

SPECIAL ARTICLE

Socioeconomic Inequalities in Health in 22 European Countries

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ABSTRACT

BACKGROUND

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Comparisons among countries can help to identify opportunities for the reduction of inequalities in health. We compared the magnitude of inequalities in mortality and self-assessed health among 22 countries in all parts of Europe.

METHODS

We obtained data on mortality according to education level and occupational class from census-based mortality studies. Deaths were classified according to cause, including common causes, such as cardiovascular disease and cancer; causes related to smoking; causes related to alcohol use; and causes amenable to medical intervention, such as tuberculosis and hypertension. Data on self-assessed health, smoking, and obesity according to education and income were obtained from health or multipurpose surveys. For each country, the association between socioeconomic status and health outcomes was measured with the use of regression-based inequality indexes.

RESULTS

In almost all countries, the rates of death and poorer self-assessments of health were substantially higher in groups of lower socioeconomic status, but the magnitude of the inequalities between groups of higher and lower socioeconomic status was much larger in some countries than in others. Inequalities in mortality were small in some southern European countries and very large in most countries in the eastern and Baltic regions. These variations among countries appeared to be attributable in part to causes of death related to smoking or alcohol use or amenable to medical intervention. The magnitude of inequalities in self-assessed health also varied substantially among countries, but in a different pattern.

CONCLUSIONS

We observed variation across Europe in the magnitude of inequalities in health associated with socioeconomic status. These inequalities might be reduced by improving educational opportunities, income distribution, health-related behavior, or access to health care.

INEQUALITIES IN HEALTH AMONG GROUPS of various socioeconomic status (as measured by education, occupation, and income) constitute one of the main challenges for public health,¹ but it is unknown to what extent such inequalities are modifiable. Because international comparative studies can help identify opportunities for reducing inequalities in health, we conducted a study aimed at measuring variations in the magnitude of inequalities in health among 22 European countries and at identifying some of the immediate determinants of these variations.

Europe offers excellent opportunities for this type of research because of the intercountry variety of political, cultural, economic, and epidemiologic histories and because good data on inequalities in health are often available.² In a previous study, we compared socioeconomically based inequalities in mortality and morbidity among 10 countries in western Europe during the 1980s.³⁻⁷ We now report a study of the magnitude of inequalities in health in a much larger number of countries in both western and eastern Europe during the 1990s and early 2000s. The inclusion of eastern Europe allows us to determine whether countries that have gone through a turbulent period of political, economic, and health care reform⁸⁻¹² have larger inequalities in health than countries elsewhere in Europe.

METHODS

We obtained data on mortality according to age, sex, cause of death, and indicators of socioeconomic status from mortality registries (Table 1). The data were based on 3.5 million deaths in 16 countries among more than 54 million persons ranging in age from 30 to 74 years at the beginning of the study. The data were drawn from national populations, except for the United Kingdom, with data from England and Wales only; Italy, with data from Turin only; and Spain, with data from Madrid, Barcelona, and the Basque country only. With regard to the mortality data from England and Wales, this article has received clearance from the Office for National Statistics Longitudinal Study (reference number 20037C). We performed two analyses of the data on death according to cause; one analysis focused on common causes of death (cancer, cardiovascular disease, and injuries), and the other focused on more specific causes of death (smoking-related causes, alcohol-related causes, and

causes amenable to medical intervention, such as tuberculosis and hypertension^{13,14}). Code numbers of the causes of death according to the ninth and tenth revisions of the *International Classification of Diseases, Clinical Modification* (ICD-9-CM and ICD-10-CM) are given in Table 1 in the Supplementary Appendix, available with the full text of this article at www.nejm.org.

Data on self-assessed health and risk factors for disease (e.g., smoking and obesity) according to age, sex, and indicators of socioeconomic status were obtained from national health or multipurpose surveys that also included self-reported socioeconomic data (Table 1). The data came from 19 countries and almost 350,000 respondents who ranged in age from 30 to 64 years in some surveys and from 30 to 69 years in others. All data are nationally representative. For self-reported illness, our study focused on the single-item question on self-assessed health ("How is your health in general?"), which has five possible answers, ranging from "very good" to "bad." In order to make use of the full range of levels of self-assessed health, we gave quantitative weights to each level (i.e., a multiplicative factor of 1.85 for each level worse than "very good") that were derived from the average number of chronic conditions in each level¹⁵ (details of the calculation are given in the legend to Fig. 2). The only risk factors for disease for which data were available in a form that enabled them to be compared across countries were current tobacco smoking and obesity, defined as a body-mass index (the weight in kilograms divided by the square of the height in meters) greater than 30.

Socioeconomic status was measured by education, occupation, and income. Education levels were categorized as no education or primary education (up to approximately 6 years of education), lower secondary education (up to approximately 9 years), higher secondary education (up to approximately 11 years), and tertiary education (bachelor's degree or higher). Data on education level were available in a comparable form for most countries from both mortality registries and health interviews or multipurpose surveys. Occupations were classified as "manual" (considered the lower level) or "nonmanual." Data on occupation were available from mortality registries for middle-aged men in a limited number of countries only. Income was categorized in approximate quintiles of equivalent net household income. The self-reported

Table 1. Countries Included in the Analysis and Sources of Data.

European Region	Country	Mortality Data			Morbidity Data			
		Type of Study*	Years	Person-years of Follow-up	No. of Deaths	Survey	Years	No. of Respondents
North	Finland	National, longitudinal, census-linked mortality study	1990–2000	25,874,201	269,781	Finbalt Health Monitor — National Public Health Institute, Helsinki	1994, 1998, 2000, 2002, 2004	16,963
	Sweden	National, longitudinal, census-linked mortality study	1991–2000	43,537,681	404,151	Swedish Survey of Living Conditions — Statistics Sweden, Stockholm	2000–2001	9,918
	Norway	National, longitudinal, census-linked mortality study	1990–2000	19,956,767	213,022	Norwegian Survey of Living Conditions — Statistics Norway, Oslo	2002	5,918
	Denmark	National, longitudinal, census-linked mortality study	1996–2000	13,926,291	136,065	Danish Health and Morbidity Survey — Danish National Institute of Public Health, Copenhagen	2000	14,503
West	United Kingdom	National, longitudinal, census-linked mortality study for a representative sample of 1% of the population of England and Wales	1991–1999	2,295,029	21,234	Health Survey for England — Department of Health, London	2001	13,960
	Ireland	Not available				Living in Ireland Panel Survey — Economic and Social Research Institute, Dublin	1995–2002	5,294
Continental	The Netherlands	Not available				General Social Survey — Statistics Netherlands, Voorburg	2003–2004	13,782
	Belgium	National, longitudinal, census-linked mortality study	1991–1995	24,861,015	283,349	Health Interview Survey — Institute of Public Health, Brussels	1997–2001	16,268
	Germany	Not available				German National Health Examination and Interview Survey — Robert Koch Institut, Berlin	1998	6,403
	Switzerland†	National, longitudinal, census-linked mortality study	1990–2000	27,910,587	255,251	Not available		
	France‡	National, longitudinal, census-linked mortality study for a representative sample of 1% of population	1990–1999	2,404,246	20,465	French Health, Health Care and Insurance Survey — Institut de Recherche et Documentation en Economie de la Santé, Paris	2004	14,727
South	Italy	Urban, longitudinal, census-linked mortality study for the city of Turin	1991–2001	4,873,109	50,621	Health Conditions and Use of Health Services — National Institute of Statistics, Rome	1999–2000	102,832
						Multipurpose Family Survey, Aspects of Daily Living — National Institute of Statistics, Rome	2000	43,011

