The benefits of reducing health inequalities in 10 European populations

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Abstract

In recent years there has been growing interest in studying the socio-economic inequalities in health. In this paper we use longitudinal data from SHARE survey to estimate the age and sex specific mortality rates by socioeconomic status (SES) for 10 European countries with the aim of studying the benefits of reducing mortality in the most disadvantaged classes.
First, we describe the existing inequalities by estimating the influence of SES (measured by two different proxies: the household total net worth and the education) on mortality between waves using Cox survival regression models. In a second step, we construct life tables for each combination of country, sex and SES, and we estimated the number of real deaths in the population. Then, some "inequality reduction" scenarios are depicted by reducing the SES gradient for each country and providing an estimate of the hypothetical saved life-years.

1. Introduction

In recent years there has been growing interest in studying the socio-economic inequalities in health in many European countries (Mackenbach et al., 2007; Avendano et al., 2009). Reducing these health inequalities has become an important policy objective. It is widely accepted, indeed, that socioeconomic inequalities in health are an unfair feature of Western societies, as health is good that all citizens – regardless of their socioeconomic status – should equally get access to.

In this paper we want to provide estimates for health disadvantage in various European countries, using survey data. In particular, we will use data from SHARE (Survey of Health, Ageing and Retirement in Europe) surveys. SHARE provides us with longitudinal information on people aged over 50. We therefore estimate the age and sex specific mortality rates by socioeconomic status for all the available country. In addition, we estimate the benefits of reducing mortality in the most disadvantaged classes, depicting some "inequality reduction" scenarios obtained by reducing the SES gradient for each country and by providing an estimate of the hypothetical saved life-years.

2. Data and methods

2.1 Data

Data from the Survey of Health, Ageing and Retirement in Europe (SHARE) are used. The survey is a panel database providing information on health and socio-economic status of non-instituzionalized adults aged 50 or over[1] representing the various European regions (Börsch-Supan et al., 2005). In this way comparable information across countries are available. In particular, in the 2004 SHARE baseline study representative samples were obtained for eleven countries which are the focus of our paper[2]: Denmark and Sweden (representing Scandinavian countries), Austria, Belgium, France, Germany, and Netherlands (representing the Central Europe), Greece, Italy, and Spain (for the Mediterranean area). The second wave of data collection was conducted in 2006-2007 and the third one in 2008-2009.

We used information on the socio-economic status (SES) of individuals in the first wave and we considered whether the same individuals are alive in the following waves. For dead individuals the

[1] The focus only on population aged 50 or over is not a limitation since most of mortality is concentrated on ages over 50. In fact, a limitation may be the fact that only non-instituzionalized individuals are considered and clearly the most healthy: as a consequence the mortality may be underestimated.

[2] Further data were collected in Israel in 2005-2006 and from the second wave (in 2006-2007) also Poland and the Czech Republic joined SHARE. These three countries are not used in this paper. Switzerland is also excluded in the analyses.

date of death is available so that we can consider the socio-economic status as a determinant of individuals' survival.

SHARE allows us to use different indicators of socioeconomic status.

Following the definition used by other researches (see Avendano et al., 2009), the first indicator that we consider is the household total net worth. Following Avendano et al. (2009) this is "the sum of all financial (net stock value, mutual funds, bonds, and savings) and housing wealth (value of primary residence net of mortgage, other real estate value, own business share, and owned cars) minus liabilities". Missing items were imputed using the methodology of multiple imputation (see SHARE Release Guide 2.5.0 waves 1& 2, Mannheim Research Institute for the Economics of Aging, 2011). The differences in the number of household members are accounted dividing wealth by the square root of household size (Buhmann et al., 1998; Huisman et al 2003; Avendano et al., 2009). In the following analyses, we collapsed wealth into country specific quintiles.

The second indicator of socio-economic status is education. In the survey it is measured using the ISCED (International Standard Classification of Education) coding; then we grouped the different levels into three categories: low corresponding to the ISCED-codes from 0 to 2 (lower secondary school or lower), medium corresponding to the ISCED-code 3 (upper secondary school), and high including ISCED-codes from 4 to 6 (postsecondary).

