Pergamon

Soc. Sci. Med. Vol. 46, No. 11, pp. 1459–1476, 1998

Printed in Great Britain
0277-9536/98 $19.00 + 0.00

PII: S0277-9536(98)00041-0

MORTALITY BY OCCUPATIONAL CLASS AMONG MEN 30–64 YEARS IN 11 EUROPEAN COUNTRIES

ANTON E. KUNST*, FEIKJE GROENHOF, JOHAN P. MACKENBACH and THE EU WORKING GROUP ON SOCIOECONOMIC INEQUALITIES IN HEALTH†

Department of Public Health, Faculty of Medicine and Health Sciences, Erasmus University, P.O. Box 1738, 3000 DR Rotterdam, The Netherlands

Abstract—This study compares eleven countries with respect to the magnitude of mortality differences by occupational class, paying particular attention to problems with the reliability and comparability of the data that are available for different countries. Nationally representative data on mortality by occupational class among men 30–64 years at death were obtained from longitudinal and cross-sectional studies. A common social class scheme was applied to most data sets. The magnitude of mortality differences was quantified by three summary indices. Three major data problems were identified and their potential effect on inequality estimates was quantified for each country individually. For men 45–59 years, the mortality rate ratio comparing manual classes to non-manual classes was about equally large for four Nordic countries, England and Wales, Ireland, Switzerland, Italy, Spain and Portugal. Relatively large ratios were only observed for France. The same applied to men 60–64 years (data for only 5 countries, including France). For men 30–44 years, there was evidence for smaller mortality differences in Italy and larger differences in Norway, Sweden and especially Finland (no data for France and Spain). Application of other summary indices to men 45–59 years showed slightly different patterns. When the population distribution over occupational classes was taken into account, relatively small differences were observed for Switzerland, Italy and Spain. When national mortality levels were taken into account, relatively large differences were observed for Finland and Ireland. For each summary index, however, France leads the international league table. Data problems were found to have the potential to bias inequality estimates, substantially especially those for Ireland, Spain and Portugal. This study underlines the similarities rather than the dissimilarities between European countries. There is no evidence that mortality differences are smaller in countries with more egalitarian socio-economic and other policies. © 1998 Elsevier Science Ltd. All rights reserved

Key words—socio-economic status, occupational class, mortality, Europe Health inequalities

INTRODUCTION

This century has witnessed an impressive increase in the life expectancy of the populations of industrialized countries (Lopez *et al.*, 1995). None the less, still large numbers of women and, especially, men die before reaching old age (WHO, 1985). In each country for which data are available, chances of premature death were found to be higher among people with a lower educational level, a lower income level or a low position in the labour market. Socio-economic differences in mortality have persisted over time and even appeared to have increased over the last decades (Dahl and Kjaersgaard, 1993a; Valkonen, 1993b; Harding, 1995; Lang and Ducimetière, 1995; Regidor *et al.*, 1995; Vågerö and Lundberg, 1995).

Several authors have addressed the question whether socio-economic differences in mortality among middle-aged men are about equally large in all countries, or whether these differences are substantially larger in some countries than in others (Kunst and Mackenbach, 1994a,b; Leclerc *et al.*, 1984, 1990; Valkonen, 1987, 1989; Leclerc, 1989; Lynge *et al.*, 1989; Vågerö and Lundberg, 1989; Minder, 1991; Wagstaff *et al.*, 1991; Leon *et al.*, 1992). Their results have generated wide interest.

*Address for correspondence.
†Members of the EU Working Group on Socioeconomic Inequalities in Health who contributed to this paper: O. Andersen, Danmarks Statistik, Copenhagen, Denmark; J.-K. Borgan, Statistics Norway, Oslo, Norway; G. Costa, Environmental Protection Agency, Piedmont Region, Italy; G. Desplanques, INSEE, Lyon, France; F. Faggiano, University of Torino, Turin, Italy; H. Filakti, Office for National Statistics, London, United Kingdom; M. do R. Giraldes, National School of Public Health, Lisbon, Portugal; S. Harding, Office for National Statistics, London, United Kingdom; C. Junker, University of Bern, Bern, Switzerland; P. Martikainen, University of Helsinki, Helsinki, Finland; C. Minder, University of Bern, Bern, Switzerland; B. Nolan, Economic and Social Research Council, Dublin, Ireland; F. Pagnanelli, National Institute of Statistics, Rome, Italy; E. Regidor, Ministry of Health, Madrid, Spain; D. Vågerö, Stockholm University, Stockholm, Sweden; T. Valkonen, University of Helsinki, Helsinki, Finland.

Mortality differences by occupational class have been found to be much larger in some European countries than in others (Vågerö and Lundberg, 1989; Leclerc *et al.*, 1990; Minder, 1991; Wagstaff *et al.*, 1991; Leon *et al.*, 1992; Kunst and Mackenbach, 1994b). For example, class differences in mortality among men 35–64 years in the 1970s appeared to be more than 3 times larger in France than in Norway (Kunst and Mackenbach, 1994b). Such a finding implies that, even though socio-economic differences in mortality are persistent in modern societies, they are highly variable. This variability has been referred to in order to argue that inequalities in health are susceptible to change through intervention (Department of Health, 1995).

Equally interesting was the observation that the smallest mortality differences by occupational class or educational level were found for Sweden, Norway, Denmark and the Netherlands, countries where income equalities were small and where egalitarian socio-economic and other policies have been pursued for many years (Vågerö and Lundberg, 1989; Wagstaff *et al.*, 1991; Leon *et al.*, 1992; Kunst and Mackenbach, 1994b). This finding supported the expectation that egalitarian socio-economic, health care and other policies are able to bring about a substantial and permanent reduction in mortality differences.

Despite the plausibility of these observations, they should be interpreted with caution. As some reviewers have noted, international comparisons can be treacherous if extensive attention is not paid to the many problems with the reliability and comparability of the data that are available for different countries (Illsley, 1990; Minder, 1991; Valkonen, 1993a; Kunst and Mackenbach, 1994c; Valkonen and Martikainen, 1997). This warning applies especially to data on mortality by occupational class. Comparative research on the basis of these data can be biased by:

— Poor comparability of the social class schemes that are available for different countries.

— The effects of excluding economically inactive men from inequality estimates and differences between countries in the size of these effects.

— The so-called numerator/denominator bias that is inherent to "unlinked" cross-sectional studies and differences between countries in the size of this bias.

A few previous comparative studies have been able to cope satisfactorily with some of these problems. For example, researchers from Sweden and Switzerland have compared their countries to England and Wales by applying the British Registrar General's social class scheme to the data available for each country (Vågerö and Lundberg, 1989; Minder, 1991; Leon *et al.*, 1992). However, no study has resolved all potential data problems or has assessed to what extent unresolved data problems could have biased the results.

The present study

The objective of the present paper is to compare Western European countries with respect to the size of mortality differences by occupational class, paying particular attention to the strength of the available evidence. This study is part of an international project on socio-economic differences in morbidity and mortality (Kunst *et al.*, 1996; Mackenbach *et al.*, 1997).

The mortality data that were acquired in this project differed in several respects from the data used in previous studies. First, whereas previous studies referred to the 1970s, these new data referred to the 1980s (either *ca.* 1980–1982 or *ca.* 1980–1989). Second, data were included for as many Western European countries as possible. Ireland was included for the first time. By also including France, Switzerland, Italy, Spain and Portugal, the southern part of Western Europe was covered as well as its northern part. Third, every effort was made to make the data that are available from the different countries as comparable as possible. For several countries, original, individual-level data on the occupation of subjects were recoded according to a standard social class scheme, the EGP scheme (Ganzeboom *et al.*, 1989; Erikson and Goldthorpe, 1992a; Bartley *et al.*, 1996).

In the analysis of these data, we addressed the following questions:

— Can mortality differences by occupational class be observed for each Western European country for which data are available?

— Are smaller mortality differences observed for some countries than for others?

— Can these variations between countries be attributed to problems with the reliability and international comparability of the data that are available for each country?

The analysis is restricted to deaths among men in the age groups of *ca.* 30–44, 45–59 and 60–64 years, respectively. Older men are excluded because most national data sets lack information on the last or longest held occupation of men retired from work. Comparisons could not be made for women because of large international differences in female labour participation rates. In addition, different countries have substantially different rules for classifying women on the basis of their activity status (gainfully employed full time, idem part time, housewife, other), their own occupation and the occupation of their (former) husbands.

DATA AND METHODS

An overview of the data sources that are used in this study is presented in Table 1. For each Western European country, we attempted to obtain data from longitudinal studies that covered (a representative sample of) the national population. Where

Table 1. Overview of sources of data

Country	Design	Period	Excluded populations	Observed no. of deaths[a]
Finland	longitudinal	1981–1990	none	39.090
Sweden	longitudinal	1980–1986	none	39.789
Norway	longitudinal	1980–1990	none	22.033
Denmark	longitudinal	1981–1990	none	34.400
England/Wales	longitudinal	1981–1989	none	2.703
Ireland	cross-sectional	1980–1982	none	6.348
France[b]	longitudinal	1980–1989	French born out of France, foreigners	15.016
Switzerland	cross-sectional	1979–1982	foreigners	13.317
Italy	longitudinal	1981–1982	institutionalized population	8.325
Spain	cross-sectional	1980–1982	military	70.524
Portugal	cross-sectional	1980–1982	military	22.581

[a]Among men 45–59 years. The numbers of deaths for England and Wales and France are small as compared to the national population because the longitudinal studies refer to samples of, respectively, 1 and 5% of the national population.
[b]Start of follow-up is the 1975 population census. The data presented in this paper refer to the 5th to 15th year of follow-up.

longitudinal data were not available, data were obtained from national cross-sectional studies. Most longitudinal studies covered the period of *ca.* 1980–1989, with the exception of Sweden (1980–1986) and Italy (1981–1982). The follow-up period of the latter study was only 0.5 years. All cross-sectional studies were centred around the national population censuses of 1980 or 1981.

Most studies covered the entire national population. The data for England and Wales and France apply to a representative sample of the national population. The only excluded subpopulation of substantial size (more than 5% of all men 30–64 years) are foreigners in France and Switzerland.

Data from different countries had to refer to the same age group in terms of age at death. The age groups 30–44 and 45–59 years were distinguished in cross-sectional studies and in longitudinal studies that classified deceased men according to their age at death. In longitudinal studies that classified men according to their age at the start of the 10-year follow-up period, the birth cohorts aged 25–39 and 40–54 years were distinguished. With a follow-period of 10 years, it was in addition possible to study class differences in dying at the age of about 60–64 years by following men aged 55–59 years at the start of follow-up.

