figure 4B. Age-standardized mortality rates (per 1000) among 0–17, girls and boys across waves

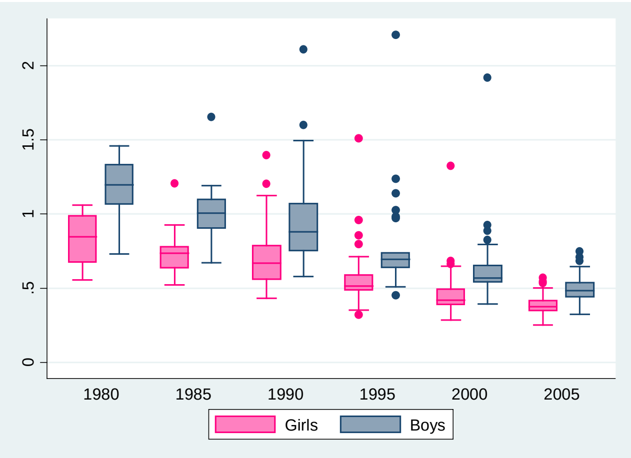


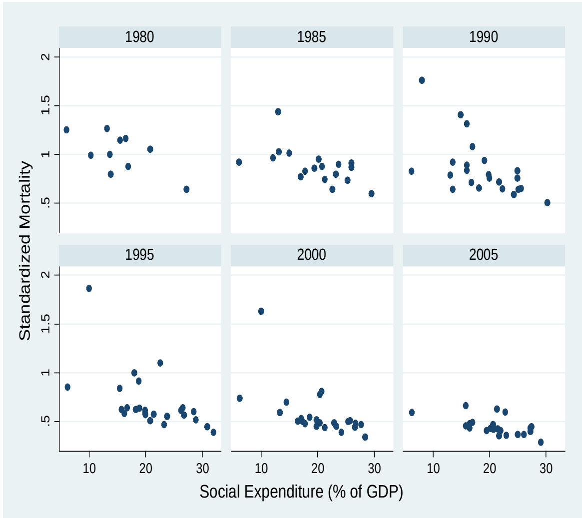
Figure 5 shows the crude relations between the pooled data of the age-standardized death rates and the three main explanatory factors. GDP and social spending have a relatively strong association with child mortality, whereas the association between relative child poverty and mortality is relatively modest. What is of interest here is the relatively high correlations in certain cross-sections. The negative association between GDP per capita and mortality actually gets stronger steadily over time (between wave 1 and wave 5) and the same applies to social spending. Poverty displays a similar tendency but there are more fluctuations between cross-sections; the strongest correlations are found in the two last observation waves.

In order to cross-check to what extent the results are biased by the former communist countries we ran controls in which the countries of the Post-Socialist cluster were excluded. In the total, i.e. pooled data correlations became weaker but the signs were not changed.

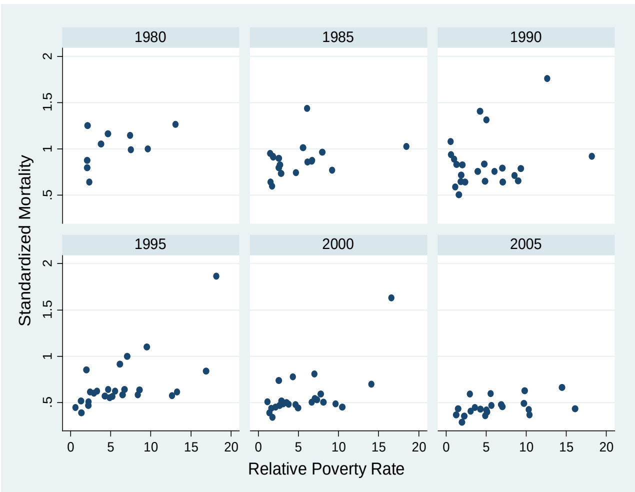
Figure 5. Relationships between mortality rates among children aged 0 to 17 and explanatory factors (GDP; Social expenditure; Relative child poverty), 1980-2005.

