The Size of Mortality Differences Associated with Educational Level in Nine Industrialized Countries

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ABSTRACT

Objectives. This study addresses the question of whether inequalities in premature mortality related to educational level differ among countries.

Methods. Data on mortality by educational level were obtained from longitudinal studies from nine industrialized countries. The data referred to men between 35 and 64 years of age. The follow-up periods occurred between 1970 and 1982. The size of mortality differences associated with educational level was measured by means of two inequality indices, both based on Poisson regression analysis.

Results. Inequalities in mortality are relatively small in the Netherlands, Sweden, Denmark, and Norway and about two times as large in the United States, France, and Italy. Finland and England and Wales occupy intermediate positions. The large inequalities in mortality in the United States and France can be attributed in part to large inequalities in education in these countries.

Conclusions. The international pattern found in this study was also observed in a comparison that used occupation as the socioeconomic indicator. Differences between countries in levels of inequality in mortality may be partially explained by the countries' different levels of egalitarian social and economic policies. (*Am J Public Health.* 1994;84:932–937)

Introduction

Inequalities in mortality that are related to socioeconomic status are a generalized phenomenon in the industrialized world. In each country for which data are available, death rates have been found to be higher in groups with lower occupational status, educational level, or income level.

The question of whether these inequalities in mortality are about equally large in all countries or whether important differences exist has aroused wide interest. The primary reason for this interest is that inequalities in other countries provide a point of reference for judging whether health inequalities in one's own country are small or large. In addition, cross-country comparisons provide a unique opportunity to assess the effects of national socioeconomic policies on the magnitude of health inequalities.

Cross-country comparisons have traditionally used occupational status as the socioeconomic indicator.[1–8] Most of these studies were confronted with serious data problems, such as international differences in occupational classifications and a lack of information on the occupational class of large sections of the population (women, old men, middle-aged economically inactive men).[9] There is therefore a strong need to complement these studies with international comparisons that are based on other indicators of socioeconomic status.

The aim of the present study was to compare a large number of countries with respect to mortality differences associated with educational level. This study refers to men in the age group 35 to 64 years. Data were obtained from studies done in the United States and a number of European countries.

Methods

Data on mortality by educational group were acquired for as many countries as possible. Studies were selected that met the following criteria: (1) the study design was longitudinal, (2) the observation period occurred in the 1970s or the early 1980s, and (3) the study population was nationally representative. The selected studies[3,10–17] are presented in Table 1. The US study[17] consisted of a follow-up of eight samples of the Current Population Survey. The Dutch study[10] was an epidemiological follow-up study of military conscripts born in 1930. All other European studies selected were follow-ups of the national population census, either for a representative sample (England and Wales[14] and France[15]) or for the entire national population.

The length of follow-up in most studies was about 10 years. Studies with shorter follow-up times were also included because from analyses of data from the Netherlands, Finland, and France we found that the size of educational mortality differences does not change with increasing follow-up length.

Table 2 presents the educational classifications used in the respective stud-

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ies. The average number of years of education was estimated by the authors in consultation with contact persons from the respective countries.

The educational level was not given for more than 1% of the populations of Denmark, Sweden, and England and Wales. In each of these cases, it was assumed that the educational level of this "unknown" group was equal to the level of the group with the lowest educational level. Support for this assumption in the Swedish case is that the occupational composition of the "unknown" group was similar to that of the group in the lowest educational category (Ö. Hemström and D. Vågerö, PhD, written communication, February 26, 1992). For Denmark, a comparison with more complete data from the Danish Health and Morbidity Survey suggested that the group with "unknown" education in the mortality study should have a low educational level. Because the mortality level of the "unknown" group in England and Wales was close to the national average, alternative assumptions about the group's educational level had a negligible effect on the measurement of the association between mortality and educational level.

Two other data problems are briefly mentioned here and will be discussed more extensively at the end of the Results section. First, the educational level of men in the Dutch study was assessed when they were 18 or 19 years old, that is, when some of them had still not left school. Second, more than two thirds of the population in Sweden, Finland, and England and Wales was assigned to a single (the lowest) educational category.