A common social class scheme, the EGP scheme, was applied to as many countries as possible. This scheme was developed in order to facilitate international comparisons of social stratification and mobility, and is therefore particularly suited for our purposes. A commonly used collapsed version of the EGP scheme distinguishes the following 7 social classes: professionals, employers, administrators and managers (I and II), routine non-manual employees (III), all self-employed men except professionals and farmers (IVa,b), farmers (IVc), foremen and skilled manual workers (V and VI), semi- and unskilled manual workers (VIIa) and farm labourers (VIIb).

For as many countries as possible, EGP conversion algorithms were applied to individual-level data on the following aspects of the jobs that men perform: occupational title (by 3 digit code), employment status (self-employed or not) and supervisory status (e.g. number of subordinates). For Sweden, England and Wales and France, conversion algorithms were available from the CASMIN project of Erikson and Goldthorpe (1992a). For Finland, Norway and Switzerland we derived conversion algorithms from a standard schedule (the "GLT" algorithm) developed by Ganzeboom *et al.* (1989).

Conversion algorithms based on the EGP scheme could not be applied to the data that were available for Ireland, Denmark, Italy, Spain and Portugal. Mortality data were available for these countries on the basis of national social class schemes. These national schemes could only be made comparable to the EGP scheme at the level of three broad classes: non-manual classes (classes I to IVb in the EGP scheme), manual classes (V to VIIa), and farmers and farm labourers (IVc and VIIb).

In most of the mortality studies there was insufficient information on the former occupation of economically inactive men (retired, disabled, unemployed, etc). These men therefore had to be excluded from the analysis. Their exclusion is likely to lead to an underestimation of the magnitude of mortality differences between occupational classes, because economically inactive men have high mortality rates and originate predominantly from lower occupational classes (Kunst and Mackenbach, 1994c; Valkonen and Martikainen, 1997). We have developed an adjustment procedure which approximately corrects for this underestimation (see Appendix A).

Methods

The relative mortality level of men in specific occupational classes was measured by means of standardized mortality ratios (SMRs), with the national age-specific mortality rates as the standard. Several summary indices are available to express the magnitude of mortality differences by occupational class (Kunst and Mackenbach, 1994c; Mackenbach and Kunst, 1997). There is not one single measure which is clearly superior to all other measures; different measure capture different perspectives on class differences in mortality. In this paper, we present three types of measure.

The first type of measure, the *rate ratio*, compares the mortality rate of a lower occupational class to that of a higher occupational class. We will apply a commonly used distinction, that between manual classes (V to VIIa) and non-manual classes (I to IVb). A disadvantage of the manual vs non-manual distinction is that there is no general theoretical principle that states that foremen and skilled manual workers have a less advantaged position in society than routine non-manual workers or self-employed men. A clearly hierarchical distinction can however be obtained by comparing manual classes to the class of professionals, large employers, administrators and managers (I and II). We will therefore also present the rate ratio that corresponds to this distinction. Rate ratios and their 95% confidence intervals were estimated by means of Poisson regression analysis. The regression model included a term that represented the contrast between manual and (upper) non-manual classes. A series of terms representing 5-year age groups were included in the regression model in order to control for different age compositions of manual and (upper) non-manual classes.

The second type of measure, the *index of dissimilarity* (*ID*), is slightly more complex. Unlike a rate ratio, it takes into account the population distribution across occupational classes. This measure reflects the "total impact" of class differences in mortality, in the sense that it is sensitive to both the effect of lower occupational class on mortality, and the population share of different occupational classes. The larger the size of occupational classes with extreme mortality rates, the higher the ID will be. Age-adjustment was accomplished by calculating the ID from SMRs.

The third type of measure, the absolute *difference in death probabilities,* is applied in order to take into account national mortality levels. Relative measures as rate ratios are often used because of their high analytical value. They do not take into account national mortality levels. This level is relevant, however, if one wants to express the importance of class differences for the total disease burden in a country: a class difference of 10% may be judged to be a more important public health problem in countries with high national death rates than in countries with low death rates. In order to compare countries from this point of view, we also applied a measure that is sensitive to national mortality levels. Unfortunately, our data did not provide internationally comparable data of national mortality levels, due to differences between studies in the exclusion of subpopulations and length of follow-up. However, national mortality registrations with a complete coverage of every country's population could be used as an alternative source (WHO, 1985). National estimates of the probability of dying between the ages of 45 and 65 years were combined with the SMRs of manual and non-manual classes in order to estimate mortality probabilities for these two classes and their difference.

Potential data problems

We identified three major problems with the reliability and comparability of the data on mortality by occupational class that were available from different countries (Kunst *et al.*, 1996). Each problem was evaluated for the potential size of effect that it has on manual vs non-manual rate ratios. Quantitative estimates of the potential size of bias are presented in Section 3. Here we describe how we derived these estimates.

The first problem relates to the comparability of the manual vs non-manual distinctions that were made with the available social class schemes. There are differences between the EGP conversion algorithms as devised by Erikson and Goldthorpe, and the standardized GLT algorithm that we applied to Finland, Norway and Switzerland (Erikson and Goldthorpe, 1992b). However, the effect of these differences on manual vs non-manual rate ratios is likely to be small. Evaluations with data from the Swedish longitudinal study showed that the original EGP algorithm and the GLT algorithm produced nearly identical rate ratios. The manual vs non-manual rate ratio for age group 20–44 years was 1.44 with the original algorithm and 1.49 with the GLT algorithm (Kunst and Groenhof, 1996c). The values for the age group 45–59 years were 1.23 and 1.22. This suggests that rate ratios are biased by about 5% or less if the GLT approximation to the EGP conversion scheme is applied.

There is a larger potential for error when occupational classes are not defined with reference to the EGP scheme. But even then, the error cannot be very large for a rate ratio that compares all manual classes to all nonmanual classes, because these two broad classes are fairly clearly defined by the nature of the work that men perform, and small borderline movements can be expected to have relatively small effects on the mortality rates for these broad groups. We therefore estimated that the use of an occupational classification that is not based on the EGP scheme biases rate ratios by 10% or less.

The second problem relates to the exclusion of economically inactive men from the data for most countries. Their exclusion is likely to result in an underestimation of the rate ratio that compares manual and non-manual classes. We applied an adjustment procedure that approximately corrects for this underestimation (see Appendix A and Kunst and Groenhof, 1996a). Due to the approximate nature of this procedure, however, not all bias could be removed. The question is, then, how large the residual bias could be. A number of evaluations (see Appendix) made it likely that adjusted rate ratios are at least as close to the real rate ratio as the unadjusted rate ratios. This implies that after an adjustment of say 10%, the residual bias around the adjusted rate ratio is 5% or less. This bias could be in either direction. Application of this general rule yielded estimates of the potential size of bias for each country and age group.

The third problem is the so-called "numerator/denominator bias" that is inherent to unlinked cross-sectional studies (Kunst and Mackenbach, 1994c). In these studies, information on the occupation of deceased is given in death certificates whereas information on the occupation of the corresponding living population is obtained from another source such as the population census. The validity of these studies is compromised if the measurement of occupation is different in these two sources of information. In an evaluation that we reported elsewhere, estimates of manual vs non-manual rate ratios on the basis of "unlinked" studies from England and Wales and France were compared to the corresponding estimates on the basis of longitudinal studies (Kunst and Groenhof, 1996b). These evaluations suggested that the numerator/denominator can bias rate ratios by about 20% or less. This bias could be in either direction.

An additional evaluation was possible for Switzerland, thanks to a special study in which for a sample of death certificates, the occupation mentioned at the certificate was compared to the occupation of the same person as registered at the preceding population census (Beer *et al.*, 1986). On the basis of an analysis of data from this sample, we estimated that manual vs non-manual rate ratios for Switzerland are underestimated by 15% or less (Kunst and Groenhof, 1996b).

RESULTS

Table 2 shows the distribution of men by occupational class. Most similar are the population distributions observed for Sweden, Norway, Denmark, France and Switzerland. In each of these countries, *ca.* 45 to 50% of the male working population is in non-manual classes, *ca.* 40% is in manual classes and *ca.* 5 to 10% works in agriculture. The proportion of men working in agriculture increases with age. Particular to England and Wales is that a very small part of men work in agriculture and that there are more men in manual classes than nonmanual classes. In Finland, Ireland, Italy, Spain and Portugal, more than 15% of men work in agriculture. As in England and Wales, manual classes form the largest group in Finland, Spain and Portugal. The proportion of men belonging to the class of professionals, large employers, administrators and managers is given only for countries where occupational classes could be defined with reference to the EGP scheme. For men 45–59 years, this proportion ranges from *ca.* 35% in Switzerland to *ca.* 25% in France and Finland.

Table 3 presents the pattern of mortality variation by occupational class among men 30–44 years. No data were available for men 30–44 years

Table 2. Distribution of study population over 3 broad occupational classes[a]. Men, 30–44, 45–59 and 60–64 years

Country	Age group	Share (%) in total population[a]			
		non-manual classes	(of which classes I, II)[b]	manual classes	agricultural classes
Finland	30–44	39.1	(27.5)	51.5	9.4
	45–59	36.3	(24.1)	46.8	17.0
	60–64	32.8	(20.6)	42.5	24.7
Sweden	30–44	51.4	(31.8)	44.3	4.3
	45–59	52.2	(30.6)	40.3	7.5
Norway	30–44	51.5	(35.2)	42.5	5.9
	45–59	48.4	(33.2)	42.3	9.3
	60–64	44.5	(28.5)	44.0	11.5
Denmark	30–44	51.6		44.5	3.9
	45–59	52.8		37.5	9.7
	60–64	49.4		38.0	12.6
England/Wales	30–44	49.6	(32.2)	48.4	2.0
	45–59	43.4	(27.4)	53.9	2.7
	60–64	49.8	(23.5)	57.3	2.9
Ireland	30–44	45.3		38.4	16.3
	45–59	38.9		32.9	28.3
France	45–59	46.6	(25.6)	42.2	11.2
	60–64	45.1	(23.1)	37.6	17.2
Switzerland	30–44	54.1	(41.3)	39.4	6.6
	45–59	49.5	(35.8)	40.1	10.4
Italy	30–44	51.7		31.9	16.4
	45–59	48.0		29.2	22.9
Spain	45–59	30.8		47.3	21.9
Portugal	30–44	40.2		48.2	11.6
	45–59	32.9		39.4	27.7

[a]As % of the total population per age group, less men with occupation unknown.
[b]The class of professionals, employers, adiministrators and managers. Distinguished for studies to which the EGP or GLT conversion algorithms could be applied.