Spain	Urban, longitudinal, census-linked mortality study for the city of Barcelona	1992–2001	8,151,810	77,101	2001	17,517
	Regional, longitudinal, census-linked mortality study for the region of Madrid	1996–1997	3,663,333	22,585		
	Regional, longitudinal, census-linked mortality study for the Basque country	1996–2001	6,098,485	41,704		
Portugal	Not available				1998–1999	34,840
East	National, longitudinal, census-linked mortality study	1991–2000	9,647,452	101,557		
	National, unlinked, cross-sectional mortality study	1999–2002	21,031,348	363,508	2000–2003	9,179
Czech Republic	National, unlinked, cross-sectional mortality study	1999–2003	25,759,210	344,973	2002	2,028
Slovakia	Not available				2002	1,200
Poland	National, unlinked, cross-sectional mortality study	2001–2003	54,883,245	717,743	Not available	
Baltic	National, unlinked, cross-sectional mortality study	2000–2002	5,156,703	78,399	1994, 1998, 2000, 2002, 2004	10,336
Latvia	Not available				1998, 2000, 2002, 2004	6,779
Estonia	National, unlinked, cross-sectional mortality study	1998–2002	3,435,255	60,794	2002, 2004	3,525
Total			303,540,302	3,462,053		348,983

* In longitudinal, census-linked, follow-up studies of mortality, socioeconomic status as determined during a census is linked to mortality data during a follow-up period after the census. In unlinked, cross-sectional studies of mortality, socioeconomic data mentioned on death certificates and elicited during the census have been used to classify the numerator and denominator of mortality, respectively.

† Non-Swiss nationals are excluded.

‡ Residents of overseas territories, members of the military, and students were excluded.

after-tax incomes of all household members, including benefits, were added, and the total was corrected for household size by dividing it by the total number of persons in the household to the power of 0.36. Income data were available from surveys in a limited number of countries only. Tables 2, 3, and 4 in the Supplementary Appendix show the distribution of study populations according to education level, occupational classification, and income level. The proportion of the population with less education tended to be large in the southern and eastern regions, whereas inequalities in income were large in England and Wales and in Portugal.

All measures were adjusted for age. Because both relative and absolute measures of inequalities in health are important, we have presented both the relative index of inequality and the slope index of inequality^{16,17} for each country separately. Both indexes are regression-based measures that take into account the whole socioeconomic distribution and that remove variability in the size of socioeconomic groups as a source of variation in the magnitude of inequalities in health.¹⁷ In the regression analysis, mortality, morbidity, or risk-factor prevalence was related to a measure of the rank of education, occupation, or income, in which the rank was calculated as the mean proportion of the population having a higher level of education, occupation, or income.

The relative index of inequality is the ratio between the estimated mortality, morbidity, or risk-factor prevalence among persons at rank 1 (the lowest education, occupation, or income level) and rank 0 (the highest level). The relative index of inequality was calculated with the use of Poisson regression analysis, which also generated 95% confidence intervals. The slope index of inequality measures absolute differences in rates (e.g., in deaths per 100,000 person-years) between the lowest and the highest ends of the socioeconomic scale. The slope index of inequality is derived from the relative index of inequality and the age-adjusted overall mortality rate according to the following formula: $\text{slope index of inequality} = 2 \times \text{mortality rate} \times (\text{relative index of inequality} - 1) \div (\text{relative index of inequality} + 1)$.¹⁶ Because the slope index of inequality depends on the overall mortality rate in the population, we have presented these overall mortality rates together with the slope indexes of inequality.

RESULTS

Figures 1A and 1B show relative inequalities in the rate of death from any cause according to education level. The relative index of inequality is greater than 1 for both men and women in all countries, indicating that, throughout Europe, mortality is higher among those with less education. The magnitude of these inequalities varies substantially among countries. For example, in Sweden, the relative index of inequality for men is less than 2, indicating that mortality among those with the least education is less than twice that among those with the most education; on the other hand, in Hungary, the Czech Republic, and Poland, the relative index of inequality for men is 4 or higher, indicating that mortality differs by a factor of more than 4 between the lower and upper ends of the education scale. The smallest inequalities for both men and women are found in the Basque country of Spain, whereas the largest inequalities are found in the Czech Republic and Lithuania. Education-related inequalities in mortality are smaller than the average for Europe in all southern European populations included in this analysis and larger than average in most countries in the eastern and Baltic regions. Data on occupation-related inequalities in mortality among middle-aged men (Fig. 1C) confirm that relative inequalities in mortality tend to be smaller in southern European populations.

Table 2 shows that the international pattern observed for relative education-related inequalities in mortality also generally applies to absolute education-related inequalities in mortality, as indicated by the slope index of inequality. In Europe as a whole, persons with less education have higher rates of death from all causes except breast cancer, as indicated by a negative slope index of inequality for this cause of death. Inequalities in the rate of death from cardiovascular disease account for 34% of education-related inequalities in the rate of death from any cause among men (451 of 1333 deaths per 100,000 person-years) and 51% of those among women (251 of 492 deaths per 100,000 person-years). Although death from almost any cause is more frequent among those with less education than among those with more education, the range of variation for a single cause of death sometimes includes both “reverse” inequalities (higher mortality in groups with higher

Figure 1. Relative Inequalities in the Rate of Death from Any Cause.

Panel A shows inequalities between men with the lowest level of education and those with the highest, and Panel B shows education-related inequalities for women. Panel C shows inequalities between men in the lower and higher occupational classes. Economically inactive men whose last occupation was unknown were excluded from the analysis. Because exclusion of these men may lead to underestimation of mortality differences between occupational classes, we applied an adjustment procedure that was developed and tested in a previous European comparative study of inequalities in mortality; the procedure is based on national estimates of the proportion of economically inactive men in each occupational class and of the mortality rate ratio of inactive as compared with active men in each occupational class.¹⁸

education) and “regular” inequalities (higher mortality in groups with lower education).

These data help to explain how smaller education-related inequalities in the rate of death from any cause in southern European populations and larger inequalities in the eastern and Baltic regions arise. Among men and women, smaller inequalities in the rate of death from any cause in the southern region are due mainly to smaller inequalities in the rate of death from cardiovascular disease. For example, among men in the Basque country, where the education-related inequality in the rate of death from any cause is below the European average, death from cardiovascular disease accounts for 46% of this difference (i.e., [451–16 deaths per 100,000 person-years] ÷ [1333–384 deaths per 100,000 person-years]). Larger inequalities in the rate of death from cardiovascular disease make an important contribution to larger inequalities in the rate of death from any cause in the eastern and Baltic regions as well; however, important contributions are also made by cancer in the eastern region and injuries in the Baltic region.