We compare countries by means of inequality indices that, for each country separately, measure the size of mortality differences associated with educational level. Indices were selected on the basis of two criteria: (1) all educational groups should be included separately in the calculation of the index, and (2) not all mortality differences should be measured, but only mortality differences that are systematically related to an ordering of educational groups from high to low socioeconomic status.[2]

These two criteria can be met by means of regression analysis. We applied Poisson (log-linear) regression, using the following regression model:

$$D_{are} = P_{are} \cdot e^{(\alpha_{ar} + \beta SES_e)},$$

TABLE 1—Studies Included in the International Comparison

Country	Reference	Follow-Up Period	Age Groups Distinguished, y[a]	Sample Size[b]
Netherlands	Doornbos & Kromhout[10]	1970–1981	38	79 000
Denmark	Andersen[11,c]	1970–1980	35–39, 40–44	289 000
Norway	Valkonen[12]	1971–1980	30–49[d]	141 000
Sweden	Vågerö & Lundberg[3,c]	1971–1980	35–39, 40–44, . . . 55–59	1 204 000
Finland	Valkonen[13,c]	1970–1980	35–39, 40–44, . . . 60–64	732 000
England & Wales	Fox & Goldblatt[14,c]	1971–1981	15–44, 45–64	162 000
France	Desplanques[15]	1975–1980	35–44, 45–54, 55–64	314 000
Italy	Pagnanelli[16]	1981–1982	18–54[d]	10 468 000
United States	Rogot et al.[17]	1979–1981	35–44, 45–54, 55–64	130 000

[a]Age at beginning of follow-up, except for England and Wales and France, where data refer to age at death.
[b]Number of male subjects at the start of follow-up in the given age groups.
[c]Data were obtained from unpublished tables.
[d]Mortality figures presented as age-standardized death rates or standardized mortality ratios.

where D is the estimated number of deaths, P is the number of person-years at risk, and SES is a measure of the socioeconomic status of each educational group. The subscripts a, r, and e denote 5-year age group, race (United States only), and educational group, and α and β are regression coefficients. The formula $(\exp\beta - 1)$ yields the inequality index used in this study. It represents the proportional increase in mortality per one unit increase in socioeconomic status.

The socioeconomic status of educational groups can be quantified in two ways. The first way is to quantify the educational level as the average number of years that are formally needed to complete that level. The corresponding inequality index represents the proportional mortality increase associated with 1 additional year's education. This index has been applied in an earlier international comparison.[12]

In the second method, the socioeconomic status of an educational group is conceptualized as the group's relative position in the social hierarchy. Following Pamuk,[18] this position is quantified as the proportion of the population that has a higher position in the social hierarchy. For example, if the highest educational group comprises 10% of the population, the relative position of its members would be between 0 and 0.10, the average being 0.05. The corresponding inequality index represents the proportional mortality increase associated with one unit increase in the relative position. More specifically, the index can be interpreted as the proportional mortality increase by moving from the top (= 0) to the bottom (= 1) of the social hierarchy.

We call the first index the partial inequality index and the second the total inequality index. These names are related to their interpretation, which can be illustrated as follows. If the score of a country on the total index is large compared with the scores of other countries, this implies large mortality differences between high and low positions on the social hierarchy. This large mortality difference can be attributed to large differences between high and low social positions in the number of years of education (i.e., large educational inequalities) or a large effect of 1 extra year of education on mortality (i.e., a large score on the partial inequality index). Thus, while the partial index measures the size of the effect of 1 extra year of education on mortality, the total index also takes into account the extent of inequality in educational levels themselves. The total inequality index therefore measures the total size of mortality differences in a population that are related to educational inequality. Since the two measures are complementary and each has a specific interpretation, both will be applied in the present study.