Table 3. Age-standardised mortality ratios of 3 broad occupational classes and the manual vs non-manual mortality rate ratio, with (without) adjustment for the exclusion of men with occupation unknown[a]. Men 30–44 years at death

Country	SMR with *(without)* adjustment			Rate ratio and 95% CI with *(without)* adjustment
	non-manual	manual	agricultural	
Finland	0.70	1.23	1.17	1.76 (1.70–1.83)
	0.74	*1.17*	*1.22*	*1.60 (1.54–1.67)*
Sweden	0.77	1.26	1.33	1.66 (1.59–1.75)
	0.82	*1.19*	*1.40*	*1.48 (1.40–1.56)*
Norway	0.77	1.27	1.11	1.65 (1.57–1.74)
	0.81	*1.21*	*1.16*	*1.49 (1.41–1.58)*
Denmark	0.82	1.25	0.70	1.53 (1.47–1.59)
	0.85	*1.21*	*0.72*	*1.43 (1.37–1.49)*
England/Wales	0.82	1.20	1.01	1.46 (1.24–1.74)
	0.84	*1.16*	*1.03*	*1.38 (1.16–1.66)*
Ireland	0.84	1.20	1.00	1.43 (1.28–1.59)
	0.87	*1.14*	*1.03*	*1.31 (1.16–1.47)*
Switzerland	0.82	1.20	1.23	1.45 (1.36–1.55)
	0.83	*1.19*	*1.24*	*1.43 (1.34–1.53)*
Italy	0.83	1.13	1.22	1.35 (1.25–1.46)
	0.88	*1.05*	*1.27*	*1.18 (1.08–1.29)*
Portugal	0.70	1.06	1.78	1.50 (1.42–1.59)
	0.73	*0.89*	*1.61*	*1.38 (1.30–1.47)*

[a]Adjusted by multiplying the observed SMRs and rate ratios with the adjustment factors discussed in Appendix A.

in Spain and France. In each country, the adjusted SMRs are lower than the national average for non-manual classes and higher than average for manual classes. The adjusted SMRs for agricultural classes are higher than average in most countries, and especially for Portugal. The manual vs non-manual rate ratios for most countries are close to 1.50. Larger rate ratios are observed for Norway, Sweden and especially for Finland. The smallest rate ratio is observed for Italy.

Comparison to the estimates given in *italic* shows to what extent the results have been modified by the adjustment for the exclusion of economically inactive men. In each country, the unadjusted rate ratio is smaller than the adjusted rate ratio. The difference is relatively large (0.15 units or more) in Finland, Sweden, Norway and Italy, where a relatively large proportion of men have their occupation unknown (see Appendix A). Note, however, that even the unadjusted rate ratios for Finland, Sweden and Norway are larger than those for other countries.

Table 4 presents the results for men in the age group 45–59 years. Also included are France and Spain. Again, in each country, the SMRs for non-manual classes are lower than the national average whereas the SMRs for manual classes are higher. The mortality rate of agricultural classes is rela-

Table 4. Age-standardised mortality ratios of 3 broad occupational classes and the manual vs non-manual mortality rate ratio, with (without) adjustment for the exclusion of men with occupation unknown[a]. Men 45–59 years at death

Country	SMR with *(without)* adjustment			Rate ratio and 95% CI with *(without)* adjustment
	non-manual	manual	agricultural	
Finland	0.79	1.20	0.92	1.53 (1.49–1.56)
	0.84	*1.13*	*0.97*	*1.36 (1.32–1.39)*
Sweden	0.86	1.20	0.79	1.41 (1.38–1.44)
	0.90	*1.14*	*0.83*	*1.26 (1.23–1.29)*
Norway	0.87	1.16	0.88	1.34 (1.30–1.39)
	0.91	*1.11*	*0.92*	*1.22 (1.18–1.27)*
Denmark	0.91	1.21	0.64	1.33 (1.30–1.36)
	0.94	*1.17*	*0.66*	*1.24 (1.21–1.27)*
England/Wales	0.81	1.18	0.78	1.44 (1.33–1.56)
	0.82	*1.16*	*0.79*	*1.40 (1.29–1.52)*
Ireland	0.91	1.26	0.82	1.38 (1.30–1.46)
	0.93	*1.23*	*0.83*	*1.32 (1.24–1.40)*
France[b]	0.76	1.30	0.90	1.71 (1.66–1.77)
	0.77	*1.28*	*0.89*	*1.65 (1.60–1.71)*
Switzerland	0.87	1.17	0.97	1.34 (1.29–1.39)
	0.88	*1.16*	*0.97*	*1.32 (1.27–1.37)*
Italy	0.89	1.18	0.93	1.35 (1.28–1.42)
	0.97	*1.06*	*0.99*	*1.10 (1.03–1.17)*
Spain	0.84	1.16	0.97	1.37 (1.34–1.39)
	0.90	*1.07*	*1.01*	*1.18 (1.15–1.20)*
Portugal	0.78	1.07	1.15	1.36 (1.31–1.40)
	0.81	*1.02*	*1.18*	*1.25 (1.20–1.29)*

[a]Adjusted by multiplying the observed SMRs and rate ratios with the adjustment factors given in Appendix A.
[b]The length of the confidence interval to the rate ratio is estimated approximately.

Table 5. Age-standardised mortality ratios of 3 broad occupational classes and the manual vs non-manual mortality rate ratio, with (without) adjustment for the exclusion of men with occupation unknown[a]. Men 60–64 years at death

Country	SMR with *(without)* adjustment			Rate ratio and 95% CI with *(without)* adjustment
	non-manual	manual	agricultural	
Finland	0.87	1.14	0.92	1.32 (1.27–1.37)
	0.94	*1.06*	*0.98*	*1.13 (1.08–1.18)*
Norway	0.90	1.15	0.82	1.28 (1.24–1.33)
	0.95	*1.09*	*0.86*	*1.15 (1.11–1.20)*
Denmark	0.95	1.15	0.69	1.21 (1.18–1.24)
	0.99	*1.11*	*0.71*	*1.12 (1.09–1.15)*
England/Wales	0.85	1.13	0.80	1.33 (1.22–1.45)
	0.86	*1.11*	*0.81*	*1.29 (1.18–1.40)*
France[b]	0.84	1.26	0.87	1.50 (1.44–1.56)
	0.86	*1.13*	*0.88*	*1.44 (1.38–1.50)*

[a]Adjusted by multiplying the observed SMRs and rate ratios with the adjustment factors discussed in Appendix A.
[b]The length of the confidence interval to the rate ratio is estimated approximately.

tively low in each country except Portugal. In most of northern Europe, agricultural classes even have a lower mortality level than nonmanual classes. The rate ratios for most countries are in a narrow range that goes from 1.35 to 1.44. Larger rate ratios are observed for Finland (1.53) and France (1.71). The confidence interval for the French rate ratio does not overlap with those for other countries. The confidence interval for the Finnish rate ratio only overlaps with that for England and Wales.

In each country, the unadjusted rate ratio is smaller than the adjusted rate ratio. The difference is relatively large (0.15 units or more) in Finland, Sweden, Italy and Spain. Without this adjustment, Sweden would have seemed to have a significantly smaller rate ratio than England and Wales, and mortality differences in Italy and Spain would have seemed to be quite small from an international perspective.

Table 5 presents the results for men in the age group 60–64 years. Data for this age groups are only available for the five countries with a longitudinal study of at least 10 years of follow-up. Also in this age group, the SMRs for both non-manual and agricultural classes are lower than national average. The SMRs for manual classes are higher. The rate ratio for Finland is larger than the one for Denmark, with Norway in-between. Unlike for younger age groups, the rate ratio for England and Wales is as large as the one for Finland. The largest rate ratio is again observed for France.

Adjustment for the exclusion of economically inactive men has greatly increased the rate ratios for the three Nordic countries. Without this adjustment, mortality differences in these countries would have seemed to be much smaller than those in England and Wales.

Alternative summary indices

Table 6 presents rate ratios in which manual classes are not compared to all non-manual classes, but only to the class of professionals, large employers, administrators or managers. This comparison is made only for countries where occupational classes could be defined with reference to the EGP scheme. Each rate ratio in Table 6 is larger than the corresponding manual vs non-manual estimate given in Tables 3–5. More importantly, the international pattern of mortality differences is the same: rate ratios for men 30–44 years are larger in the Nordic countries than in England and Wales and Switzerland, whereas rate ratios for men 45–59 and 60–64 years are relatively large for France and, to a lesser extent, Finland. Table 6 more clearly shows that the rate ratios for England and Wales are, as compared to those for most Nordic countries, relatively small for men 30–44 years and relatively large for men 60–64 years.

Figure 1 illustrates the application of the *index of dissimilarity* (ID). This is done for deaths among men 45–59 years. The international pattern observed with the ID is approximately the same as

Table 6. Mortality rate ratio comparing manual classes to the class of professionals, employers, administrators and managers. Adjusted for the exclusion of men with occupation unknown[a]. Men, 30–44, 45–59 and 60–64 years at death

Country	30–44 years	45–59 years	60–64 years
	rate ratio (95% CI)	rate ratio (95% CI)	rate ratio (95% CI)
Finland	2.02 (1.93–2.11)	1.71 (1.66–1.76)	1.41 (1.35–1.47)
Sweden	2.16 (2.03–2.29)	1.59 (1.55–1.63)	no data
Norway	1.78 (1.67–1.89)	1.47 (1.42–1.53)	1.31 (1.26–1.35)
England/Wales	1.49 (1.23–1.82)	1.61 (1.47–1.78)	1.47 (1.32–1.63)
France[b]	no data	2.15 (2.07–2.23)	1.70 (1.60–1.80)
Switzerland	1.46 (1.36–1.57)	1.37 (1.31–1.42)	no data

[a]Using the same adjustment factors as those applied to the manual vs non-manual rate ratio. Adjustment factors that were developed especially for comparison of manual classes to professionals and others had nearly the same values.
[b]The lengths of the confidence intervals are estimated approximately.

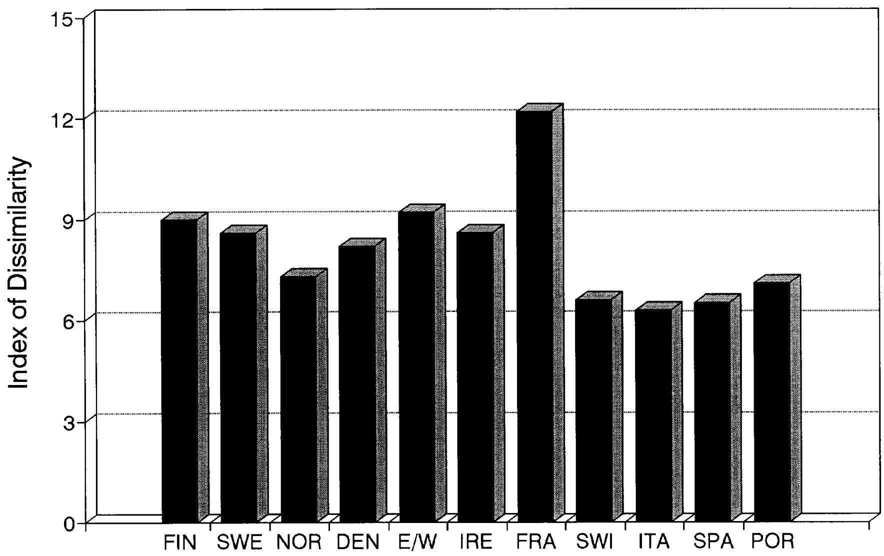

Fig. 1. The index of dissimilarity (%). Men, 45–59 years at death.

the one observed with rate ratio measures. A high ID is observed for France. The ID value for other countries is between 6 and about 9, implying that between 6 and 9% of all deaths in these countries should be redistributed in order to have the same mortality level in the three broad occupational classes. The ID is smallest in Switzerland, Italy and Spain. The class of farmers and farm labourers contributes to the small ID values for these countries, because there this class forms a substantial part of the population while its mortality level is close to the national average.