In Europe as a whole, inequalities in mortality from smoking-related conditions account for 22% of the inequalities in the rate of death from any cause among men and 6% of those among women (Table 2). Inequalities in smoking-related mortality tend to be larger in the eastern and Baltic regions (among men only) and smaller (or even “reverse”) in the southern region. In Europe as a whole, inequalities in alcohol-related mortality account for 11% of inequalities in the rate of death

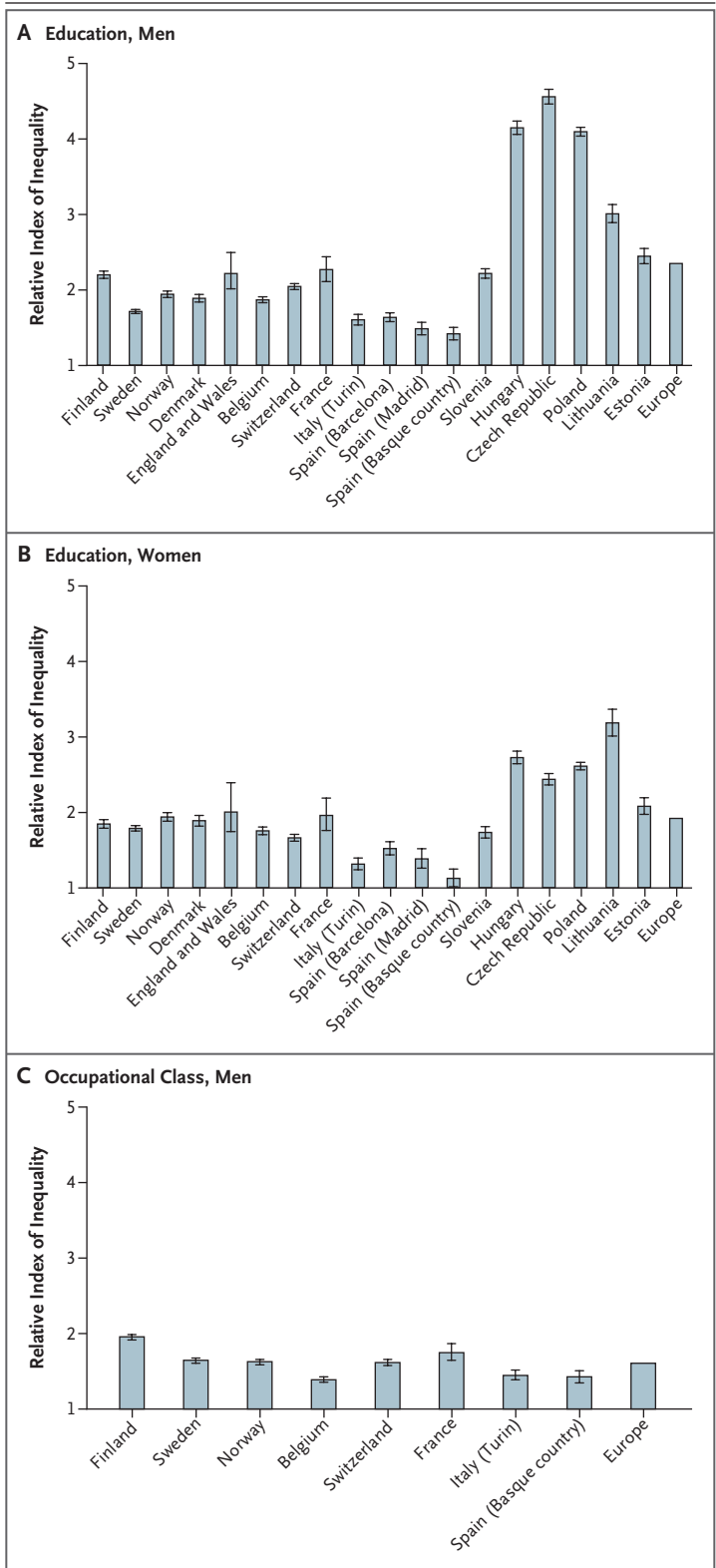


Table 2. Absolute Inequalities in Overall and Cause-Specific Mortality Rates between Persons with the Lowest and Those with the Highest Level of Education.*

Country	Average Rate of Death from Any Cause†	Slope Index of Inequality According to Cause of Death										Causes Amenable to Medical Intervention‡				
		All Causes	All Cancer-Related Causes	Breast Cancer‡	Lung Cancer‡	All Cardiovascular Disease	Ischemic Heart Disease	Cerebrovascular Disease	Injuries	All Other Diseases	Alcohol-Related Causes§		Smoking-Related Causes¶			
Men																
Finland	1673	1255	213	135	533	393	94	143	347	101	215	88				
Sweden	1188	625	90	37	309	229	50	52	175	50	71	26				
Norway	1529	980	169	95	434	307	78	70	305	62	166	49				
Denmark	1344	828	126	75	235	157	39	89	363	23	60	44				
United Kingdom (England and Wales)	1124	862	225	141	401	284	67	19	157	28	241	NA				
Belgium	1510	915	274	179	233	99	55	64	340	36	302	28				
Switzerland	1475	1012	283	136	401	132	61	91	348	117	260	61				
France	1241	1044	333	71	232	67	68	109	357	196	204	114				
Italy (Turin)	1377	639	232	107	140	57	52	23	243	63	177	24				
Spain (Barcelona)	1370	662	230	90	88	26	40	38	304	77	218	36				
Spain (Madrid)	1355	530	181	56	38	-16	11	26	278	75	170	34				
Spain (Basque country)	1108	384	107	39	16	-6	3	63	177	46	107	24				
Slovenia	1902	1439	303	124	405	67	219	203	482	224	327	83				
Hungary	2110	2580	666	260	1003	482	385	222	671	420	508	66				
Czech Republic	1664	2130	676	247	825	472	259	138	489	146	364	73				
Poland	1804	2192	589	260	750	295	223	187	637	145	408	75				
Lithuania	2531	2536	383	197	807	505	159	643	677	304	424	195				
Estonia	2799	2349	355	191	929	610	263	436	618	286	323	162				
Europe total	1635	1333	328	153	451	233	131	147	425	141	288	72				