GDP

Social spending



Child poverty



In Table 3a and 3b we show the results from our pooled cross-sectional time series analysis for this age group for girls and boys, respectively. The analytical strategy is basically the same as for infants, although as said the logged age-standardized mortality rates now are calculated to allow for exposure time on mortality after our poverty measurements. Hence, we calculated the mortality rates as the average of the age-standardized mortality rates of the LIS year plus that of the three following years. Also the basic story for the age group of 0 to 17 is very much the same as that we showed for the infants (Table 2). Actually the poverty estimates across all four models are almost of the same magnitude as for infant mortality (but with clearly lower p-values) and this basic finding is also seen for the other variables except for welfare state regime. That the other estimates are so similar is actually quite natural since a large share of the mortality in age group 0-17 happens during the first year of life. Still, this does not really hold for our regime estimates. Here the relative order between the regimes is basically the same as that we found for infant mortality but the difference between them is much lower. In other words, the relative advantage of the Nordic countries is much less among 0-17 than among infants.

Table 3a and 3b. Associations between logged age-standardized mortality rates (age 0–17) and explanatory factors for girls(a) and boys(b), respectively. Results from pooled cross-sectional time series analyses. No (countries): 26, N (observations): 122.

a) Girls 0-17

	Model 1		Model 2		Model 3		Model 4	
	Coef.	p-values	Coef.	p-values	Coef.	p-values	Coef.	p-values
Constant	-0,117	0,024	0,054	0,410	0,343	0,001	0,135	0,239
Child poverty (40%)	0,020	0,007	0,021	0,000	0,014	0,013	0,013	0,062
Wave	-0,167	0,000	-0,136	0,000	-0,124	0,000	-0,146	0,000
GDP /1000 US dollars			-0,010	0,000	-0,009	0,000	-0,003	0,187
Social spending					-0,018	0,000	-0,017	0,000
Welfare Regime:								
Central European							0,113	0,000
Liberal							0,084	0,179
South-European							0,068	0,407
Post-Socialist							0,289	0,039
Other							0,097	0,310
R Squared		0,76		0,85		0,87		0,90

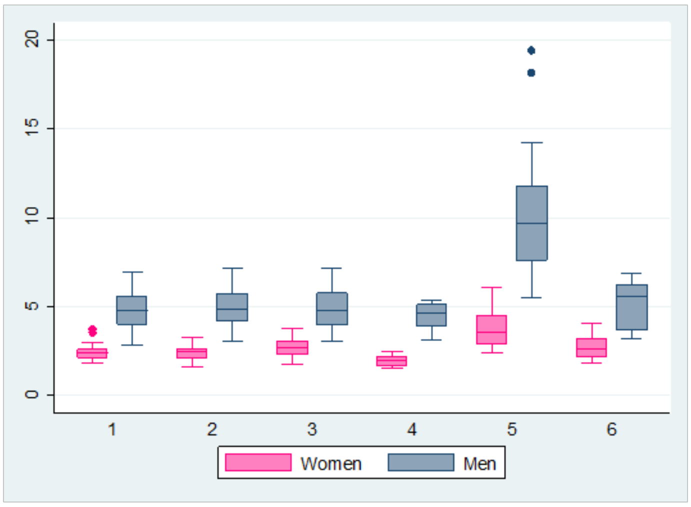
b) Boys 0-17

	Model 1		Model 2		Model 3		Model 4	
	Coef.	p-values	Coef.	p-values	Coef.	p-values	Coef.	p-values
Constant	0,229	0,000	0,390	0,000	0,695	0,000	0,582	0,000
Child poverty (40%)	0,021	0,002	0,021	0,000	0,014	0,010	0,015	0,017
Wave	-0,183	0,000	-0,154	0,000	-0,140	0,000	-0,157	0,000
GDP /1000 US dollars			-0,009	0,000	-0,008	0,000	-0,004	0,161
Social spending					-0,019	0,000	-0,020	0,000
Welfare Regime:								
Central European							0,102	0,000
Liberal							0,026	0,663
South-European							0,025	0,753
Post-Socialist							0,260	0,057
Other							-0,022	0,789
R Squared		0,77		0,77		0,82		0,88