Table 7 presents an absolute measure of mortality differences. National probabilities of dying between the ages of 45 and 65 years range from about 16.5% in Sweden and Switzerland, to more than 23% in Finland and Ireland (column 1). Manual classes in Finland, Ireland and France have the highest probabilities (column 3). Manual classes in Sweden and Switzerland have lower probabilities than manual classes from other countries (column 3), and even lower probabilities than the non-manual class of Ireland (column 2). Most important for the present paper is the absolute difference between manual and non-manual classes (column 4). As with relative measures, the largest differences are observed for France. Small differences are observed in both northern and southern countries. Finland and Ireland have a more unfavourable position than they had on the basis of relative measures.

Evaluation of data problems

Table 8 presents estimates of the potential size of bias in the manual vs non-manual rate ratios that have been presented in Tables 3–5. Three major sources of systematic error are evaluated. Their potential effects on rate ratios is quantified on the basis of evaluations that are described in Section 2. The potential size of bias related to the approximate nature of social class schemes is estimated to be 5% for countries to which the GLT algorithm was applied, or 10% for countries with class schemes not based on the EGP scheme. The potential size of bias related to the "unlinked" design of

Table 7. Absolute difference between men from manual and non-manual classes in the probability of dying between the ages 45 and 65 years

Country	Probability of dying (%)			Absolute manual vs non-manual difference
	national population[a]	non-manual classes[b]	manual classes[b]	
Finland	24.0	18.9	28.8	9.8
Sweden	16.4	14.1	19.7	5.6
Norway	18.0	15.7	20.9	5.2
Denmark	21.0	19.1	25.4	6.3
England/Wales	20.3	16.5	24.0	7.5
Ireland	23.1	21.0	29.1	8.1
France	21.3	16.2	27.6	11.5
Switzerland	16.7	14.5	19.5	5.0
Italy	20.8	18.5	24.6	6.0
Spain	18.1	15.2	21.1	5.8
Portugal	21.0	16.4	22.5	6.1

[a]Calculated from national life tables presented by the WHO (1985).
[b]Estimated by multiplying national values with the class-specific SMRs (adjusted values) presented in Table 4.

Table 8. The potential size of bias related to three sources of systematic error, expressed as the possible over- or underestimation of manual vs non-manual mortality rate ratios

Country	Potential size of specific biases (in %)					Sum for 45–59 years
	approximation to EGP scheme	"unlinked" study design	exclusion of men with occupation unknown[a]			
			30–44	45–59	60–64	
Finland	5	0	5	7	9	12
Sweden	0	0	7	6	[b]	6
Norway	5	0	6	6	6	11
Denmark	10	0	4	4	4	14
England/Wales	0	0	3	2	2	2
Ireland	10	20	5	3	[b]	33
France	0	0	[b]	2	3	2
Switzerland	5	15[c]	1	1	[b]	21
Italy	10	0	8	12	[b]	22
Spain	10	20	[b]	8	[b]	38
Portugal	10	20	5	5	[b]	35

[a]Estimated as one half of the adjustment factor for the manual vs non-manual rate ratio. The adjustment factors for men 45–59 years are given in Appendix A. Quotients are rounded off upwards.
[b]No rate ratio estimates are made for these age groups.
[c]A special evaluation of the Swiss data (see text) showed that the potential error in these data is likely to be 15% or less, and in upwards direction.

cross-sectional studies is larger (15 or 20%) but confined to only four countries. The bias related to the approximate nature of our correction for exclusion of economically inactive men (see Appendix A) is likely to be modest, but it adds to the uncertainty of the rate ratios for all countries.

In the last column of Table 8, the total potential size of error is estimated as the sum over all three sources of error. This sum size of error would only occur if all specific sources of error would attain their maximum value and, in addition, happen to be in the same direction. This sum estimate is therefore likely to be an exaggeration of the real size of error. The sum value indicates that rate ratio estimates are highly certain in Sweden, England and Wales and France (potential error $<10\%$), followed by Finland, Norway and Denmark ($<15\%$). Highly uncertain are rate ratio estimates for Ireland, Spain and Portugal.

Table 9 applies the estimates of potential size of systematic error to the rate ratios given in Tables 3–5. The resulting margins of uncertainty can be used to assess the strength of the evidence for differences between countries in the size of the manual vs non-manual rate ratio. When the margins of uncertainty of two rate ratios clearly overlap, differences between these rate ratios might be wholly due to the combined effect of the three sources of systematic error that are evaluated in Table 8. If they do not overlap, or only marginally, there is strong evidence that mortality differences are larger in one country than in the other country.

For men 30–44 years, there is strong evidence that mortality differences in Finland and Sweden are larger than in England and Wales and Italy. For men 45–59, and in some cases for men 60–64 years, there is strong evidence that mortality differences in France are larger than in both Sweden, Norway, Denmark, England and Wales, Switzerland and Italy. For men 60–64 years, there is strong evidence that mortality differences in England and Wales are larger than in Denmark.

Table 9. Margin of uncertainty around manual vs non-manual mortality rate ratios. Men, 30–44, 45–59 and 60–64 years at death

Country	30–44 years		45–59 years		60–64 years	
	rate ratio[a]	margin uncert[b]	rate ratio[a]	margin uncert[b]	rate ratio[a]	margin uncert[b]
Finland	1.76	(1.58–1.94)	1.53	(1.34–1.70)	1.32	(1.20–1.44)
Sweden	1.66	(1.54–1.78)	1.41	(1.33–1.49)		[c]
Norway	1.65	(1.47–1.83)	1.34	(1.19–1.49)	1.28	(1.20–1.36)
Denmark	1.53	(1.32–1.74)	1.33	(1.14–1.52)	1.21	(1.16–1.26)
England/Wales	1.46	(1.42–1.50)	1.44	(1.41–1.47)	1.33	(1.30–1.36)
Ireland	1.43	(0.93–1.93)	1.38	(0.92–1.84)		[c]
France		[c]	1.71	(1.68–1.74)	1.50	(1.46–1.55)
Switzerland	1.45	(1.36–1.75)	1.35	(1.27–1.63)		[c]
Italy	1.35	(1.11–1.59)	1.35	(1.05–1.65)		[c]
Spain		[c]	1.37	(0.85–1.89)		[c]
Portugal	1.50	(0.98–2.03)	1.36	(0.88–1.84)		[c]

[a]The rate ratio estimates given in Tables 3–5.
[b]Margin of uncertainty. Calculated as the rate ratio plus/minus the potential size of error. This size of error is calculated as the rate ratio estimate times the sum value given in the last column of Table 8 (and divided by 100). The sum value given there refers to 45–59 years; the values for 30–44 and 60–64 can be slightly different.
[c]No rate ratio estimates are made for these age groups.

In some of these cases, however, 95% confidence intervals overlap, implying that the differences between rate ratios can be attributed to *random* error instead of *systematic* error. This applies especially to the comparisons involving England and Wales, including those with Finland and Sweden (30–44 years), Denmark (60–64 years) and France (60–64 years, but not 45–59 years).

There remain a few cross-national differences that cannot be explained by random error *or* systematic error, especially those related to France (45–64 years). Most of these cross-national differences could in principle be explained by a combined effect of both random *and* systematic error. This would only occur, however, if both types work in the same direction. In addition, it was noted that the potential effect of systematic error is probably exaggerated. Therefore, the evidence for larger mortality differences in France can be considered to be strong.

DISCUSSION

The objective of this paper was to compare European countries with respect to mortality differences by occupational class, paying particular attention to potential data problems. In comparison to previous studies, more countries were included, more recent data were used, and more efforts were made to increase the reliability and comparability of the available data.

Summary of results

In all countries, men in manual classes were found to have higher mortality rates than men in (upper) non-manual classes. This was found for men 30–44 and 45–59 years and also for men 60–64 years where data were available. The death rates of the class of farmers and farm labourers were generally lower than the national average.

For men 45–59 years, the mortality rate ratio comparing manual classes to non-manual classes was about equally large for four Nordic countries, England and Wales, Ireland, Switzerland, Italy, Spain and Portugal. Relatively large ratios were only observed for France. The same applied to men 60–64 years (data for only 5 countries, including France). For men 30–44 years, there was weak evidence for mortality differences to be larger in Finland, Sweden and Norway, and smaller in Italy (no data for France and Spain).

A summary measure that took into account the population distribution over occupational classes showed the smallest values for Switzerland, Italy and Spain. When mortality differences were expressed in absolute terms, thereby taking into account national mortality levels, Finland and Ireland were found to have a more unfavourable position. For each summary measure, however, France leads the international league table.

The rate ratios estimates were evaluated against three problems with the reliability and international comparability of the available data. This evaluation supported the observation made by previous authors, that data problems have the potential to substantially bias the comparison between countries. This applied especially to comparisons involving Spain, Portugal and Ireland. We cannot exclude the possibility that mortality differences in these countries are as large as in France. On the other hand, the available data provided strong evidence that other countries have smaller mortality differences than in France.

Re-evaluation of data problems

When evaluating the three major data problems, we have probably exaggerated their potential effect on the observed size of mortality differences. This conservative approach was motivated by the fact that there are a few other data problems that could not be evaluated quantitatively but that could have caused additional bias. In this section, we discuss these other data problems.

The first problem relates to the study period. Whereas data for most countries refer to *ca.* 1985 (1980 to 1989), the data for Ireland, Switzerland, Italy, Spain and Portugal refer to *ca.* 1981 (1980 to 1982). This 4-year difference would bias the comparison between countries if mortality differences strongly change over time. Increases in mortality differences during the 1980s have been observed for countries in both the northern and southern part of Western Europe (see Table 12 of Appendix A) (Dahl and Kjaersgaard, 1993a; Valkonen, 1993b; Harding, 1995; Lang and Ducimetière, 1995; Regidor *et al.*, 1995; Vågerö and Lundberg, 1995). As a result, slightly larger mortality differences would probably have been observed for Ireland, Switzerland, Italy, Spain and/or Portugal when data would have been available for the entire 1980s. It is unlikely, however, that mortality differences increase dramatically within a period of 4 years. Trend estimates for France and Italy that are presented in Table 12 suggest that manual vs non-manual rate ratios may have increased by about 0.10 units in 5 years. This increase is not negligible, but taking into account this increase would not alter the international position of these countries.