Women	811	483	49	-8	14	262	168	72	25	161	31	28	42
Finland	673	381	73	-6	20	172	104	44	8	128	15	39	18
Sweden	811	518	103	-14	44	239	141	62	5	169	16	79	30
Norway	830	511	103	-12	63	160	90	42	22	230	9	70	27
Denmark	672	462	111	-22	59	236	154	31	1	96	7	103	NA
United Kingdom (England and Wales)	761	417	47	-11	11	198	77	55	11	163	6	29	10
Belgium	676	337	53	-3	10	158	74	46	5	120	10	21	22
Switzerland	536	375	50	35	6	130	33	44	36	163	30	17	82
France	721	197	15	-17	-9	94	34	34	-3	94	8	-4	11
Italy (Turin)	569	236	7	-12	-14	103	36	34	5	126	7	-14	12
Spain (Barcelona)	543	175	-12	-29	-17	96	30	29	-1	94	-3	-17	9
Spain (Madrid)	422	51	-76	-19	-20	56	23	17	7	74	3	-24	2
Spain (Basque country)	853	459	-13	-21	-18	263	62	127	28	180	44	-3	33
Slovenia	1023	948	120	-17	20	511	237	216	51	258	82	61	26
Hungary	868	726	144	10	17	356	182	134	26	203	23	33	32
Czech Republic	840	750	139	6	10	356	117	142	29	222	23	28	27
Poland	1053	1099	130	7	7	535	297	162	178	251	87	39	51
Lithuania	1213	851	7	-5	4	493	273	187	109	252	101	16	48
Estonia	778	492	55	-9	10	251	120	85	30	172	30	28	27

* Code numbers of the causes of death according to the 9th and 10th revisions of the *International Classification of Diseases, Clinical Modification* (ICD-9-CM and ICD-10-CM) are given in Table 1 of the Supplementary Appendix. The slope index of inequality is a regression-based measure of absolute differences in mortality rates between the lowest and the highest ends of the socioeconomic scale. NA denotes not available.

† Age-standardized rates of death for all educational groups are given.

‡ Rates of death from breast cancer among men are not given.

§ Alcohol-related causes are accidental poisoning by alcohol and alcoholic psychosis, dependence, abuse, cardiomyopathy, and cirrhosis of the liver and pancreas.

¶ Smoking-related causes are chronic obstructive pulmonary disease and cancer of the buccal cavity, pharynx, esophagus, larynx, trachea, bronchus, and lung.

|| Causes amenable to medical intervention are tuberculosis and other infectious and parasitic diseases, cervical cancer, breast cancer, Hodgkin's disease, leukemia, hypertension, cerebrovascular disease, pneumonia or influenza, appendicitis, hernia, peptic ulcer, cholelithiasis and cholecystitis, and complications of childbirth.

from any cause among men and 6% of those among women. Larger inequalities in alcohol-related mortality contribute to larger inequalities in the rate of death from any cause in Hungary (among men and women) and the Baltic region (among men only). In Europe as a whole, deaths from conditions amenable to medical intervention account for 5% of inequalities in the rate of death from any cause. However, these inequalities are larger than the European average in Lithuania and Estonia, where they contribute to the larger inequalities in the rate of death from any cause (among men only).

Figure 2 shows the relative inequalities in the prevalence of poorer self-assessed health (weighted on the basis of the burden of chronic disease) according to education and income level. The relative index of inequality is greater than 1 in all countries, indicating worse health in groups of lower socioeconomic status throughout Europe. The variation of this measure among countries is considerably less than that of inequalities in the rate of death from any cause, and the international pattern also tends to be different from that of death from any cause. In Italy and Spain, education-related inequalities in self-assessed health are smaller than average, a finding that mirrors the smaller education-related inequalities in the rate of death from any cause observed in Turin, Barcelona, Madrid, and the Basque country. In the Baltic region, on the other hand, education-related inequalities in self-assessed health are smaller than average, whereas education-related inequalities in death from any cause are larger. Income-related inequalities in self-assessed health are not larger in the eastern and Baltic regions than in other parts of Europe and are remarkably large in the northern and western regions, particularly England and Wales, where income inequalities are also large (see Table 4 in the Supplementary Appendix).

In Europe as a whole, both smoking and obesity are more common among people of lower education level; education-related inequalities in smoking are larger among men, and education-related inequalities in obesity are larger among women (Fig. 3). There are striking differences among countries in the magnitude and even the direction of these inequalities, however. Large education-related inequalities in smoking are seen in the northern, western, and continental regions; small inequalities (and, among women, even re-

verse inequalities, in which smoking rates are higher in groups with more education) are seen in the southern region. In the eastern and Baltic regions, the pattern is unclear. Large education-related inequalities in obesity are seen in the southern region, particularly among women, for whom the relative indexes of inequality are above 4, indicating that the prevalence of obesity among those with the least education is more than four times higher than that among those with the most education. By contrast, education-related inequalities in obesity tend to be smaller than average in the eastern and Baltic regions.

DISCUSSION

As compared with our study of inequalities in mortality and morbidity related to socioeconomic status in 10 western European countries during the 1980s,³ the present, more extensive study of the situation during the 1990s and early 2000s found much larger among-country variability in the magnitude of inequalities in health. Inequalities in mortality from selected causes suggest that some variations may be attributable to socioeconomic differences in smoking, excessive alcohol consumption, and access to health care. We also found among-country variations in the magnitude of inequalities in self-assessed health, but in a different pattern, precluding a generalization from inequalities in mortality to inequalities in overall health.

Our study had several limitations. International comparability of data on socioeconomic inequalities in health is still imperfect, and the degree of comparability is likely to decline with increasing geographical coverage. There are differences among countries in various aspects of data collection, and some of these might affect the size of inequalities in health, as we have shown previously.¹⁸ We found smaller inequalities in mortality in some urban, relatively prosperous southern European populations that are not necessarily representative of the whole of Italy or Spain. Some studies have shown, however, that inequalities in health tend to be larger in urban than in rural areas.¹⁹ Our previous study in the 1980s, which used national data for Italy and Spain from methodologically less-refined sources, also showed smaller inequalities in mortality in these countries.^{4,5} We found larger inequalities in mortality in the eastern and Baltic regions. All these coun-