Mortality rates among adult men and women

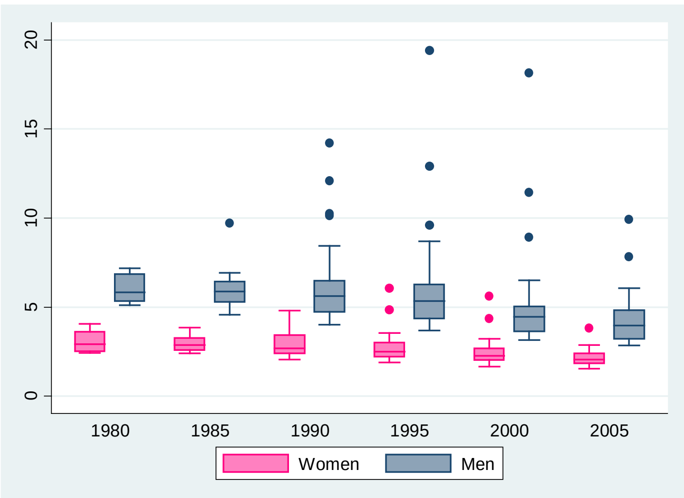
When comparing adult mortality rates with child mortality rates, interesting shifts in the rank-order of “good” and “bad” regimes can be observed. Whereas in both groups of children (figures 2A/2B and 4A/4B), the Nordic welfare cluster displayed the lowest mortality rates, among adults the Southern European cluster outperforms the Nordic one (Figure 6A). The figure reveals the exceptionally high mortality rates among males in the Post-Socialist countries – average age-standardized mortality rate for males across time points is as high as 10,22 and 3,74 for women; the corresponding figures for the Southern European cluster are 4,50 and 1,96. As in the case of child mortality, there is a general downward trend over time.

Figure 6A. Age-standardized mortality rates (per 1000) among women and men (25-64) in different welfare state regimes.



1=Nordic; 2=Central European; 3=Liberal; 4=South-European; 5=Post-Socialist; 6=Other

Figure 6B. Age-standardized mortality rates (per 1000) among women and men (25-64) across waves



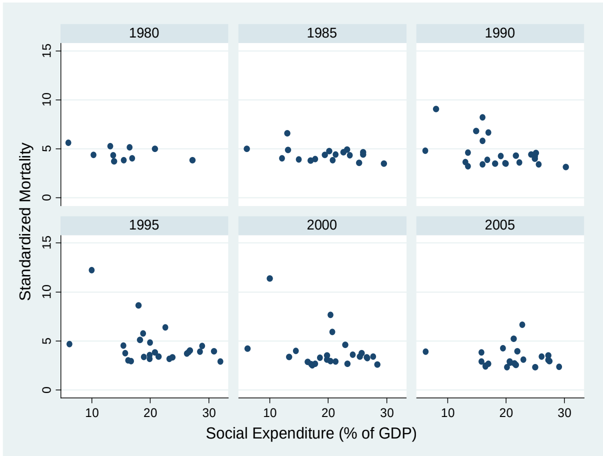
The upper left-hand panel in figure 7 displays once again the well-known curvilinear relationship between mortality and GDP per capita – the mirror picture of this is the relationship between GDP and life-expectancy.

Neither social spending nor relative adult poverty rate display any clear-cut relationship with mortality. Although the relation is somewhat different in different waves the general message is that the bivariate plots basically show no association.

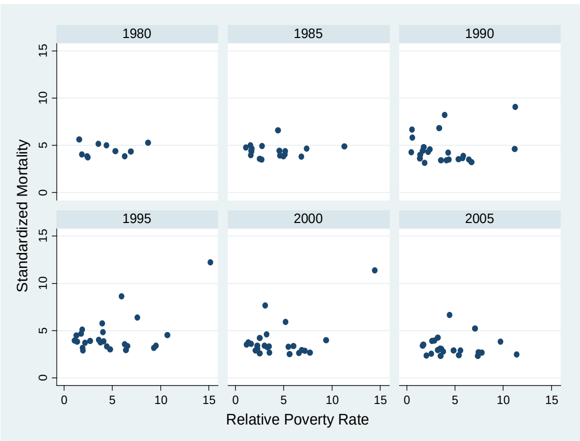
Figure 7. Relationships between adult (25-64 years of age) mortality rates and explanatory factors (GDP; Social spending; Relative adult poverty), 1980–2005.

GDP

Social spending



Adult poverty



Results from pooled cross-sectional regressions are separately given for women (Table4a) and men (Table 4b). In general the association between poverty and mortality is weaker in the models for the adult population than for children. Starting with the results for women we can note that poverty remains significantly and positively associated with mortality across all four models. The general picture that the poverty estimate attenuates when you control for social spending is also evident for women in the same manner as we earlier saw for children. Somewhat oddly, we find that the poverty estimate actually increases when also adjusting for welfare regime type (compare model 4 to model 3). Scrutinizing the estimate for regime we note that the association between regime and adult mortality is different than that between regime and child mortality. In contrast to child mortality, where the Nordic cluster had the lowest estimate, the Central- and especially the Southern-European regime types show statistically significantly lower mortality rates than the Nordic regime among women, when controlling for poverty, wave, GDP and social spending.