The regression equation assumes that mortality has a log-linear relationship with educational level. This assumption

TABLE 2—Educational Classifications Applied in the Various Studies

Country	Educational Groups	Average No. of Years of Education	% of Total Male Study Population[a]
Netherlands[10,b]	Primary education	8.0	48.2
	Lower vocational education	10.0	21.0
	Lower secondary education	12.0	17.8
	Higher level	15.5	12.9
Denmark[11]	9 years' education or less	8.0	27.8
	Educational level unknown	8.0	12.6
	10–12 years' education	11.0	40.0
	Vocational education, level unknown	11.5	7.1
	13–14 years' education	13.5	6.2
	15 years' education or more	16.0	6.3
Norway[12]	Primary school or not reported	7.5	38.9
	Second level, first stage	9.0	20.8
	Second level, second stage	11.0	27.6
	Third level, first stage	14.0	8.2
	Third level, second stage	17.0	4.4
Sweden[3]	Educational level unknown	8.0	2.6
	Primary education	8.0	81.6
	Some education after primary school	9.5	6.3
	Secondary education	14.0	9.5
Finland[13]	Basic education, lower level	8.0	76.6
	Basic education, upper level	9.0	3.1
	Secondary education, lower level	10.5	8.7
	Secondary education, upper level	12.0	5.8
	Higher education, lowest level	13.5	2.1
	Higher education, undergraduate level	15.0	0.9
	Higher education, postgraduate level	17.0	2.8
England and Wales[14]	Educational level unknown	10.0	2.2
	No higher qualifications	10.0	82.1
	A-level only	12.0	6.3
	Nondegree higher qualifications	14.0	5.0
	Degree or equivalent	17.0	4.4
France[15,c]	No qualifications	7.0	31.6
	Second level, first stage	10.0	46.1
	Second level, second stage	12.0	8.2
	Baccalaureate	15.0	6.6
	Higher education	18.0	7.6
Italy[16,d,e]	Elementary education not completed	...	3.9
	Elementary education completed	...	40.1
	Lower secondary education	...	31.5
	Upper secondary education	...	17.3
	Postsecondary education	...	7.2
United States[17]	Elementary, grades 1–4 or lower	3.0	2.8
	Elementary, grades 5–7	6.0	5.5
	Elementary, grade 8	8.0	8.2
	High school, years 1–3	10.0	14.8
	High school, year 4	12.0	35.3
	College, years 1–3	14.0	13.7
	College, year 4	16.0	10.0
	College, 5 years or more	18.0	9.7

[a]At the beginning of follow-up.
[b]Educational level was assessed when the subjects were 18 or 19 years old.
[c]Percentages in the last column refer to the entire French population instead of the study population because the latter is based on a sample stratified by socioeconomic group.
[d]No reliable estimates are available for number of years of education corresponding to the educational groups used in the Italian study.
[e]Estimated from data on the same cohort in the survey Health Conditions of the Population and the Use of Health Services, 1986–1987.

was checked by means of (1) inspection of residuals and (2) the inclusion of a quadratic term for the education measure in the regression equation. No large departures from (log) linearity were observed.

Results

Total Inequality Index

Table 3 presents measurements of the total amount of inequality in mortality. The size of inequality decreases strongly with increasing age. Since the precise delimitation of age groups differs among studies, comparisons between studies cannot readily be made on the basis of Table 3. To facilitate comparisons, inequality estimates are presented in Figure 1 according to mean age at death.

At age 55 years and older, the smallest inequalities in mortality were observed for Sweden. The value of 0.36 for the oldest age group implies, according to the fitted regression equation, that death rates estimated for those at the bottom of the Swedish educational hierarchy are 36% higher than the death rates estimated for those at the top. Larger inequalities in mortality are observed for, in order of magnitude, England and Wales, Finland, the United States, and France. The total amount of inequality in France is almost four times as large as that for Sweden.

At ages below 55 years, the differences between Sweden, Finland, and France follow the same pattern but are less pronounced. The total amount of inequality in mortality is less than two times as large in France as in Sweden. The small inequality estimate for England and Wales and the very large estimate for the United States might have resulted from large chance fluctuations.

Data on inequalities in mortality below the age of 55 years were available for four additional countries. The inequality estimate for the Netherlands is considerably smaller than that for Sweden, while the estimates for Norway and Denmark are nearly identical to that for Sweden. The inequality estimates for Italy and France are equally large.