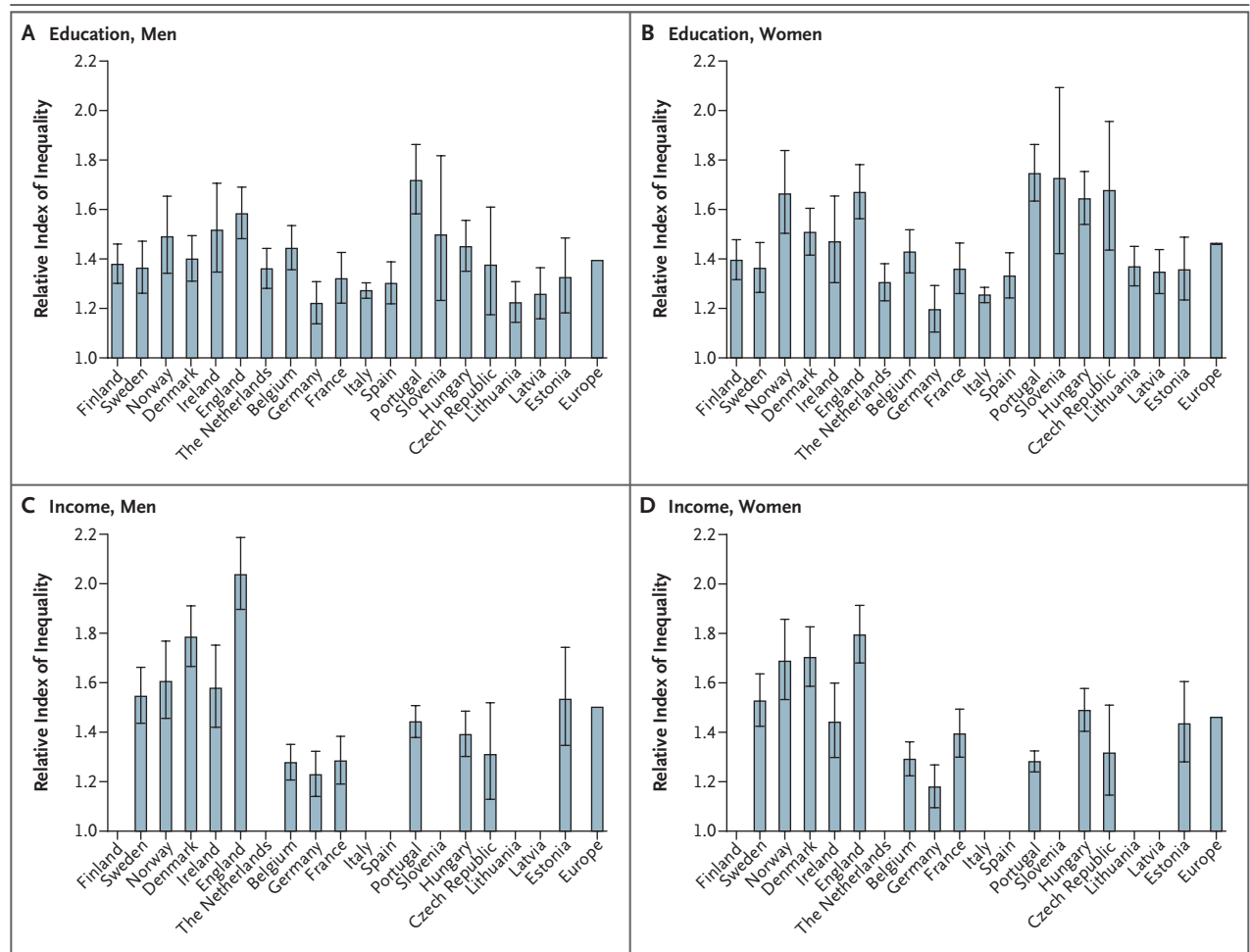


Figure 2. Relative Inequalities in the Prevalence of Poorer Self-Assessed Health.

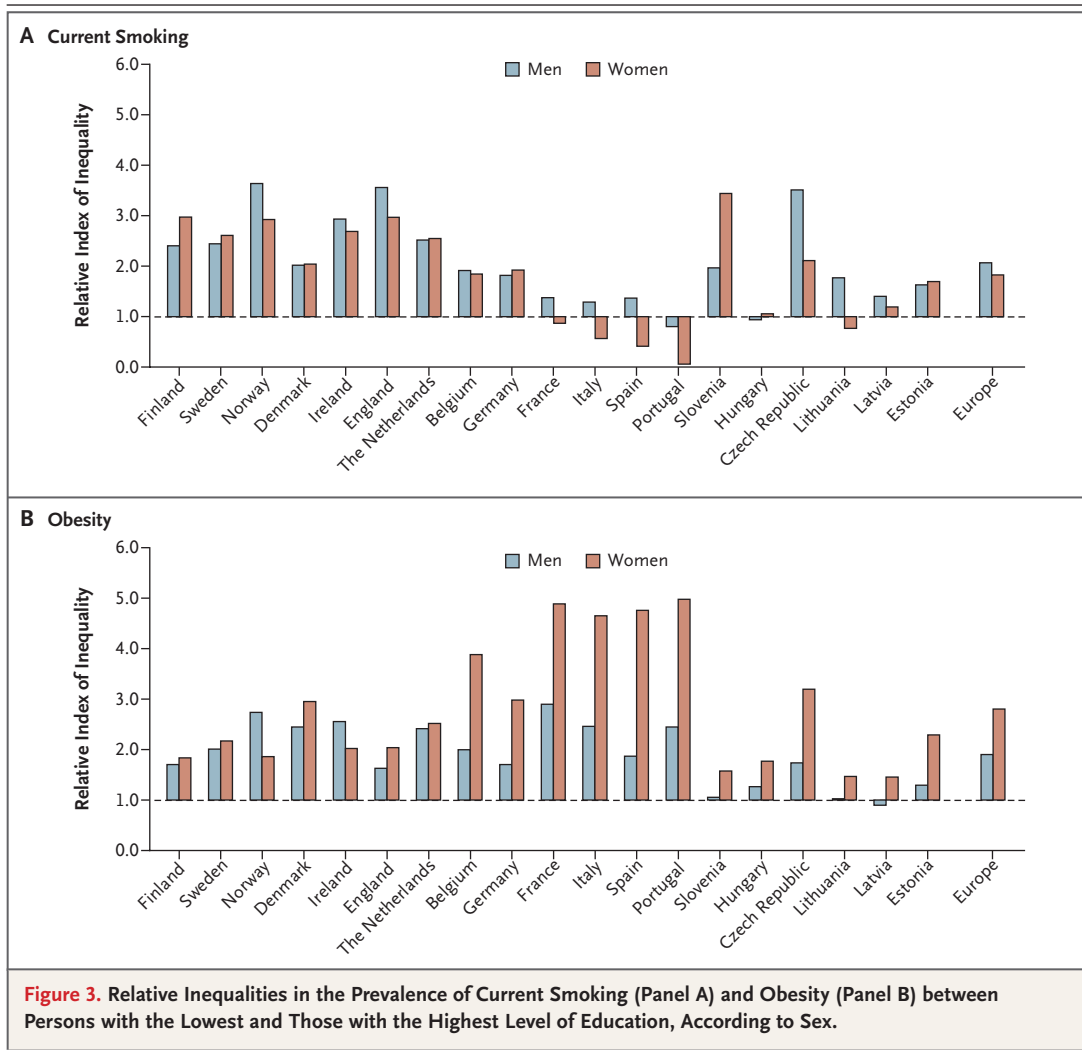
Panels A and B show inequalities between persons with the lowest and those with the highest level of education for men and women, respectively. Panels C and D show inequalities between persons with the lowest and those with the highest level of income for men and women, respectively. In order to make use of the full range of levels of self-assessed health, we calculated the estimated burden of disease associated with each level on the basis of the number of chronic conditions reported by respondents to these surveys. Relative differences in self-reported chronic conditions between answer categories of the self-assessed health question were remarkably similar between countries and varied only marginally around a multiplicative factor of 1.85 (i.e., each step down on the self-assessed health scale was found to be associated with 1.85 times more chronic conditions). On the basis of this analysis, we assigned a weight for burden of disease to each category of answer to the question “How is your health in general?” “Very good” was assigned a weight of $1.85^0 = 1$, “good” a weight of $1.85^1 = 1.85$, “fair” a weight of $1.85^2 = 3.42$, and “poor” or “very poor” a weight of $1.85^3 = 6.33$. Sensitivity analyses showed that the ranking of countries according to the magnitude of inequalities in self-assessed health did not change when these weights were varied within the range of observed values.¹⁵

tries except Slovenia, which has smaller inequalities in mortality, provided data from cross-sectional, non-census-linked studies. Although this may suggest bias,²⁰ it is also possible that Slovenia, which is close to Italy, shares some of the favorable characteristics of the southern region.