The second problem relates to confounding. Socio-demographic characteristics such as nationality, region of birth and place of residence can act as confounders of the association between occupational class and mortality. These variables have not been controlled for in the inequality estimates presented in this paper. One might question whether this would have substantially changed these inequality estimates. Inequality estimates for Finland have been found to be fairly insensitive to confounding by several socio-demographic characteristics (Valkonen and Martelin, 1988), but this type of evaluation has not been made for other European countries. In France, the magnitude of mortality differences strongly varies by region of residence with larger mortality differences in the north (Vallin, 1995), but uncertain is to what extent control for region would change estimates of class differences in mortality in France. In Italy, confounding by region of birth reduces the observed socio-economic mortality differences to a small extent. Preliminary calculations, for which we used data from the Turin study (Costa and Faggiano, 1995), showed that control for region of birth increases manual vs non-manual rate ratios by 0.04 points only. Socio-economic mortality differences in Sweden might to some extent be explained by the low class position and relative high mortality of Finnish immigrants.

The third problem is that foreigners are excluded from the data for Switzerland and France. The inequality estimates for these countries therefore refer to the native population only. It is uncertain how these estimates would change when the foreign population would be included in an appropriate way. Simply adding this population to the data would probably result in smaller inequality estimates, because foreigners in these countries usually have manual occupations but do not have high mortality rates (Brahmi, 1980). However, simply adding foreigners to the study population might introduce confounding by, for example, ethnic-cultural factors or health selection during international migration. If attempts would be made to control for this confounding, the adjusted inequality estimates might become either smaller or larger than the original estimates. Unfortunately, there are no Swiss or French data that can be used to make proper estimates of the size of mortality differences in the total population instead of the native population.

Evaluation of the manual vs non-manual distinction

In order to achieve as much comparability as possible, this paper relied heavily on the robust distinction between manual and non-manual classes. This raises the question whether similar results would have been obtained with other, theoretically perhaps more satisfactory, class distinctions.

One point of concern is that manual and non-manual classes overlap considerably in terms of socio-economic status. Whereas there is a clear manual vs non-manual divide in terms of social mobility patterns, the distinction is much more blurred in terms of job prestige (Treiman, 1977), educational levels and, especially, income levels (Ganzeboom *et al*., 1989; Erikson and Goldthorpe, 1992a). An occupational class that strongly contributes to this overlap are lower non-manual workers, who, according to the principles underlying the EGP scheme (Erikson and Goldthorpe, 1992a), have about the same labour market position as skilled manual workers. For this reason, several countries were also compared on the basis of summary indices from which this class was excluded (see Table 6). This exclusion resulted in larger mortality differences between manual and (upper) non-manual classes. More important to the present paper is that the relative positions of countries did not change.

A related point of concern relates to the large heterogeneity of the manual class and non-manual class. This problem is inherent to any socio-economic indicator if this indicator is used to subdivide the population into a few broad groups. More homogeneity would be obtained by further divisions within both manual and non-manual classes. For most countries included in this study, we acquired data on mortality differences at the level of a 7-class version of the EGP scheme (Kunst *et al*., 1996). Cross-national comparisons at this level could only be made, however, between France, Sweden and England and Wales (Kunst *et al*., 1996; Kunst, 1997). The results of these comparisons strongly agreed with those presented here, with mortality differences being two times as large in France as in Sweden and England and Wales. At the present state of knowledge, it is uncertain whether the relative position of other countries would also remain the same if more occupational classes were distinguished.

A more fundamental concern relates to the cross-national comparability of the manual vs non-manual distinction or any other social class scheme. Do the distinguished classes mean the same thing in each country? This issue is subject to a discussion that cannot easily be resolved. We applied to this study the EGP scheme since many sociologists have judged it to be applicable to cross-national comparisons in different fields of social science. This scheme captures a crucial feature of occupational class: the position of men on the labour market determines their command over a wide range of resources, including resources that are needed to obtain a high labour market position (e.g. education) and the rewards that accrue to those who have attained this position (e.g. income). Countries have in common this basic property of occupational class being a link between diverse kinds of resources and rewards (Ganzeboom *et al*., 1992).

The cross-national comparability of the manual vs non-manual distinction may appear to be more problematic when judged against the strength of association between occupational class and specific resources. Suppose, for example, that occupational class is strongly linked to educational level in country A and to income level in country B. In that case, no scheme would be able to satisfy the requirement that the resulting occupational classes are identical in A and B in terms of the predictive power for both educational level and income level. Note, however, that it would be highly interesting in this case to assess whether mortality differences according to occupational class are larger in country A (where class is more strongly related to education) or in country B (where class is more strongly related to income). One approach in such cases is, first, to describe socio-economic differences in the different countries by applying one standard social class scheme and, next, to assess whether cross-national variations in class differences in mortality can be related to cross-national variations in class differences in income, education or other relevant resources. This paper must be regarded as the first step in this approach.

Generalisability of the results

The use of occupational class to measure socio-economic differences in mortality raises the question whether the same results would be observed with other socio-economic indicators. Comparisons between countries with respect to mortality by income, housing tenure or other indicators of material deprivation is one alternative, but these comparisons are not possible due to problems with the availability and comparability of the necessary data. Instead, data on mortality by educational level in the 1980s were available for five countries: Finland, Norway, Denmark, France and Italy. Some results are presented in column 1 of Table 12 of Appendix A. These results and more detailed results presented elsewhere (Kunst *et al.*, 1996; Kunst, 1997), show that the relative position of countries was virtually the same for education as for occupational class. There is, however, one important exception. Whereas class differences in mortality among men 30–44 years in Italy were relatively small, differences by educational level were found to be as large as in France.

It should be born in mind that this study is restricted to deaths among men younger than 60 years or, for some countries, 65 years. The restriction to these age groups can be justified with reference to the dramatic nature of premature deaths, and the fact that mortality differences tend to be much larger below the age of 60 years than at older ages (Fox *et al.*, 1985; Lynge *et al.*, 1989; Olausson, 1991; Martelin, 1994). Nonetheless, deaths below 60 years represent only a small part of the burden of mortality in industrialised countries. The results of this study cannot be assumed to apply to ages of 60 years and over.

For women, mortality differences by occupational class were difficult to assess due to problems with the classification of housewives and other women not gainfully employed (Kunst *et al.*, 1996). It is much easier to classify women according to their educational level. For the five countries mentioned above, we observed that mortality differences by educational level among women have approximately the same pattern as for men (Kunst *et al.*, 1996).

Comparison to results of previous studies

Studies on mortality differences by occupational class in the 1970s observed larger cross-national variations than we observed for the 1980s (Vågerö and Lundberg, 1989; Leclerc *et al.*, 1990; Minder, 1991; Wagstaff *et al.*, 1991; Leon *et al.*, 1992; Kunst and Mackenbach, 1994b). The general impression of these studies was that mortality differences by occupational class were much smaller in Denmark, Sweden, and Norway than in Finland and France, with England and Wales inbetween.

The situation in the 1970s is reassessed in Table 10. Table 10 is based on unpublished data that were available to a previous study (Kunst and Mackenbach, 1994b). We reanalyzed these data according to the methods used in the present paper. The first column reproduces the results for the 1970s as they were reported before. For men 45–69 years, manual vs non-manual rate ratios were very small in Norway, Denmark and Sweden, followed by England and Wales, then by Finland, and then by France.

A main problem with these estimates is that economically inactive men are excluded from the estimates for Norway, Denmark, Sweden and France, and to a lesser extent from the estimates for

Table 10. Mortality rate ratio comparing manual classes to nonmanual classes, longitudinal results for the 1970's compared to results for the 1980's. Men, 45–59 or 45–69 years at death[a]

Country	Observed RR (95% CI)[b]		Adjusted RR	
	1970's, 45–69 years	1970's, 45–59 years	1970's[c], 45–59 years	1980's[d], 45–59 years
Norway	1.05 (1.04–1.07)	1.12 (1.09–1.15)	1.18	1.34
Denmark	1.07 (1.06–1.09)	1.18 (1.15–1.20)	1.22	1.33
Sweden	1.09 (1.08–1.10)	1.18 (1.16–1.21)	1.26	1.41
England/Wales	1.20 (1.16–1.25)	1.21 (1.13–1.30)	1.25	1.44
Finland	1.35 (1.33–1.37)	1.39 (1.36–1.43)	1.40	1.53
France	1.39 (1.33–1.46)	1.44 (1.35–1.55)	1.61	1.71

[a]Most 1970's cohorts were aged 40–54 (40–64) years at the baseline year and followed for 10 years (*ca.* 1971–1980). The French 1970's cohort was 40–59 (40–64) years at baseline and followed for 5 years (1976–1980).
[b]Calculated as in Table 4. Self-employed men (excluding farmers) are included with non-manual classes in most countries except England and Wales. Source: Kunst and Mackenbach (1994b), unpublished data.
[c]Adjusted with the formula given in Appendix A, using as input information on the population share and relative mortality of men with occupation unknown in the 1970's.
[d]Taken from Table 4.

England and Wales. As a first step to avoid this problem, rate ratios were calculated for men 45–59 years only, thereby excluding men 60–69 years, most of whom were retired. As shown in column 2, all rate ratios increase, but the increase is strongest for Norway, Denmark and Sweden. As a second step, the rate ratios for men 45–59 years were adjusted for the exclusion of inactive men. As shown in column 3, this adjustment results in much larger rate ratios for Norway, Denmark, Sweden and France.

The adjusted rate ratios can be compared to our estimates for the 1980s (summarized in column 4). This comparison suggests that the rate ratios have increased in each country, as has been observed in national trend studies. It is important to the present study to note that the relative positions of these countries have remained approximately the same. Thus, the discrepancies between the results of the present study and previous studies are in part due to the failure of previous studies to adjust for the exclusion of economically inactive men, and in part due to different selections of age groups. A high degree of correspondence is observed when restricting the analysis to men 45–59 years. This consistency over time lends further credibility to the patterns observed in the present study with relatively large socio-economic differences in mortality in Finland and, especially, France.

Explanations

The results are surprising because they do not support the expectation that mortality differences are consistently smaller in Nordic countries as compared to countries like England and Wales, Ireland and Mediterranean countries. It was expected that smaller mortality differences would have resulted from the egalitarian socio-economic policies that have been pursued since the 1930s in Sweden and, with some delay, in the other Nordic countries.