Partial Inequality Index

In Figure 2, countries are compared with respect to the partial inequality index, that is, the proportional increase in mortality associated with 1 additional year of education. Italy could not be included because of the absence of reliable data on the number of years of education.

The rank order of countries from small to large partial inequality estimates is the same as the order shown in Figure 1

for the total inequality estimate. The only exception is the United States, for which the total amount of inequality in mortality (total index) is large but the effect of 1 additional year of education (partial index) is relatively small. Among the European countries, the rank order of countries is the same for both inequality indices, but the differences in the total amount of inequality in mortality (total index) are much larger than the differences in the effect of 1 additional year of education on mortality (partial index).

As explained in the Methods section, large mortality differences related to educational level (the total index) can be attributed to a large effect of educational level on mortality (the partial index) or to large inequalities in educational levels. The results suggest that the former explanation seems not to hold for the United States and to hold only to some extent for France. This suggests that the large total amount of inequality in the United States and France is, at least in part, related to large inequalities in educational levels themselves.

To document this inference, we used a measure of inequality in educational levels that could be applied to the data for most countries: the average number of years of education of the top 20% of the population minus the average number of years of education of the bottom 80% of the population. According to this approximate measure, inequalities in education in the United States (5.75 years) and France (6.75 years) are indeed larger than those in other countries (e.g., England and Wales [3.75 years] and Sweden [4.25 years]).

TABLE 3—The Size of Mortality Differences Associated with Educational Level among Men, by Country and Age Group

Country	Total Inequality Estimate[a] (95% Confidence Interval)		
	Age 35–44 y[b]	45–54 y	55–64 y
Netherlands	0.72 (0.51, 0.95)[c]	. . .	. . .
Denmark	1.17 (1.02, 1.33)	. . .	. . .
Norway	1.02 (0.89, 1.16)[d]	. . .	. . .
Sweden	1.20 (1.02, 1.41)	0.60 (0.51, 0.69)	0.36 (0.28, 0.45)[e]
Finland	1.49 (1.32, 1.68)	0.99 (0.90, 1.08)	0.79 (0.71, 0.87)
England and Wales[f]	1.04 (0.43, 1.92)	0.75 (0.49, 1.06)	. . .
France[g]	1.97 (1.60, 2.39)	1.59 (1.31, 1.90)	1.28 (1.02, 1.56)
Italy	1.85 (1.75, 1.97)[h]	. . .	. . .
United States	2.62 (1.26, 4.78)	1.06 (0.51, 1.80)	1.05 (0.69, 1.48)

[a]The total inequality estimate represents the proportional mortality increase moving from the top to the bottom of the educational hierarchy.
[b]Age at beginning of follow-up.
[c]The men in the Dutch study were 38 years old.
[d]The men in the Norwegian study were 30 to 49 years old.
[e]The oldest age group in the Swedish study was 55 to 59 years.
[f]The age groups studied in England and Wales were approximately 10 to 40 years and 40 to 60 years.
[g]The age groups studied in France were approximately 32 to 41 years, 42 to 51 years, and 52 to 61 years.
[h]The men in the Italian study were 18 to 54 years old.

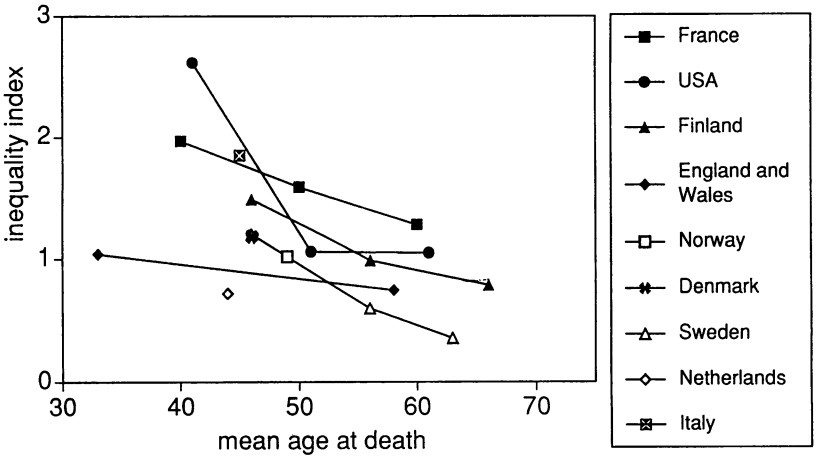

FIGURE 1—Total inequality index, by country and age group.