Internationally comparable data on inequalities in specific determinants of mortality and morbidity are scarce, and we could study only smoking and obesity. The contribution to inequality of

other factors, such as alcohol consumption, use of health care, working and housing conditions, and psychosocial stressors, could not be studied directly.

Both smoking and obesity have been shown to contribute to inequalities in health related to socioeconomic status in studies of individual persons in some countries.²¹⁻²³ Obesity, however, is unlikely to be a major contributor to international variations in inequalities in health, because in-



equalities in obesity related to socioeconomic status are large where inequalities in mortality related to socioeconomic status, particularly mortality from cardiovascular disease, are small (i.e., in the southern region). Smoking, on the other hand, does appear to be a major explanatory factor. It has been well documented that countries in the southern region are in an earlier stage of the smoking epidemic than countries in the northern, western, and continental regions.^{24,25} We still found reverse inequalities in smoking among women and small inequalities among men, findings that are consistent with the smaller inequalities in mortality in the southern region, particularly from conditions related to smoking. The history of the smoking epidemic is much less well documented for the eastern and Baltic regions,^{26,27} and it is therefore difficult to determine why in-

equalities in mortality from smoking-related conditions are large, whereas inequalities in smoking are often small.

The role of hazardous drinking (daily consumption of large amounts of alcohol-containing beverages, binge drinking, or consumption of surrogate alcohols) in generating high mortality rates in eastern Europe, particularly among men, has been well documented.²⁸⁻³⁰ We have not been able to find comparable survey data on inequalities in alcohol consumption related to socioeconomic status in eastern Europe, but our analysis of cause-specific mortality suggests that rates of hazardous drinking are substantially higher in the lower than in the higher socioeconomic groups, particularly among men. Low levels of social support, lack of control over one's life, and material hardship, combined with a culture that approves of exces-

sive alcohol consumption, are likely to be involved.^{8,9}

Although the role of deficiencies in health care in the high mortality rates of eastern Europe has been pointed out before,^{31,32} our study demonstrates the magnitude of inequalities in mortality related to socioeconomic status from conditions amenable to medical intervention in this part of Europe. Our results suggest that inequalities in access to good-quality health care have a role in generating inequalities in mortality. Inequalities in access to health care leading to inequalities in survival from chronic conditions may also partly explain the discrepancy between our results for mortality and those for self-assessed health. Inequalities in the prevalence of poorer self-assessed health are the result of inequalities in both the incidence and the duration of health problems, which may be shortened by lower survival rates among less-educated persons in eastern Europe.

Smoking, obesity, excessive alcohol consumption, and deficiencies in health care represent only some of the immediate determinants of inequalities in health, and both lifestyle choices and patterns of use of health care are likely to be constrained by inequalities in general living conditions, as structured by political, economic, social, and cultural forces. Within western Europe, there is little evidence that among-country variations in the magnitude of inequalities in health are related to variations in political factors. For example, Italy and Spain have welfare policies that are less generous and less universal than those of northern Europe,^{33,34} but they appear to have substantially smaller inequalities in mortality, perhaps partly because of cultural factors, such as the Mediterranean diet and the reluctance of women

to take up smoking.^{35,36} Cultural factors seem to have prevented differences in access to material and other resources in these populations from translating into inequalities in lifestyle-related risk factors for mortality.

We also found no evidence for systematically smaller inequalities in health in countries in northern Europe. This is surprising, because these countries have long histories of egalitarian policies, reflected by, among other things, welfare policies. These policies provide a high level of social-security protection to all residents of the country, resulting in smaller income inequalities and lower poverty rates.^{33,34,37} Our results suggest that although a reasonable level of social security and public services may be a necessary condition for smaller inequalities in health, it is not sufficient. Lifestyle-related risk factors have an important role in premature death in high-income countries³⁸ and also appear to contribute to the persistence of inequalities in mortality in the northern region.³⁹

Our study shows that although inequalities in health associated with socioeconomic status are present everywhere, their magnitude is highly variable, particularly for inequalities in mortality. This result implies that there is opportunity to reduce inequalities in mortality. Developing policies and interventions that effectively target the structural and immediate determinants of inequalities in health is an urgent priority for public health research.⁴⁰