These results agree with the observation made by stratification sociologists, that occupational class membership persists as a major determinant of the life styles and living conditions of citizens of industrialised countries (Goldthorpe and Marshall, 1992; Warde, 1994). This persistence was stressed by Erikson and Goldthorpe (1992a), who observed that patterns of intergenerational mobility between occupational classes were highly stable over time and across industrialised countries. For example, Sweden was found to have only slightly higher rates of social mobility than England and France. In view of this persistence of occupational class as a determinant of one's chances in life, it is no surprise to find for each European country that occupational class remains an important determinant of one's chances of premature death as well.

This common theme can nonetheless have major variations. The present study provided strong evidence for at least one case of cross-national variation. Mortality differences in France were shown to be about two times as large as in England and Wales. This finding contrasts with the evidence of recent studies that these two countries are highly similar with respect to the size of income inequalities in the early 1980s (Atkinson *et al.*, 1995) and with respect to social mobility patterns until the 1970s (Erikson and Goldthorpe, 1992a). This suggests that additional factors should be invoked when explaining the large mortality differences in France. Causes of death related to alcohol abuse have been found to contribute much to the mortality excess of manual classes in France (Desplanques, 1984). The reasons for their higher alcohol consumption are not well understood, but it is likely that some unique socio-cultural factors (e.g. related to traditions and social values attached to wine consumption) have strengthened the links between health and disadvantage in French society.

A comparison that has already been given attention in the Black Report is that between Sweden and England and Wales (Townsend *et al.*, 1988). Previous studies concluded that mortality differences by occupational class were smaller in Sweden than in England and Wales (Vågerö and Lundberg, 1989; Minder, 1991; Kunst and Mackenbach, 1994b). However, this conclusion needs more nuance. There is evidence from the present study that the position of Nordic countries vs England and Wales varies by age, with mortality differences in Nordic countries being relatively small at ages 60–64 years, and relatively large at ages 30–44 years (Tables 6 and 9). This pattern does not contest the possibility that egalitarian socio-economic policies are associated with smaller differences in mortality. Is seems, however, that any positive effect of egalitarian policies is overshadowed in these countries by specific factors that operate at younger ages or among younger birth cohorts. There might be a relationship with external causes of death (accidents and violence), for which mortality rates among men 30–44 years are higher in most Nordic countries than in England and Wales (WHO, 1985). Perhaps the age-dependence is in part cohort-specific and a reflection of class differences in childhood living conditions in the 1940s or later.

The position of Sweden as compared to England and Wales is more favourable when class differences are expressed in absolute terms (Table 7). One might question whether small absolute differences can be considered a merit of the egalitarian socio-economic and other policies that have been pursued in Sweden for several decades. These policies would reduce class differences in mortality in absolute terms rather than relative terms, if they bring benefit to high as well as low occupational classes. This would imply that the main effect of egalitarian socio-economic and other policies would be to reduce national mortality levels. There is some but controversial evidence for an effect on national or sub-national life expectancies (Kaplan *et al.*, 1996; Wilkinson, 1996; Judge *et al.*, 1997; Regidor *et al.*, 1997). Nonetheless, it is surprising that, in relative terms, lower occupational classes do not seem to have benefitted more than higher classes.

In conclusion, available data on the magnitude of class differences in all-cause mortality cannot provide support to the suggestion of previous studies that these class differences are highly variable across Western European countries. Nor can they provide support to the suggestion that egalitarian socio-economic and other policies are able to bring about a substantial reduction in socio-economic differences in mortality. The situation in France illustrates that there are other determinants as well, some of which may have concealed a beneficial effect of egalitarian policies.

Implications

Cross-national comparisons are motivated in part by the search for countries where health inequalities are substantially smaller than elsewhere. From this study, however, there appears to be no western European country where socio-economic differences in mortality can be considered to be small from an international perspective. There is an analogue with the findings from several trend studies that mortality differences are not small from a historical perspective either (see Table 12 of Appendix A) (Dahl and Kjaersgaard, 1993a; Valkonen, 1993b; Harding, 1995; Lang and Ducimetière, 1995; Regidor *et al.*, 1995; Vågerö and Lundberg, 1995). Thus, comparisons both over time and across countries underline the persistent nature of socio-economic differences in premature mortality. This observation raises the question why socio-economic factors are able to exert their strong influence on premature mortality, despite major time-place variations in contributing causes of death and associated risk factors, as well as in the wider social, economic and cultural contexts. This question has been raised by several authors (House *et al.*, 1992; Evans *et al.*, 1994; Charlton and White, 1995; Link and Phelan, 1995; Vågerö and Illsley, 1995; Wilkinson, 1996; Kunst, 1997). It appears that a better understanding of the persistent nature of health inequalities is needed before we can appraise the role of specific factors in generating these inequalities, as well as the potential effect of interventions that are directed at these factors specifically.

Even though socio-economic differences in mortality are a common theme in all western European countries, it is a theme with variations. The variations demonstrated in this study were highly unpredictable. Probably no one would have expected that relatively large mortality differences would be observed in France and Finland rather than other countries. Similarly, there were no reasons to expect that the main difference between Sweden and England and Wales relates to the age-dependence rather than the magnitude of socio-economic differences in mortality. These unexpected observations show that we still poorly understand how the association between socio-economic factors and premature mortality is modified by the respective national contexts. Cultural as well as socio-economic conditions appear to play a role, and many of these conditions seemed to have largely escaped the attention of the health inequalities debate (Kunst, 1997). Further exploration of the role of the wider national context is not a purely academic exercise. It is essential to predict the future course of health inequalities, and perhaps to identify new ways to change their unfavourable course over the past decades.

The potential role of socio-economic policies appears as yet to be uncertain. Our study could not provide empirical support to the expectation that egalitarian socio-economic policies can contribute to reducing socio-economic inequalities in health. This observation needs not bring into doubt the fact that socio-economic policies can make a contribution. The questions to be addressed in future research are, instead, whether these effects can be expected to be substantial and which of the several alternative social and economic policies are most effective in addressing the health of disadvantaged population groups. The wide variety in socio-economic policies in different European countries (Esping Andersen, 1990) provide several "natural experiments" that might be explored in more focused studies. A major challenge to these studies is to take into account the several other factors that may act as confounders or effect modifiers in the association between socio-economic policies and socio-economic inequalities in health. This task is by no means simple. There are possible approaches, however, to face this task. It may be particularly informative to study secular trends in health inequalities both countries with drastic changes in socio-economic policies and in countries with more stable development. In addition, future studies may include income or other socio-economic indicators that are perhaps more sensitive to egalitarian socio-economic policies (Kunst *et al.*, 1996; van Doorslaer *et al.*, 1997) and analyze key causes of death and their associated risk factors (Cavelaars *et al.*, 1997; Kunst *et al.*, 1998).

Acknowledgements—This study was supported by a grant from the European Union's Biomed-1 program (CT92-1068). The design of this study, the specifications of the data and the interpretation of the preliminary results were discussed during three workshops (Rotterdam 1993, Rotterdam 1994, Rome 1995). In addition to the authors of this paper, the following persons contributed to the discussions: J. van den Berg, J. T. P. Bonte and J. J. M. Geurts (Netherlands), J. Matheson and R. Wilkinson (United Kingdom), E. Lahelma and A.-P. Sihvonen (Finland), O. Lundberg (Sweden), L. Grödvedt (Norway), N. Moss and N. Rasmussen (Denmark), A. Ritsatakis (WHO Europe, Denmark), K. Gärtner, U. Helmert, K.

Martin and A. Mielck (Germany), Th. Krebs and Th. Spuhler (Switzerland), J. Holub and J. Votinsky (Czech Republic), Ar. Mizrahi and A. Mizrahi (France), R. Crialesi (Italy), A. Karokis, A. E. Philalithis and J. Yfantopoulos (Greece), J.-M. Berthelot and R. Wilkins (Canada) and P. Ellen Parsons (United States). The central statistical offices of all participating countries gave permission for the use of unpublished data from national mortality registries. Harry Ganzeboom, John Goldthorpe, and Robert Erikson have helped us to apply the EGP social class scheme to national mortality data sets.

REFERENCES

Atkinson, A. B., Rainwater, L. and Smeeding, T. M. (1995) *Income Distribution in OECD Countries*. OECD, Paris.

Bartley, M., Carpenter, L., Dunnell, K. and Fitzpatrick, R. (1996) Measuring inequalities in health: An analysis of mortality patterns using two social classifications. *Sociol. Health Illness* **18,** 455–475.

Beer, V., Greusing, Th. and Minder, Ch. E. (1986) Berufsbezogene sozio-ökonomische Gruppen für die Schweiz: Sozialwissenschaftliche Grundlagen und Üntersuchungen zur Validität. *Sozial- und Präventivmedizin* **31,** 274–280.

Brahmi, M. (1980) La mortalité des étrangers en France. *Population* **3,** 603–622.

Cavelaars, A. E. J. M., Kunst, A. E. and Mackenbach, J. P. (1997) Socio-economic inequalities in risk factors of morbidity and mortality in the European Community: An international comparison. *J. Health Psychology* **2,** 353–372.

Charlton, B. G. and White, M. (1995) Living on the margin: A salutogenic model for socio-economic differentials in health. *Public Health* **109,** 235–243.

Costa, G. and Faggiano, F. (1995) *Socio-economic Inequalities in Health in Italy. Turin Longitudinal Study*. Department of Public Health, University of Turin, Italy.

Dahl, E. and Kjaersgaard, P. (1993a) Trends in socioeconomic mortality differentials in post-war Norway: Evidence and interpretations. *Sociol. Health Illness* **15,** 587–611.

Dahl, E. and Kjaersgaard, P. (1993b) Social mobility and inequality in mortality. *Eur. J. Public Health* **3,** 124–132.

Department of Health (1995) *Variations in Health. What can the Department of Health and the NHS do*? Department of Health, London.

Desplanques, G. (1984) *La mortalité des adults: Résultats de 2 etudes longitudinales (période 1955–1980)*. INSEE, Paris.

van Doorslaer, E., Wagstaff, A. and Bleichrodt, H. *et al.* (1997) Income-related inequalities in health: Some international comparisons. *J. Health Economics* **16,** 93–112.

Erikson, R. and Goldthorpe, J. H. (1992a) *The Constant Flux*. Clarendon Press, Oxford.

Erikson, R. and Goldthorpe, J. H. (1992b) Comment on Sφrensen's "Rejoinder". *Eur. Sociol. Rev.* **8,** 311–312.

Esping Andersen, G. (1990) *Three Worlds of Welfare Capitalism*. Polity Press, Oxford.

Evans, R. G., Hodge, M. and Pless, I. B. (1994) If not genetics, then what? Biological pathways and population health. In *Why are Some People Healthy and Others Not*?, eds. R. G. Evans, M. L. Barer and T. R. Marmor, pp. 161–188. Aldin de Gruytere, New York.