Evaluation of Potential Sources of Bias

Two potential sources of bias were briefly mentioned in the Methods section.

First, the educational level of subjects in the Dutch study was determined in 1950, when they were 18 or 19 years old. The level of education that an 18- or 19-year-old man had completed in 1950 was probably closely related to the educational level that he finally would achieve. However, discrepancies may exist, which implies misclassification of subjects. The most likely effect of such misclassification on inequality estimates is underestimation. Perhaps the underestimation is so large that it explains the relatively small observed inequalities for the Netherlands. We therefore feel that there is insufficient evidence to conclude that inequalities are smaller in the Netherlands than in Scandinavian countries.

Second, more than two thirds of the population of Sweden, Finland, and England and Wales was assigned to a single (the lowest) educational category. As a consequence, the relationship between mortality and educational level within a large segment of the population could not be included in the calculation of the inequality indices. Therefore, the inequality estimates are less accurate for these countries than for other countries. Perhaps, however, this problem is less serious than it seems. Recall that the relationship between mortality and educational level is approximately linear. This implies that approximately the same regression estimates would be obtained whether 4 or, say, 10 educational groups are distinguished. We found support for this expectation in additional analyses on all countries with detailed educational classifications. We reestimated inequality indices after combining the lower 80% of the population into one large educational category. Despite this substantial loss of information, the new inequality estimates

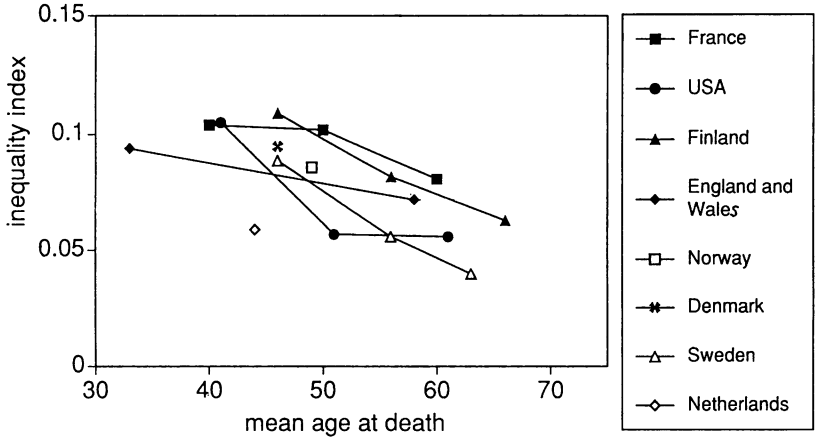

FIGURE 2—Partial inequality index, by country and age group.

were nearly the same as the estimates that were based on detailed educational classifications (less than 10% difference).

Discussion

An important question for the evaluation of socioeconomic inequalities in health is the extent to which these inequalities can be regarded as variable. This question has often been approached by time-series analysis, which has shown for various countries an increase in inequalities in mortality during the postwar period.[12,15,18–22] We chose a different approach by addressing the question, To what extent do inequalities in mortality vary across countries? Substantial cross-country differences were observed in the size of mortality differences associated with educational level. Differences are relatively small in the Netherlands, Sweden, Denmark, and Norway and about two times as large in the United States, France, and Italy. Finland and England and Wales occupy intermediate positions.

In addition, we investigated to what extent the large mortality differentials in the United States and France can be attributed to relatively large inequalities in educational levels themselves or to a large effect of educational level on mortality. We found that international variations in the size of inequalities in educational levels are most important, whereas the effect of education on mortality is approximately equally large in all countries.