Turning to the results for men (Table 4b) the picture is somewhat less clear. Although the poverty estimates as such are not lower than for women, the variability, as evident from the high p-values, is much higher. And, somewhat strangely, the poverty estimate has its largest value and is clearly significant first in the final model. Once again we find a different order across the regime types compared to the earlier analyses on child mortality. The Post-Socialist cluster has an extremely high estimate, especially remembering all other covariates that we have adjusted for. Apart from that cluster we can note that in comparison to the Nordic regime, the Southern European, liberal and "other" regimes have lower adjusted male mortality rates.

This difference between Southern and Northern Europe has been corroborated also by other cross-national research on mortality differences [41]. But here it seems as if these differences, both for women and men, are accentuated by the fact that we control for the other welfare state related variables. Simultaneously, this accentuates also the poverty effect for both women and men.

Table 4a and 4b. Associations between logged age-standardized mortality rates and explanatory factors among women (a) and men (b) aged 25–64. Results from pooled cross-sectional time series analyses. N (countries): 26, N (observations): 122.

a) Women 25-64

	Model 1		Model 2		Model 3		Model 4	
	Coef.	p-values	Coef.	p-values	Coef.	p-values	Coef.	p-values
Constant	1,150	0,000	1,376	0,000	1,518	0,000	1,359	0,000
Adult poverty (40%)	0,016	0,018	0,010	0,004	0,006	0,006	0,017	0,004
Wave	-0,077	0,000	-0,042	0,000	-0,034	0,000	-0,060	0,000
GDP /1000 US dollars			-0,012	0,000	-0,012	0,000	-0,007	0,001
Social spending					-0,009	0,000	-0,006	0,009
Welfare regime:								
Central European							-0,051	0,041
Liberal							0,009	0,852
South-European							-0,274	0,000
Post-Socialist							0,232	0,004
Other							-0,125	0,244
R Squared		0,85		0,91		0,92		0,94

b) Men 25-64

	Model 1		Model 2		Model 3		Model 4	
	Coef.	p-values	Coef.	p-values	Coef.	p-values	Coef.	p-values
Constant	1,919	0,000	2,296	0,000	2,457	0,000	2,226	0,000
Adult poverty (40%)	0,021	0,111	0,013	0,082	0,008	0,197	0,029	0,000
Wave	-0,091	0,000	-0,031	0,002	-0,024	0,042	-0,069	0,000
GDP /1000 US dollars			-0,021	0,000	-0,021	0,000	-0,011	0,000
Social spending					-0,009	0,050	-0,007	0,001
Welfare regime:								
Central European							-0,058	0,070
Liberal							-0,195	0,001
South-European							-0,256	0,000
Post-Socialist							0,397	0,000
Other							-0,315	0,003
R Squared		0,89		0,95		0,95		0,97

Sensitivity analyses

We have performed a number of sensitivity analyses with regard to inclusion/exclusion of countries and setting a higher poverty threshold. We also tested the impact of income inequality (as expressed by the Gini-index). We argue that the 40% poverty threshold comes closer to “absolute” poverty level, not least combined with the national wealth indicator (GDP), than 60% poverty threshold which comes closer to income inequality measured by the Gini coefficient. However, since Gini and poverty measures are strongly correlated[5] they cannot simultaneously be used as explanatory variables.

When it comes to deviant cases we have in reality one country that stands out, namely Russia. During the time span covered by this study, Russia had high poverty rates and especially extreme death risks. Therefore, when we reran all regressions omitting Russia, the estimates changed substantially. By and large our poverty estimates attenuated by about a third for children and made the poverty estimates for adults insignificant. In sum, the results seem more robust for younger age groups: children in particular are exposed to the lethal effects of poverty.

Methodological considerations

We chose to study the possible influence of poverty with level rather than change. This choice was made mainly for theoretical reasons since we suggest that it is the long-term and broad difference in poverty that matters, rather than any yearly fluctuation. We realise that models focusing on change would capture unmeasured heterogeneity but, on the other hand, such models also increase the noise to signal ratio. In the end we note, in line with Babones [42] in his comparative analysis of income inequality and health, that a major complication for any fixed models is the remarkable stability for both variables over time.