Fox, A. J., Goldblatt, P. O. and Jones, D. R. (1985) Social class mortality differentials: Artefact, selection or life circumstances? *J. Epidemiol. Community Health* **39,** 1–8.

Ganzeboom, H. B. G., Luijkx, R. and Treiman, D. J. (1989) Intergenerational class mobility in comparative perspective. *Res. Social Stratif. Mobility* **8,** 3–84.

Ganzeboom, H. B. G., de Graaf, P. M. and Treiman, D. J. (1992) A standard international socio-economic index of occupational status. *Social Science Research* **21,** 1–56.

Goldblatt, P. (1989) Mortality by social class, 1971–1985. *Population Trends* **56,** 6–15.

Goldblatt, P., Fox, J. and Leon, D. (1991) Mortality of employed men and women. *Am. J. Industrial Med.* **20,** 285–306.

Goldthorpe, J. and Marshall, G. (1992) The promising future of class analysis: A response to recent critiques. *Sociology* **26,** 381–400.

Harding, S. (1995) Social class differences in mortality of men: Recent evidence from the OPCS Longitudinal Study. *Population Tremds* **80,** 31–37.

House, J. S., Kessler, R. C., Herzog, A. R. *et al.* (1992) Social stratification, age and health. In *Aging, Health Behaviors and Health Outcomes*, eds. K., Warner Schaie, D. Blazer and J. S. House, pp. 1.32. Lawrence Erlbaum Associates, Hillsdale, New Yersey.

Illsley, R. (1990) Comparative review of sources, methodology and knowledge. *Social Science and Medicine* **31,** 229–236.

Judge, K., Mulligan, J. and Benzeval, M. (1997) Income inequality and population health. *Social Science and Medicine* **46,** 567–579.

Kaplan, G. A., Pamuk, E. R., Lynch, J. W., Cohen, R. D. and Balfour, J. L. (1996) Inequality in income and mortality in the United States: Analysis of mortality and potential pathways. *Br. Med. J.* **312,** 999–1003.

Kunst, A. E. and Mackenbach, J. P. (1994a) The size of mortality differences associated with educational level in nine industrialized countries. *Am. J. of Public Hlth.* **84,** 932–937.

Kunst, A. E. and Mackenbach, J. P. (1994b) International variation in the size of mortality differences associated with occupational status. *Int. J. Epidemiol.* **23,** 742–750.

Kunst, A. E. and Mackenbach, J. P. (1994c) *Measuring Socio-economic Inequalities in Health*. World Health Organization, Copenhagen.

Kunst, A. E., Cavelaars, A. E. J. M., Groenhof, F., Geurts, J. J. M., Mackenbach, J. P. and EU Working Group on Socio-economic Inequalities in Health (1996) *Socio-economic Inequalities in Morbidity and Mortality in Europe: A Comparative Study*. Erasmus University, Rotterdam.

Kunst, A. E. and Groenhof, F. (1996a). Mortality differences by educational level and occupational class: The effect of excluding economically inactive men. In *Socio-economic Inequalities in Morbidity and Mortality in Europe: A Comparative Study*, eds. A. E. Kunst *et al.*, Vol. 2: Working documents, pp. 99–146. Erasmus University, Rotterdam.

Kunst, A. E. and Groenhof, F. (1996b). Potential sources of bias in "unlinked" cross-sectional studies. In *Socio-economic Inequalities in Morbidity and Mortality in Europe: A Comparative Study*, eds. A. E. Kunst *et al.*, Vol. 2: Working documents, pp. 147–162. Erasmus University, Rotterdam.

Kunst, A. E. and Groenhof, F. (1996c). *Comparison of two Conversion Algorithms for the EGP Social Class Scheme: Application to Mortality in Sweden, 1980–1986*. Erasmus University, Rotterdam.

Kunst, A. E. (1997). Cross-national comparisons of socio-economic differences in mortality. Thesis, Erasmus University, Rotterdam.

Kunst, A. E., Groenhof, F. Mackenbach, J. P. and the EU Working Group on Socio-Economic Inequalities in Health (1998) Occupational class and cause-specific mortality among middle-aged men in 11 European

countries: Comparison of population-based studies. *Br. Med. J.*, in press.
Lang, T. and Ducimetière, P. (1995) Premature cardiovascular mortality in France: Divergent evolution between social categories from 1970 to 1990. *Int. J. Epidemiol.* **24,** 331–339.
Leclerc, A., Lert, F. and Goldberg, M. (1984) Les inegalites sociales devant la mort en Grande-Bretagne et en France. *Social Science and Medicine* **19,** 479–487.
Leclerc, A. (1989) Differential mortality by cause of death: Comparison between selected European countries. In *Health Inequalities in European Countries*, ed. A. J. Fox, pp. 92–108. Gower Publishing Company Limited, Aldershot, U.K.
Leclerc, A., Lert, F. and Fabien, C. (1990) Differential mortality: Some comparisons between England and Wales, Finland and France, based on inequalities measures. *Int. J. Epidemiol.* **19,** 1001–1010.
Leon, D., Vågerö, D. and Olausson, P. O. (1992) Social class differences in infant mortality in Sweden: A comparison with England and Wales. *Br. Med. J.* **305,** 687–691.
Link, B. G. and Phelan, J. (1995). Social conditions as fundamental causes of disease. *J. Health Social Behavior*, 80–94 (extra issue).
Lopez, A. D., Casselli, G. and Valkonen, T. (eds.) (1995) *Adult Mortality in Developed Countries: From Description to Explanation*. Clarendon Press, Oxford.
Lynge, E., Andersen, O. and Horte, L. G. (1989) Mortality: A comparison of within-country differentials based on selected occupational groups reported in a variety of countries. In *Health Inequalities in European Countries*, ed. A. J. Fox, pp. 163–172. Gower Publishing Company Limited, Aldershot, U.K.
Mackenbach, J. P. and Kunst, A. E. (1997) Measuring the magnitude of socio-economic inequalities in health: An overview of available measures illustrated with two examples from Europe. *Social Science and Medicine* **44,** 757–771.
EU Working Group on Socio-Economic Inequalities in Health Mackenbach, J. P., Kunst, A. E., Cavelaars, A. E. J. M., Groenhof, F. and Geurts, J. J. M. (1997) Socio-economic inequalities in morbidity and mortality in western Europe: A comparative study. *Lancet* **349,** 1655–1659.
Martelin, T. (1994) Mortality by indicators of socioeconomic status among the Finnish elderly. *Social Science and Medicine* **38,** 1257–1278.
Minder, Ch. E. (1991) A conceptual and methodological discussion of transnational comparisons of socio-economic mortality differences and an example. In *Proceedings of the 5th meeting of the UN/WHO/CICRED Network on socio-economic differential mortality in industrialized countries*, pp. 278–294. CICRED, Paris.
Olausson, P. O. (1991) Mortality among the elderly in Sweden by social class. *Social Science and Medicine* **32,** 437–440.
Regidor, E., Gutiérrez-Fisac, J. L. and Rodríquez, C. (1995) Increased socioeconomic differences in mortality in eight Spanish provinces. *Social Science and Medicine* **41,** 801–807.
Regidor, E., Navarro, P., Dominguez, V. and Rodriguez, C. (1997) Inequalities in income and long term disability in Spain: Analysis of recent hypotheses using cross-sectional study based on individual data. *British Medical J.* **315,** 1130–1135.
Townsend, P., Davidson, N., and Whitehead, M. (1988) *Inequalities in Health (The Black Report and The Health Divide)*. Penguin Books, London.
Treiman, D. J. (1977) *Occupational Prestige in Comparative Perspective*. Academic Press, New York.
Vågerö, D. and Illsley, R. (1995) Explaining health inequalities: Beyond Black and Barker. A discussion of some issues emerging in the decade following the Black Report. *European Sociology Review* **11,** 1–23.
Vågerö, D. and Lundberg, O. (1989) Health inequalities in Britain and Sweden. *Lancet* **2,** 35–36.
Vågerö, D. and Lundberg, O. (1995) Socio-economic mortality differentials among adults in Sweden. In *Adult Mortality in Developed Countries: From Description to Explanation*, eds. A. D. Lopez, G. Casselli and T. Valkonen, pp. 223–242. Clarendon Press, Oxford.
Valkonen, T. (1987) Social inequality in the face of death. In *Proceedings of the plenaries of the European Population Conference 1987*, pp. 201–261. Central Statistical Office of Finland, Helsinki.
Valkonen, T. and Martelin, T. (1988) *Occupational Class and Suicide: An Example of the Elaboration of a Relationship*. Department of Sociology, University of Helsinki, Finland.
Valkonen, T. (1989) Adult mortality and level of education: A comparison of six countries. In *Health Inequalities in European Countries*, ed. A. J. Fox, pp. 142–162. Gower Publishing Company Limited, Aldershot, U.K.
Valkonen, T., Martelin, T. and Rimpelä, A. (1990) *Eriarvoisuus kuoleman edessä. Sosio-ekonomiset kuolleisusserot Suomessa.* Central Statistical Office of Finland, Helsinki.
Valkonen, T. (1993a) Problems in the measurement and international comparisons of socio-economic differences in mortality. *Social Science and Medicine* **36,** 409–418.
Valkonen, T. (1993b) Trends in regional and socio economic mortality differentials in Finland. *Int. J. Health Sci.* **3,** 157–166.
Valkonen, T. and Martikainen, P. (1997) Problems of comparability resulting from the exclusion of economically inactive persons in studies of social class differences in mortality. In *Proceedings of the EAPS Workshop on Morbidity and Mortality Data: Problems of Comparability*, eds. A. Hancioglу and G. Wunsch. Ankara.
Vallin, J. (1995) Can sex differentials in mortality be explained by socio-economic mortality differentials? In *Adult Mortality in Developed Countries: From Description to Explanation*, eds. A. D. Lopez, G. Casselli and T. Valkonen, pp. 179–200. Clarendon Press, Oxford.
Wagstaff, A., Paci, P. and van Doorslaer, E. (1991) On the measurement of inequalities in health. *Social Science and Medicine* **33,** 545–557.
Warde, A. (1994) *Cultural change and class differentiation: Distinction and taste in the British middle classes, 1968–1988*. Paper presented to the XIIIth World Congress of Sociology, Bielefeld, July 1994.
Wilkinson, R. G. (1996) *Unhealthy Societies: The Afflictions of Inequality*. Routledge, London.
World Health Organisation (1985) *World Health Statistics Annual*. WHO, Geneva.