2.2 Methods

Our analysis of health inequalities and potential scenarios of their reductions consisted in three steps.

First, we start with the accurate description of existing inequalities. In particular, we estimate the influence of SES on mortality by mean of Cox survival regression models. Net of age and sex, they estimate the effects of SES on the risk of death considering the first wave as a starting time.

In a second step, from the results of the regression models we construct life tables for each combination of country, sex and SES status. Predicted values of mortality rates have been obtained by the estimated models and from these predicted values we constructed the life tables. From the life tables we take five-years age-specific mortality rates by SES and referring to the population by gender, SES and countries (obtained from weighted survey samples), we estimated the number of real deaths in the population.

Then, considering separately men and women, some "inequality reduction" scenarios are depicted by reducing the SES gradient for each country and providing an estimate of the saved life-years (clearly, all scenarios are hypothetical).

3. Empirical analysis

3.1 Inequalities based on wealth as a SES proxy

First of all, table 1 presents for each gender and for each country the hazard ratios of SES in the regression models.

Table 1. *Estimated hazard ratios for wealth quintiles of Cox regression models net of age and sex for the different countries.*

	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
AUSTRIA	1.327	0.786	0.918	0.751	1.000 (ref)
BELGIUM	1.179	1.160	1.035	0.896	1.000 (ref)
DENMARK	2.051	2.064	1.517	0.959	1.000 (ref)
FRANCE	1.602	1.796	1.046	0.634	1.000 (ref)
GERMANY	1.169	1.205	0.997	0.769	1.000 (ref)
GREECE	3.518	2.820	2.023	1.944	1.000 (ref)
ITALY	1.307	1.522	1.171	1.152	1.000 (ref)
NETHERLANDS	2.232	2.259	1.644	2.040	1.00 (ref)
SPAIN	1.490	1.176	1.051	0.690	1.00 (ref)
SWEDEN	2.310	1.250	1.108	1.184	1.00 (ref)

Table 2 describes the existing inequalities for men and women of the different countries considering as a synthetic measure of mortality the life expectancy at the age of 50. It should be noted that these life expectancies are constantly higher than those reported by official statistics. For example, France life expectancy at 50 reported by the national institute of statistics (INSEE) is 29.09 for men and 34.96 for women, while life expectancies at 50 reported in table 2 are all higher than these values. This discrepancy is certainly due to the fact that all individuals in institutions (included hospitals) are not included in the SHARE sample. Moreover, it is likely that individuals living at home but with severe health conditions have not participated to the survey. Therefore, we should expect that individuals of SHARE sample have a better health – and, consequently a higher life expectancy – that the whole population. We should keep this in mind when commenting the results of our computations.

Both the hazard ratios and the estimated life expectancies at 50 by wealth quintiles reveal a varying level of inequality in each country. In Greece, for example the mortality rate of men aged over 50 belonging to the 1st wealth quintile (i.e. the poorest group) increases of 251% with respect men belonging to the 5th wealth quintile (i.e. the richest). This brings about a difference of about 9 years of life expectancy. In other countries (for example in Germany or in Belgium) the difference across the wealth quintiles is milder. It should also be noted that not in every country we find the highest mortality among the poorest and the lowest among the richest. In Austria, for instance, the highest value of life expectancy is found for the 4th wealth quintile. Generally speaking, we can say that there is an increasing mortality between the richest population and the poorest, and in all countries the life expectancy among the 1st quintile group is lower than the life expectancy of the 5th quintile group. However such a decrease is not linear, and it is often found that a quintile group has a higher life expectancy than the adjacent richer one.