Another methodological concern in our study is the fact that we have an unbalanced panel structure. In other words, we have different countries in different waves. Although our method statistically speaking takes that into account, it may still have an influence on our findings. This is an analogy to the finding from a simulation analysis of Pop et al [16] suggesting that the composition of the sample of high-income countries may be crucial. Still, in sensitivity analyses we found that balanced panel by and large gave similar results. In summary, it seems as if the relative poverty rates are of importance to child mortality for the sample of countries and the time-period examined. That child mortality is more instantly affected by relative poverty seems reasonable also from life course perspective. As highlighted so much in life course epidemiology mortality risks for adults are also affected by circumstances during earlier phases of life. It is also in line with earlier income inequality and mortality associations that have found more consistent relations between child mortality and inequality [43].

Conclusions

The aim of this study was to analyse the effect of relative poverty upon mortality rates among three age groups, namely infants, children and working aged adults, also stratified by gender. We used a low threshold (40% of median) to measure relative poverty, which thereby measures more severe poverty prevalence. Our time period is from 1980 to 2005 and we have an unbalanced time series for 26 countries belonging to the rich world but also including post-socialist countries from Eastern Europe. Our method is pooled cross-sectional time series analysis. Recently we have seen a number of studies that goes beyond the cross-sectional picture between income inequality and mortality [16,

[5] Correlation between the whole population level Gini and relative poverty rate with 40% threshold is 0,85 and Gini and relative poverty rate with 60% threshold is 0,89.

42, 44, 45] To our knowledge this is the one of the first studies that goes beyond the cross-sectional picture with a focus on poverty rather than inequality. There is ample evidence for profound differences in poverty across welfare regimes [46-48], suggesting that poverty, welfare regime and mortality also may be interrelated.

Our results are basically the following: We find support for that the prevalence of poverty is of importance. The strength and the level of significance vary depending what additional variables are included into the model. When including social spending the poverty estimate for children attenuates by a third. A statistical explanation for that is the strong and robust association between poverty and social spending. When thinking about the order of impacts one can, with overwhelming empirical evidence, argue that social spending is causally related to poverty: the higher the spending level in a country, the lower the poverty levels. The welfare state matters for poverty and poverty matters for child mortality. We also include welfare regime type in our final models. We anticipated that if we take into consideration the welfare regimes' belongingness, the relative role of poverty rates would be eaten up. However, for children the effect on the poverty estimate was negligible and in the case of adults the inclusion of welfare regime fortified the connection between poverty and mortality.

For children this does not influence the poverty and mortality association but it is important to note that the regime type as such has a clear influence on child mortality, also when controlling for GDP and social spending. This result suggests in other words that there are other regime-specific factors that are important.

For adults, the results are less straightforward. Here the results depend on which model you focus upon. Interestingly enough, for both women and men we find that the poverty estimate becomes stronger when controlling also for welfare state regime type. The reason is not so self-evident but from earlier research we know that several of the Southern-European countries are ranked at the top of life expectancy figures in Europe and across the world. We also know that they are less favourably ranked when it comes to poverty rates. The regime variable in a sense captures whatever it is that is specifically health promoting to these countries and the resulting poverty estimate is hereby adjusted for that regime-specific aspect. When making such an adjustment the remaining effect of poverty increases substantially.

Another intriguing result is then that welfare regimes do not treat all the age groups similarly. When it comes to the Nordic welfare model, it seems to be good for infants and for children but when moving to older age groups it is not anymore that superior and some Central and Southern European countries outperform it. The results also show exceptionally high mortality rates among males living in the post-socialist countries. This result, in turn, indicates that welfare state and poverty have an impact on mortality but there are other factors in play, factors like drinking and eating habits and the way healthy and unhealthy behaviour is distributed between socioeconomic groups, according to income and education attainment levels.

Our study is definitely not the final answer to the question of whether or not the prevalence of poverty in relatively rich countries still have an influence on death risks. Our study is somewhat different than most of the cross-country studies linking poverty and mortality. They have either used a more world-wide inclusion of countries, but the question then becomes somewhat different, or they have used a much smaller sample of countries and in particular been totally cross-sectional in their design. Moreover, we have used age specific analysis both when it comes to poverty calculations and mortality rates, thereby further specifying the tests.

Finally, if there is a policy lesson from this analysis, it is that national governments should invest to eliminate child poverty.

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