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APPENDIX

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REFERENCES

- Marmot M. Social determinants of health inequalities. *Lancet* 2005;365:1099-104.
- Kunst AE, Bos V, Mackenbach JP. Guidelines for monitoring health inequalities in the European Union. Rotterdam: the Netherlands: Department of Public Health, 2001.
- Mackenbach JP, Kunst AE, Cavelaars AEJM, Groenhouf F, Geurts JJ. Socioeconomic inequalities in morbidity and mortality in Western Europe. *Lancet* 1997;349:1655-9.
- Kunst AE, Groenhouf F, Mackenbach JP, Heath EW. Occupational class and cause-specific mortality in middle aged men in 11 European countries: comparison of population based studies. *BMJ* 1998;316:1636-42.
- Kunst AE, Groenhouf F, Mackenbach JP. Mortality by occupational class among men 30-64 years in 11 European countries. *Soc Sci Med* 1998;46:1459-76.
- Cavelaars AEJM, Kunst AE, Geurts JJM, et al. Differences in self-reported morbidity by educational level: a comparison of 11 Western European countries. *J Epidemiol Community Health* 1998;52:219-27.
- Cavelaars AEJM, Kunst AE, Geurts JJM, et al. Morbidity differences by occupational class among men in seven European countries: an application of the Erikson-Goldthorpe social class scheme. *Int J Epidemiol* 1998;27:222-30.
- Bobak M, Marmot M. East-West mortality divide and its potential explanations: proposed research agenda. *BMJ* 1996;312:421-5.
- McKee M, Shkolnikov V. Understanding the toll of premature death among men in eastern Europe. *BMJ* 2001;323:1051-5.
- Leinsalu M, Vägerö D, Kunst AE. Estonia 1989-2000: enormous increase in mortality differences by education. *Int J Epidemiol* 2003;32:1081-7.
- Shkolnikov VM, Andreev EM, Jasilionis D, Leinsalu M, Antonova OI, McKee M. The changing relation between education and life expectancy in central and eastern Europe in the 1990s. *J Epidemiol Community Health* 2006;60:875-81.
- Murphy M, Bobak M, Nicholson A, Rose R, Marmot M. The widening gap in mortality by educational level in the Russian Federation, 1980-2001. *Am J Public Health* 2006;96:1293-9.
- Charlton JR, Hartley RM, Silver R, Holland WW. Geographical variation in mortality from conditions amenable to medical intervention in England and Wales. *Lancet* 1983;1:691-6.
- Nolte E, McKee M. Measuring the health of nations: analysis of mortality amenable to health care. *BMJ* 2003;327:1129. [Erratum, *BMJ* 2004;328:494.]
- Kunst AE, Roskam AJ. Comparison of educational inequalities in general health in 12 European countries: application of an integral measure of self-assessed health. Rotterdam, the Netherlands: Department of Public Health, 2007. (Accessed May 12, 2008, at <http://www.eurothine.org>.)
- Pamuk ER. Social class inequality in mortality from 1921 to 1972 in England and Wales. *Popul Stud (Camb)* 1985;39:17-31.
- Mackenbach JP, Kunst AE. Measuring the magnitude of socio-economic inequalities in health: an overview of available measures illustrated with two examples from Europe. *Soc Sci Med* 1997;44:757-71.
- Kunst AE. Cross-national comparisons of socioeconomic differences in mortality. (Ph.D. thesis. Rotterdam, the Netherlands: Erasmus University, 1997.)
- Bos V, Kunst AE, Mackenbach JP. Socio-economic inequalities in mortality in the Netherlands: analyses on the basis of information at the neighborhood level. *TSG Tijdschrift voor Gezondheidswetenschappen* 2002;80:158-65. (In Dutch.)
- Shkolnikov VM, Jasilionis D, Andreev EM, Jdanov DA, Stankuniene V, Ambrozaitiene D. Linked versus unlinked estimates of mortality and length of life by education and marital status: evidence from the first record linkage study in Lithuania. *Soc Sci Med* 2007;64:1392-406.
- Davey Smith G, Blane D, Bartley M. Explanations for socio-economic differentials in mortality evidence from Britain and elsewhere. *Eur J Public Health* 1994;4:131-44.
- Pekkanen J, Tuomilehto J, Uutela A, Vartiainen E, Nissinen A. Social class, health behaviour, and mortality among men and women in eastern Finland. *BMJ* 1995;311:589-93.
- van Oort FVA, van Lenthe FJ, Mackenbach JP. Material, psychosocial, and behavioural factors in the explanation of educational inequalities in mortality in the Netherlands. *J Epidemiol Community Health* 2005;59:214-20.
- Lopez AD, Collishaw NE, Piha T. A descriptive model of the cigarette epidemic in developed countries. *Tobacco Control* 1994;3:242-7.
- Huisman M, Kunst AE, Mackenbach JP. Educational inequalities in smoking among men and women aged 16 years and older in eleven European countries. *Tobacco Control* 2005;14:106-13.
- Kubik AK, Parkin DM, Plesko I, et al. Patterns of cigarette sales and lung cancer mortality in some central and eastern European countries, 1960-1989. *Cancer* 1995;75:2452-60.
- Pudule I, Grinberga D, Kadziauskiene K, et al. Patterns of smoking in the Baltic Republics. *J Epidemiol Community Health* 1999;53:277-82.
- Leon DA, Chenet L, Shkolnikov VM, et al. Huge variation in Russian mortality rate 1984-94: artefact, alcohol, or what? *Lancet* 1997;350:383-8.
- Britton A, McKee M. The relation between alcohol and cardiovascular disease in Eastern Europe: explaining the paradox. *J Epidemiol Community Health* 2000;54:328-32.
- Powles JW, Zatonski W, Vander Hoorn S, Ezzati M. The contribution of leading diseases and risk factors to excess losses of healthy life in Eastern Europe: Burden of Disease study. *BMC Public Health* 2005;5:116.
- Velkova A, Wolleswinkel-van den Bosch JH, Mackenbach JP. The East-West life expectancy gap: differences in mortality from conditions amenable to medical intervention. *Int J Epidemiol* 1997;26:75-84.
- Nolte E, McKee M. Population health in Europe: how much is attributable to health care? *World Hosp Health Serv* 2004;40:12-4, 40, 42.
- Esping-Andersen G. The three worlds of welfare capitalism. Oxford, England: Polity Press, 1999.
- Ferrera M. The "Southern model" of welfare in social Europe. *J Eur Soc Policy* 1996;6:17-37.
- Mackenbach JP, Cavelaars AEJM, Kunst AE, Groenhouf F. Socioeconomic in-

- equalities in cardiovascular disease mortality: an international study. *Eur Heart J* 2000;21:1141-51.
36. Knoops KTB, de Groot LCPGM, Kromhout D, et al. Mediterranean diet, lifestyle factors, and 10-year mortality in elderly European men and women: the HALE project. *JAMA* 2004;292:1433-9.
37. Fritzell J. Still different? Income distribution in the Nordic countries in a European comparison. In: Kautto M, Fritzell J, Hvinden B, Kvist J, Uusitalo H, eds. *Nordic welfare states in the European context*. London: Routledge, 2001:18-41.
38. Ezzati M, Hoorn SV, Rodgers A, Lopez AD, Mathers CD, Murray CJ. Estimates of global and regional potential health gains from reducing multiple major risk factors. *Lancet* 2003;362:271-80. [Erratum, *Lancet* 2005;365:28.]
39. Dahl E, Fritzell J, Lahelma E, Martikainen P, Kunst A, Mackenbach J. Welfare state regimes and health inequalities. In: Siegrist J, Marmot M, eds. *Health inequalities in Europe*. Oxford, England: Oxford University Press, 2006:193-222.
40. Mackenbach JP, Bakker MJ. Tackling socioeconomic inequalities in health: an analysis of recent European experiences. *Lancet* 2003;362:1409-14.

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CORRECTION

Socioeconomic Inequalities in Health in 22 European Countries

To the Editor: Mackenbach et al. (June 5 issue)¹ present interesting findings on the magnitude of socioeconomic inequalities in health in Europe, but they provide potentially misleading messages to policy leaders. The authors show that inequalities in health are smaller in Italy and Spain than they are in more egalitarian northern European countries, and they conclude that there is little evidence that the magnitude of inequalities in health is related to political factors. However, their conclusions are based on data that can hardly be considered to be comparable. Data from cities such as Turin (Italy), Madrid, and Barcelona do not include health variations across regions, which can be particularly large in countries such as Italy.² Furthermore, there is substantial heterogeneity across countries (especially southern vs. northern Europe) in terms of the validity and reliability of health and socioeconomic data.³ Generalizations on the relationship between egalitarian policies and inequalities in health should be based on comparable evidence and a solid theoretical framework; this can prevent misleading interpretations of the importance of societal determinants of inequalities in health and can promote adequate policy responses to reduce them.

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References

1. Mackenbach JP, Stirbu I, Roskam A-JR, et al. Socioeconomic inequalities in health in 22 European countries. *N Engl J Med* 2008;358:2468-2481.
2. Fantini MP, Stivanello E, Dallolio L, Loghi M, Savoia E. Persistent geographical disparities in infant mortality rates in Italy (1999-2001): comparison with France, England, Germany, and Portugal. *Eur J Public Health* 2006;16:429-432.
3. Gnesotto R, DeVogli R. Health Monitoring Systems in Europe: structures and processes. Activity report: conclusions and recommendations. Venice, Italy: European Commission Health Monitoring Program, 2003. (Accessed September 2, 2008, at http://ec.europa.eu/health/ph_projects/2001/monitoring/fp_monitoring_2001_frep_13_en.pdf.)