Table 2. *Estimated life expectancy at 50 by wealth quintiles, sex and countries.*

	MEN				
	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
AUSTRIA	31.351	36.478	35.024	36.765	34.199
BELGIUM	35.070	35.250	36.247	37.382	36.451
DENMARK	30.323	30.303	33.068	37.209	36.867
FRANCE	31.305	30.337	34.897	38.949	35.304
GERMANY	32.830	32.532	34.019	35.963	34.015
GREECE	35.253	37.046	39.572	39.899	44.055
ITALY	28.784	27.372	29.740	29.882	31.274
NETHERLANDS	32.103	32.013	34.568	32.854	38.359
SPAIN	27.294	29.470	30.523	34.379	30.950
SWEDEN	30.219	35.060	36.018	35.455	36.815
	WOMEN				
	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
AUSTRIA	35.024	39.524	38.257	39.981	37.505
BELGIUM	41.671	41.749	42.448	43.354	42.689
DENMARK	34.185	34.126	36.852	40.543	40.221
FRANCE	36.814	35.867	40.060	43.271	40.413
GERMANY	38.100	37.894	39.304	41.064	39.269
GREECE	37.863	39.515	41.750	42.041	45.612
ITALY	33.970	32.573	34.937	35.125	36.371
NETHERLANDS	36.854	36.779	39.147	37.563	42.463
SPAIN	31.574	33.747	34.784	38.373	35.198
SWEDEN	35.676	40.197	40.975	40.511	41.714

3.2 Health inequalities reduction scenarios based on wealth as a SES proxy

We use age-specific mortality rates referring to 5-year age groups (50-54, 55-59, …85+) by wealth quintiles obtained from Cox regression models and we multiply these mortality rates by the population at risk by wealth quintiles. In this way, we obtain an estimated number of deaths, by age groups and wealth quintiles for each country.

Subsequently, we simulate the number of life-years that would be gained if people of lower SES experienced the lower mortality rates of those of higher SES.

In particular, we considered three different scenarios:

1. mortality rates of the 1st wealth quintile decrease to those of the 2nd;
2. mortality rates of the 1st and 2nd wealth quintile decrease to those of the 3rd;
3. all individuals have the mortality rates of the 3rd quintile.

Scenarios 1 to 2 follow a successively more ambitious order, with scenario 2 being more ambitious than the first one. The idea of the third scenario is to impose zero costs – health losses to higher groups would exactly offset health gains to lower groups.

If we had a monotonic association between wealth and mortality, scenarios 1 and 2 should provide a reduction of the number of expected deaths, but since in many countries the relationship is not monotonic (as shown by Tables 1 and 2) we will found cases in which the number of expected deaths increases. In Denmark, for instance, since the life expectancy of the 1st quintile group is higher than that of the 2nd group, we should expect a increased number of deaths for Scenario 1.

By comparing the number of deaths simulated in the different scenarios to the number of deaths in the initial situation (Table 3), we can derive the number of deaths saved in each scenario.

These estimates are reported in Table 4.

Table 3. *Estimated number of deaths by wealth quintiles, sex and countries.*

	MEN				
	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
AUSTRIA	20,213	13,724	11,781	12,730	15,141
BELGIUM	22,151	18,087	16,423	12,822	15,225
DENMARK	15,698	15,233	12,817	7,374	6,947
FRANCE	148,870	168,072	117,583	68,688	109,814
GERMANY	202,100	162,814	149,262	116,351	152,225
GREECE	24,243	20,335	15,369	13,522	4,797
ITALY	260,369	215,262	143,406	201,996	177,525
NETHERLANDS	52,520	32,995	15,911	23,235	15,700
SPAIN	162,662	132,485	134,349	80,239	98,884
SWEDEN	32,897	22,763	18,055	19,206	12,766
	WOMEN				
	1st quintile	2nd quintile	3rd quintile	4th quintile	5th quintile
AUSTRIA	42,284	14,388	16,168	14,253	14,062
BELGIUM	27,780	19,420	11,289	15,554	13,643
DENMARK	26,721	20,431	12,654	6,610	6,163
FRANCE	282,779	171,474	107,745	61,505	101,800
GERMANY	535,144	211,382	95,917	78,265	82,585
GREECE	34,922	21,533	12,989	11,914	3,920
ITALY	371,767	215,970	155,934	180,119	144,115
NETHERLANDS	75,536	46,333	12,864	28,004	9,014
SPAIN	192,651	121,447	123,436	92,784	144,139
SWEDEN	60,343	22,935	15,019	15,893	7,533

Generally speaking, among these three scenarios, the second one provides the highest reduction of deaths, but the situation varies across countries. In Austria, for example, scenario 1 provides a much higher reduction of deaths than scenario 2. All scenarios in at least one case do not generate a reduction of deaths but an increase. This happens for scenario 1 in several countries, for scenario 3 in Denmark.