The latter finding corroborates the fascinating finding of Valkonen's comparative study of England and Wales, Hungary, and the Scandinavian countries.[12] Valkonen found that in the 1970s, at ages below 50 years the relationship between education and mortality was "surprisingly similar": in each country death rates diminished by about 8% with an increase of 1 year in educational attainment. He warned, however, that this finding should not be taken as evidence of a "universal law" of health inequalities, because large cross-country differences were observed for specific causes of death and, in addition, might be observed for other time periods or other age groups. Indeed, we found that at ages older than 50 years, the effect of 1 year of additional education on mortality varied substantially among countries, with the effect in France being two times as large as that in Sweden.

We used education as the socioeconomic indicator because this indicator has been judged to be more comparable internationally than occupation.[9] Although in individual populations education and occupational status are strongly correlated,[23] the question remains whether the same international pattern of inequalities in mortality would be found if occupation were used as the socioeconomic indicator. The answer is probably affirmative: a recent study comparing seven European countries with respect to occupational mortality found virtually the same rank order of countries from small to large inequalities: (1) the Netherlands, Denmark, Norway, and Sweden; (2) England and Wales; (3) Finland; and (4) France.[24]

Cross-country comparisons provide a new opportunity to identify circumstances that are associated with large or small mortality differentials. A relevant question, therefore, is why the extent of inequalities in premature mortality varies among countries.

The first line of explanation relates to the selection hypothesis, which states that health and education are related in part because educational achievement depends on, among other things, health or health-related factors. The contribution of health selection to the generation of inequalities in adult mortality has been much disputed but is bound to be the subject of conjecture as long as lifelong longitudinal studies are not carried out.[25,26] Important for the present study is that the magnitude of health selection is likely to vary among countries as a function of educational and training structures.[26] Lahelma and Valkonen posited a more specific hypothesis: In countries where people coming from different strata have more equal access to education, the achieved educational level may depend less on social background and more on personal characteristics, including health and health-related factors. Paradoxically, then, health and education may be relatively closely related in open, competitive societies.[27] Testing this hypothesis requires detailed assessment of international variation in educational and training structures, which is outside the scope of this paper. The hypothesis may partially account for the fact that the United States, where intergenerational social mobility is larger than in nearly any other industrialized country,[28] is also one of the countries with the largest inequalities in both mortality and morbidity.

The alternative line of explanation relates to the causation hypothesis, which stresses the effect of educational level on health. The higher death rates of lower-educational-level groups are explained at least in part by a higher prevalence of risk factors for disease, such as factors related to life-styles, material living conditions, working conditions, and ways of coping with stress. A logical extension of this assertion is that international variations in the social distribution of risk factors explain, at least in part, the international variation in inequalities in mortality.

An illustration is offered by France and Italy. Leclerc et al. showed that diseases related to alcoholism and alcohol abuse accounted for a substantial part of the excess mortality of lower social classes in France, whereas their role is much more limited in Finland and in England and Wales.[1,29] Italian data suggest that to an important extent, the large mortality differences in Italy are also attributable to

excessive alcohol-related mortality among members of lower socioeconomic groups.[16]

Explanations cannot be confined to risk factors for disease, but should also consider the more distal social, economic, and cultural factors. One potentially relevant factor is welfare and income policies. Wilkinson's work is particularly relevant here.[30,31] He demonstrated that national death rates are strongly related to the extent of income inequality, and he inferred from this finding that large income inequalities are associated with large inequalities in mortality. Our study allows for a first test of this hypothesis. During the 1970s, income inequalities were relatively large in the United States, France, and Italy and approximately equally small in the other countries.[32,33] Income inequalities in Finland, still large in the 1960s, diminished rapidly during the 1970s. This rank order of countries in terms of income inequalities strongly corresponds to their rank order in terms of inequalities in mortality. Thus, our material corroborates Wilkinson's inferences. A main challenge to future international comparisons is to determine whether this association is spurious or reflects a true positive effect of egalitarian social and economic policies. □

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