The authors reply: Studies using a variety of data sources, including harmonized surveys,^{1,2,3} have shown that variations within western Europe in the magnitude of socioeconomic inequalities in health

are mostly uncorrelated with variations in welfare policies. Our study shows that inequalities in mortality are smaller in some Spanish and Italian populations than those in other western European countries. Although we acknowledge that the situation in these urban regions may be different from the national average, national data on Spain and Italy from the 1980s also suggest that inequalities in mortality in these two countries are smaller.⁴ This is unlikely to be due to the policies or underlying political choices in these countries. The smaller inequalities in smoking, diet, and other immediate determinants of inequalities in health in these countries more likely reflect their cultural and social histories. Although it is impossible for other countries to copy these histories, Spain and Italy provide important policy lessons on how to reduce inequalities in health: tackling immediate determinants of such inequalities may be an effective way to reduce health inequalities in countries with a reasonable level of welfare provision.

Since the publication of our article, we have discovered an error in the mortality data from England, related to an ambiguity in the label of one educational category as used in this data set. The corrected data are available with a revised version of our article and the full text of this letter at www.nejm.org. These data show that we underestimated inequalities in mortality in England and Wales, but none of the conclusions of our article are substantially affected.

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References

1. Eikemo TA, Huisman M, Bambra C, Kunst AE. Health inequalities according to educational level in different welfare regimes: a comparison of 23 European countries. *Sociol Health Illn* 2008;30:565-582.
2. Espelt A, Borrell C, Rodríguez-Sanz M, et al. Inequalities in health by social class dimensions in European countries of different political traditions. *Int J Epidemiol* 2008 March 13 (Epub ahead of print).
3. Dahl E, Fritzell J, Lahelma E, Martikainen P, Kunst A, Mackenbach J. Welfare state regimes and health inequalities. In: Siegrist J, Marmot M, eds. *Social inequalities in health: new evidence and policy implications*. Oxford, England: Oxford University Press, 2006:193-222.
4. Kunst AE, Groenhouf F, Mackenbach JP, Health EW. Occupational class and cause-specific mortality in middle-aged men in 11 European countries: comparison of population-based studies. *BMJ* 1998;316:1636-1642.

CORRECTION

Socioeconomic Inequalities in Health in 22 European Countries

Socioeconomic Inequalities in Health in 22 European Countries

We have discovered an error in the mortality data from England; this error is related to an ambiguity in the labels of educational categories. An alternative interpretation of the labels of educational categories in the mortality data for England and Wales reduces the number of persons with education unknown and therefore increases both the number of person-years and the number of deaths available for analysis. The resulting changes show that we underestimated inequalities in mortality in England and Wales, but none of the conclusions of our article are substantially affected. The changed results for England and Wales also slightly affect the totals for Europe. In the Results section of the text (page 2472), the fourth sentence, "For example, in Sweden and in England and Wales, the relative index of inequality for men is less than 2, indicating that mortality among those with the least education is less than twice that among those with the most education; on the other hand, in Hungary, the Czech Republic, and Poland, the relative index of inequality for men is 4 or higher, indicating that mortality differs by a factor of more than 4 between the lower and upper ends of the education scale," should have read, "For example, in Sweden, the relative index of inequality for men is less than 2, indicating that mortality among those with the least education is less than twice that among those with the most education; on the other hand, in Hungary, the Czech Republic, and Poland, the relative index of inequality for men is 4 or higher, indicating that mortality differs by a factor of more than 4 between the lower and upper ends of the education scale."

In the Results section of the text (page 2472), the 10th sentence, "Inequalities in the rate of death from cardiovascular disease account for 33% of education-related inequalities in the rate of death from any cause among men (442 of 1328 deaths per 100,000 person-years) and 50% of those among women (246 of 489 deaths per 100,000 person-years)," should have read, "Inequalities in the rate of death from cardiovascular disease account for 34% of education-related inequalities in the rate of death from any cause among men (451 of 1333 deaths per 100,000 person-years) and 51% of those among women (251 of 492 deaths per 100,000 person-years)."

In the Results section of the text (page 2473), the third full sentence, "For example, among men in the Basque country, where the education-related inequality in the rate of death from any cause is below the European average, death from cardiovascular disease accounts for 45% of this difference (i.e., [442–16 deaths per 100,000 person-years]÷[1328–384 deaths per 100,000 person-years])," should have read, "For example, among men in the Basque country, where the education-related inequality in the rate of death from any cause is below the European average, death from cardiovascular disease accounts for 46% of this difference (i.e., [451–16 deaths

per 100,000 person-years]÷[1333–384 deaths per 100,000 person-years])."

In the Results section of the text (page 2473), the fifth full sentence, "In Europe as a whole, inequalities in mortality from smoking-related conditions account for 21% of the inequalities in the rate of death from any cause among men and 6% of those among women (Table 2)," should have read, "In Europe as a whole, inequalities in mortality from smoking-related conditions account for 22% of the inequalities in the rate of death from any cause among men and 6% of those among women (Table 2)."

In Table 1 (page 2470), the fifth and sixth columns for the fifth row (United Kingdom) should have been 2,295,029 and 21,234 rather than 445,568 and 3,867.

In Table 1 (page 2471), the fifth and sixth columns for the last row (Europe) should have been 303,540,302 and 3,462,053 rather than 301,690,841 and 3,444,686.

In Table 2 (page 2474), the first through third, fifth through ninth, and 11th through 12th columns for the fifth row (United Kingdom [England and Wales]) should have been 1124, 862, 225; 141, 401, 284, 67, 19; 28, 241 rather than 1005, 529, 184; 92, 189, 132, 6, 9; 39, 154. The first through third, fifth through eighth, and 11th through 12th columns for the last row on the page (Europe total) should have been 1635, 1333, 328; 153, 451, 233, 131; 141, 288 rather than 1615, 1328, 326; 152, 442, 229, 127; 142, 285. In Table 2 (page 2475), the first through 12th columns for the fifth row (United Kingdom [England and Wales]) should have been 672, 462, 111, –22, 59, 236, 154, 31, 1, 96, 7, 103 rather than 593, 315, 42, –8, 50, 115, 66, 85, –9, 146, 20, 98. The first through eighth and the 10th column for the last row (Europe total) should have been 778, 492, 55, –9, 10, 251, 120, 85; 172 rather than 766, 489, 54, –8, 8, 246, 117, 86; 173. The corrected data show a higher average rate of death from any cause for England and Wales and higher slope indexes of inequality both for death from any cause and for specific causes of death. As a result, the totals for Europe as a whole also increase slightly.

In Figure 1A (page 2473), the bar for England and Wales should have been just above 2 rather than just below 2. In Figure 1B, the bar for England and Wales should have been just above 2 rather than just below 2. The corrected data show a higher relative index of inequality in England and Wales for both men and women.