We then have to take into account the fact that those individuals whose lives would be saved in 2004 would be expected to live many more years beyond 2004, on average. To do so, we consider the life expectancies by 5-years age groups for each of the SES classes. The total number of life years saved with improved mortality is equal to the number of lives saved in 2004 multiplied by remaining life expectancy, for each age group and SES class. Table 5 reports these data.

Table 4. *Estimated number of individual whose lives would be saved under alternative scenarios by sex and countries*.

	MEN		
	Scenario 1	Scenario 2	Scenario 3
AUSTRIA	6,443	3,052	2,070
BELGIUM	335	3,722	1,993
DENMARK	-29	6,118	-503
FRANCE	-12,452	96,742	56,480
GERMANY	-5,246	46,198	16,812
GREECE	3,551	12,148	7,906
ITALY	-30,615	63,029	36,605
NETHERLANDS	-352	17,640	14,225
SPAIN	26,621	49,249	13,674
SWEDEN	11,002	14,672	14,572
	WOMEN		
	Scenario 1	Scenario 2	Scenario 3
AUSTRIA	11,312	6,755	5,219
BELGIUM	185	2,852	1,300
DENMARK	-107	8,121	3,182
FRANCE	-19,410	107,582	79,098
GERMANY	-9,606	70,908	52,980
GREECE	4,175	13,899	11,091
ITALY	-38,494	61,018	40,631
NETHERLANDS	-441	20,377	19,501
SPAIN	29,842	51,637	16,041
SWEDEN	16,538	20,280	20,382

* a negative number indicates that the number of deaths under that scenario is higher than that observed in real data.

The increase in deaths observed in Table 4 is reflected in results of Table 5. In fact, in some cases, despite a reduction of deaths, a negative number of life years was saved (in other words, a reduction of years saved): this is the case of scenario 3 for men in Denmark, for example. This might seem odd, but it depends on the fact that the number of saved lives is not uniformly distributed over the age groups. In this case, we have an increase of deaths in the younger age groups – for which life expectancy is higher – and a reduction for the older groups. Therefore the number of deaths increased in the first groups accounts for a higher number of life years lost than the number of deaths reduced in the older groups.

Table 5. *Total number of life years saved under alternative scenarios by sex and countries.*

	MEN		
	Scenario 1	Scenario 2	Scenario 3
AUSTRIA	82,432	33,912	22,114
BELGIUM	3,602	46,702	24,970
DENMARK	-126	67,719	-18,748
FRANCE	-106,746	1,080,192	619,732
GERMANY	-55,800	471,245	191,215
GREECE	40,294	152,680	81,480
ITALY	-246,280	559,343	281,790
NETHERLANDS	-2,394	172,366	147,007
SPAIN	245,804	481,219	125,364
SWEDEN	103,597	144,712	141,910
	WOMEN		
	Scenario 1	Scenario 2	Scenario 3
AUSTRIA	141,058	65,754	56,108
BELGIUM	1,992	33,849	16,557
DENMARK	-987	77,127	18,754
FRANCE	-178,985	1,011,561	819,064
GERMANY	-77,013	568,329	457,754
GREECE	45,669	159,706	128,839
ITALY	-325,702	586,785	411,509
NETHERLANDS	-3,065	163,838	176,102
SPAIN	283,683	481,684	138,046
SWEDEN	151,065	146,969	194,263

3.3 Inequalities based on education as SES proxy

A similar approach can be followed using education as the SES proxy.

Cox survival regression models are used with education, sex and age as covariates (Table 6 reports the hazard ratios estimates for education) to estimate age-specific mortality rates and life expectancies (Table 7 reports the life expectancies at the age of 50).

Table 6. *Estimated hazard ratios for educational levels of Cox regression models net of age and sex for the different countries.*

	Low	Medium	High
AUSTRIA	2.873	2.208	1.000 (ref)
BELGIUM	1.378	1.252	1.000 (ref)
DENMARK	1.256	1.354	1.000 (ref)
FRANCE	5.138	2.450	1.000 (ref)
GERMANY	1.260	1.208	1.000 (ref)
GREECE	1.361	1.024	1.000 (ref)
ITALY	0.897	0.494	1.000 (ref)
NETHERLANDS	1.092	0.874	1.00 (ref)
SPAIN	0.992	0.556	1.00 (ref)
SWEDEN	1.611	2.194	1.00 (ref)

Also these tables, as the corresponding ones obtained considering wealth as a SES proxy, reveal a varying level of inequality in each country. We need, however, to be cautious in interpreting the results reported. These are particularly odd for Italy and Spain, where education seems to increase mortality rather than reduce it, in contradiction with most of the existing literature. It should be noted that the proportion of high educated individuals (the reference group) is very low in Italy and Spain, so the strange effect of education might partly depend on this.

Table 7. *Estimated life expectancy at 50 by educational levels, sex and countries.*

	MEN		
	Low	Medium	High
AUSTRIA	31.516	34.092	40.968
BELGIUM	35.186	36.026	37.935
DENMARK	33.045	32.345	35.085
FRANCE	30.666	37.074	43.390
GERMANY	33.056	33.462	34.843
GREECE	37.865	39.86	40.018
ITALY	29.082	34.553	28.062
NETHERLANDS	32.967	34.699	33.649
SPAIN	30.338	35.326	30.247
SWEDEN	33.996	31.717	37.562
	WOMEN		
	Low	Medium	High
AUSTRIA	35.928	38.262	43.889
BELGIUM	41.822	42.437	43.752
DENMARK	35.889	35.255	37.839
FRANCE	37.371	42.711	46.938
GERMANY	38.287	38.553	39.930
GREECE	39.809	41.659	41.902
ITALY	33.96	39.073	32.949
NETHERLANDS	37.344	38.952	38.018
SPAIN	34.379	39.319	34.277
SWEDEN	38.464	36.307	41.693

3.4 Health inequalities reduction scenarios based on education as a SES proxy

The number of deaths is obtained multiplying age-specific mortality rates for education groups by the population at risk (Table 8).

Following in principle the approach used above, we can simulate the number of life-years that would be gained if people of lower educational groups experienced the lower mortality rates of those of higher educational levels. Three different scenarios are considered:

1. mortality rates of individual with low education decrease to those of individuals with a medium educational level.
2. all individuals have the mortality rates of the higher educated ones;
3. all individuals have the mortality rates of the individuals with a medium educational level.

Table 8. *Estimated number of deaths by educational levels, sex and countries.*

	MEN		
	Low	Medium	High
AUSTRIA	17.595	31.680	17.645
BELGIUM	49.140	19.551	16.530
DENMARK	19.125	24.580	14.450
FRANCE	500.469	100.396	39.366
GERMANY	87.172	470.230	222.176
GREECE	62.987	10.118	5.267
ITALY	645.874	215.826	83.356
NETHERLANDS	82.972	29.430	28.248
SPAIN	532.421	19.071	41.025
SWEDEN	73.433	14.954	18.082
	WOMEN		
	Low	Medium	High
AUSTRIA	61.395	30.979	7.725
BELGIUM	58.250	17.229	12.577
DENMARK	42.932	22.540	8.836
FRANCE	307.999	342.798	15.844
GERMANY	580.875	335.300	97.517
GREECE	67.814	13.664	3.002
ITALY	1.018.123	38.511	23.138
NETHERLANDS	133.283	23.041	16.867
SPAIN	631.818	9.670	31.589
SWEDEN	99.361	12.174	11.184

Table 9 reports the estimates of the number of deaths saved in each scenario, obtained comparing the number of deaths simulated in the different scenarios to the number of deaths in the initial situation (of Table 8).

Once again, Scenario 2 looks as the most ambitious, as it provides the highest number of lives "saved" (with the exception of Italy and Spain because the above mentioned strange effect of education on mortality in these countries, and of Netherlands).

Table 10 reports the total number of life years saved with improved mortality under the different scenarios.

Table 9. *Estimated number of individual whose lives would be saved under alternative scenarios by sex and countries.*

	MEN		
	Scenario 1	Scenario 2	Scenario 3
AUSTRIA	3.843	27.143	-7,077
BELGIUM	3.727	14.359	692
DENMARK	-1.054	8.366	-5,053
FRANCE	214.328	391.556	179,506
GERMANY	3.316	78.715	-29,505
GREECE	10.856	11.734	10,776
ITALY	273.752	-166.464	311,365
NETHERLANDS	13.397	2.353	16,277
SPAIN	191.650	-16.647	209,320
SWEDEN	-17.966	27.743	-30,595
	WOMEN		
	Scenario 1	Scenario 2	Scenario 3
AUSTRIA	9.320	39.883	4,186
BELGIUM	3.020	11.079	1,473
DENMARK	-1.922	9.661	-4,227
FRANCE	159.631	304.985	145,913
GERMANY	13.268	114.995	-733
GREECE	10.079	11.742	9,967
ITALY	324.970	-114.828	336,525
NETHERLANDS	17.327	5.362	18,435
SPAIN	200.427	-11.729	209,743
SWEDEN	-18.720	26.655	-26,172

* a negative number indicates that the number of deaths under that scenario is higher than that observed in real data.

Table 10. *Total number of life years saved under alternative scenarios by sex and countries.*

	MEN		
	Scenario 1	Scenario 2	Scenario 3
AUSTRIA	50.668	495.547	-96,575
BELGIUM	45.599	190.835	3,569
DENMARK	-8.477	106.432	-54,352
FRANCE	2.535.021	6.173.183	2,037,912
GERMANY	31.929	788.208	-289,936
GREECE	126.902	138.048	125,659
ITALY	3.478.302	-1.385.444	3,998,139
NETHERLANDS	137.900	21.481	170,097
SPAIN	2.335.931	-211.213	2,620,868
SWEDEN	-122.770	289.350	-225,204
	WOMEN		
	Scenario 1	Scenario 2	Scenario 3
AUSTRIA	118.216	643.371	38,221
BELGIUM	40.983	156.885	17,373
DENMARK	-17.008	111.651	-50,304
FRANCE	2.410.432	5.118.601	2,143,051
GERMANY	97.423	1.194.207	-76,090
GREECE	138.049	165.496	135,396
ITALY	4.031.140	-1.251.323	4,282,652
NETHERLANDS	177.261	51.940	189,986
SPAIN	2.558.004	-161.087	2,712,657
SWEDEN	-130.019	282.586	-213,138

5. Future developments

In the future, we intend to define other scenarios, also in the light of the results provided by those we have depicted above. A scenario we can take into consideration is a refinement of scenario 3: similarly to scenario 3, it also pivots the social gradient about the level of the intermediate class, but only 50% of the way to becoming a horizontal line. In practice, this is achieved by halving the coefficients of the Cox regression models. This looks like as the least implausible but preliminary analyses showed that – especially when we use wealth as SES indicator – it provides an increase of the number of deaths in too many countries. In some cases this might depend on the fact that halving the Cox regression coefficients we actually half the log of the hazard ratio. Therefore, the reduction of higher SES groups mortality rates is greater than the increase of lower SES groups mortality rates. We can therefore provide a different scenario in which the hazard ratios and not the Cox coefficients are halved. In this way we expect to find fewer countries with a negative reduction of the number of deaths. A further refinement could be provided by assuming that mortality of all SES groups will decrease but with a decreasing rate over wealth quintiles. This looks a more likely scenario, as it would be difficult to believe that mortality decreases only for low SES groups. Finally, we can decide to change the mortality rates of countries more gradually. Since we have been using five-years mortality rates, this can be done projecting the over-50 population for ten, rather than five, years. In this way, in the first five years we can apply an intermediate set of mortality rates, which will basically be an average of the original rates and the rates defined by the scenarios. In the next five years, the rates defined by the scenario would be applied.

In addition, another future step consists on providing an estimate of the monetary expected benefits due to inequality reduction for each country and for each scenario, basing on available estimates of the value of a statistical life in each country. Again, the two measures of SES (the household total net worth and education) will be used alternatively.

Lastly, future work intends to examine also the benefits of reducing morbidity: a cross-sectional approach with data from the survey HITT (Health in Time of Transitions) will be used for this aim.

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