APPENDIX A

A Rule For Adjusting Estimates Of The Magnitude Of Mortality Differences By Occupational Class For The Effect Of Excluding Economically Inactive Persons

In many studies, the last occupation of economically inactive men is unknown and these men therefore have to be excluded from the calculation of mortality rates by occupational class. Since economically inactive men have higher-than-average mortality rates, their exclusion results in an underestimation of mortality rates of working populations (the "healthy worker effect", Goldblatt *et al.*, 1991). Since, in addition, economically inactive men originate predominantly from lower working classes, their exclusion is likely to result in an underestimation of mortality differences by occupational class. This appendix presents a rule that we have developed in order to be able to adjust for this underestimation. In a working document given elsewhere (Kunst and Groenhof, 1996b), we describe in detail the development and application of this rule, and a number of tests that we made to assess its performance. This document is summarized in this appendix.

The observed mortality rates ($\text{rate}_{\text{class } \boldsymbol{x}}^{\text{active members}}$) need to be increased by a specific factor in order to approach the mortality rates that would have been observed when inactive men were included in the analysis ($\text{rate}_{\text{class } \boldsymbol{x}}^{\text{all members}}$). This adjustment factor equals to:

$$\text{rate}_x^{\text{all}}/\text{rate}_x^{\text{active}} = ((P_x^{\text{active}}*\text{rate}_x^{\text{active}}) + (P_x^{\text{inactive}}*\text{rate}_x^{\text{inactive}}))/\text{rate}_x^{\text{active}} \quad \text{(A1)}$$

where $\boldsymbol{P}_{\boldsymbol{x}}^{\text{active}}$ and $\boldsymbol{P}_{\boldsymbol{x}}^{\text{inactive}}$ represent the proportion of all person-years lived in class $\boldsymbol{x}$ that is lived by those who are, respectively, economically active and economically inactive. Dividing numerator and denominator by $\text{rate}_{\boldsymbol{x}}^{\text{active}}$ and substituting $\boldsymbol{P}_{\boldsymbol{x}}^{\text{active}}$ by $(1 - \boldsymbol{P}_{\boldsymbol{x}}^{\text{inactive}})$ yields:

$$= 1 + P_x^{\text{inactive}}*(\text{RR}_x^{\text{inactive/active}} - 1) \quad \text{(A2)}$$

where $\text{RR}_{\boldsymbol{x}}^{\text{inactive/active}}$ represents the following mortality rate ratio: $\text{rate}_{\boldsymbol{x}}^{\text{inactive}}/\text{rate}_{\boldsymbol{x}}^{\text{active}}$.

Thus, an adjustment factor can be calculated if estimates are available for the values of two parameters: $\boldsymbol{P}_{\boldsymbol{x}}^{\text{inactive}}$ the share of economically inactive men in all person-years lived in class $\boldsymbol{x}$; and $\text{RR}_{\boldsymbol{x}}^{\text{inactive/active}}$ the mortality rate ratio comparing inactive men of class $\boldsymbol{x}$ to active men of class $\boldsymbol{x}$.

These class-specific values are not available in most mortality data sets, but could be approximated with reference to the known values for the total population. Two assumptions have to be made.

First, we assumed that $\boldsymbol{P}_{\boldsymbol{x}}^{\text{inactive}} = \text{constant}_{\boldsymbol{x}}*\boldsymbol{P}_{\text{all classes}}^{\text{inactive}}$. This assumption states that the proportion of men in occupational class $\boldsymbol{x}$ that are economically inactive is equal to some constant times the national average. Approximate estimates of these constants could be derived from survey data that were available from each country (Kunst and Groenhof, 1996a). For most countries, the value for manual classes was close to 1.40, with a standard deviation of about 0.10 units. The average values for non-manual and agricultural classes were 0.70 and 0.80, respectively. The available evidence suggested that the values for the Nordic countries are less extreme and that a better approximation to the constants for manual and non-manual classes in these countries is 1.25 and 0.75.

Second, we assumed that $\text{RR}_{\boldsymbol{x}}^{\text{inactive/active}} = \text{RR}_{\text{all classes}}^{\text{inactive/active}}$. This assumption states that there is no interaction between occupational class and activity status in their relationship to mortality. Data on the magnitude of this interaction were available from published studies from England and Wales, Norway and Finland (Goldblatt, 1989; Valkonen *et al.*, 1990; Dahl and Kjaersgaard, 1993b). In each study, $\text{RR}^{\text{inactive/active}}$ values were found to be fairly constant between occupational classes. For example, in the OPCS Longitudinal study for 1981–1985, the RR values were 1.98, 2.01, 2.09 and 2.09 for, respectively, Registrar-General class I and II, class IIIN, class IIIM and class IV and V. Approximately constant RR values were also observed in our own data on Finland, Norway, France and Italy when educational levels instead of occupational classes were compared.

With these two assumptions, Equation (A2) can be used to estimate the extent to which the observed mortality rates for a specific economically active population should be adjusted in order to obtain an estimate of their "true" mortality rate. The adjustment factors were equal to:

$$1 + P_{\text{all}}^{\text{inactive}}*(\text{RR}_{\text{all}}^{\text{inactive/active}} - 1)$$
for all economically active persons (A3a)

$$1 + 1.4*P_{\text{all}}^{\text{inactive}}*(\text{RR}_{\text{all}}^{\text{inactive/active}} - 1)$$
for manual classes (A3b)

$$1 + 0.7*P_{\text{all}}^{\text{inactive}}*(\text{RR}_{\text{all}}^{\text{inactive/active}} - 1)$$
for non-manual classes (A3c)

$$1 + 0.8*P_{\text{all}}^{\text{inactive}}*(\text{RR}_{\text{all}}^{\text{inactive/active}} - 1)$$
for agricultural classes (A3d)

with $\boldsymbol{P}_{\text{all}}^{\text{inactive}}$ the share of the economically inactive population in the number of person-years lived in the total population, and $\text{RR}_{\text{all}}^{\text{inactive/active}}$ the inactive/active mortality rate ratio observed for the total population. For the Nordic countries, the value 1.4 in Equation (A3b) is replaced by 1.25, and 0.7 in Equation (A3c) is replaced by 0.75. Dividing the adjustment factor for a specific occupational class (Equations (A3b)–(A3d)) by the adjustment for all active men, Equation (A3a), yields the adjustment factor for the SMR of that occupational class. Dividing the adjustment factor for manual classes, Equation (A3b), by the adjustment factor for non-manual classes, Equation (A3c), yields the adjustment factor for the manual vs non-manual mortality rate ratio.

Table 11 presents the adjustment factors that were calculated for men 45–59 years in the 11 mortality studies. Adjustment factors are small for England and Wales, France and Switzerland. In these countries, information on occupational class is lacking for only a minor part of the study population thanks to, among other factors, the use of information on previously held occupations. The adjustment factor for Italy is relatively high because of the high mortality rates of inactive men. These high rates are related to the short follow-up period of the Italian longitudinal study [during which the high mortality rates of initially inactive men do not yet wear off (Goldblatt *et al.*, 1991)].

In several tests, we evaluated the performance of adjustment factors that are calculated by means of Equations (A3a)–(A3d) (Kunst and Groenhof, 1996a). Table 12 summarizes the results of some of these tests. For studies from 4 countries, estimates are presented of the size of mortality differences by educational level and by occupational class. In each study, the measure of educational level (elementary and lower secondary vs higher) and occupational status (manual vs non-manual) are strongly correlated. Therefore, a high correspondence in their rate ratios, and their trends over time, might be expected.

Column 1 shows the size of mortality differences by educational level as observed for the total population. The moderate increase in rate ratios over time is in agreement with the results of Finnish and French studies on trends in mortality differences during the 1980's (Valkonen, 1993b; Lang and Ducimetière, 1995). Exclusion of inactive men (column 2) substantially reduces the rate ratios. This reduction is largest during the first 5 years of follow-up, thereby creating the impression that mortality differences have dramatically increased during the study period. Application of adjustment factors (column 3) consistently brings the biased rate ratios closer to the values given in column 1 for the total population.

Column 4 shows estimates of the size of mortality differences by occupational class, with exclusion of economically inactive men. The rate ratios are as low as the

Table 11. Factors for adjusting class-specific standardised mortality ratios (SMRs) and manual vs non-manual rate ratios for the exclusion of (part of) the economically inactive men. Men 45–59 years at death, 11 European countries

Country	Follow-up period (years)	Input parameters		Adjustment factor[a]		
		% of person-years at risk lived by excluded men	mortality RR of excluded inactive men vs other men	SMR non-manual	SMR manual	rate ratio[b]
Finland	0–9	14.2	3.15	−5.9	5.9	12.4
Sweden	0–6	12.3	3.31	−5.5	5.5	11.7
Norway	0–9	18.6	2.27	−4.8	4.8	10.0
Denmark	0–9	6.6	3.45	−3.5	3.5	7.2
England/Wales	0–8	5.6	1.78	−1.2	1.7	3.0
Ireland	[b]	7.2	1.96	−1.9	2.6	4.6
France	5–14	2.6	3.23	−1.6	2.2	3.9
Switzerland	[b]	5.1	1.33	−0.5	0.7	1.2
Italy	0–0.5	10.6	4.86	−8.7	11.6	22.3
Spain	[b]	13.2	3.05	−6.4	8.5	15.9
Portugal	[b]	17.3	1.78	−3.6	4.8	8.7

[a]Represents the % by which the class-specific SMRs and the RR should be decreased (−) or increased (+) in order to approach the SMRs and RR that would have been observed when all inactive men would have been included.
[b]Cross-sectional study.

Table 12. The effect of excluding economically inactive men on low vs high mortality rate ratios, and the accuracy of the adjustment procedure. Four longitudinal studies with 2 follow-up periods (*ca.* 1981–1985 and 1986–1990) or 3 periods (1976–1980, 1981–1985 and 1986–1990). Men 50–59 years at the start of each subperiod

Country	Follow-up period (years)	Low vs high education			Manual vs non-manual	
		all men	excluding inactive men	idem, adjusted[a]	excluding inactive men	idem, adjusted[b]
Finland	0–4	1.42	1.21	1.47	1.18	1.41
	5–9	1.52	1.34	1.53	1.39	1.56
Norway	0–4	1.31	1.15	1.32	1.13	1.28
	5–9	1.37	1.27	1.39	1.23	1.33
France	0–4	1.51	1.29	1.42	1.32	1.49
	5–9	1.54	1.48	1.55	1.42	1.51
	10–14	1.75	1.72	1.78	1.64	1.71
Italy (Turin)	0–4	1.21	1.02	1.16	0.98	1.16
	5–8	1.33	1.24	1.32	1.18	1.28

[a]By adjustment, Equations (3a)–(d) with $P_{\text{all}}^{\text{inactive}}$ and $\text{RR}_{\text{all}}^{\text{inactive/active}}$ measured for each subperiod separately. As constants are assumed 1.2 and 0.6 for low and high education, respectively. These constants are assumed on the basis of the observation that, in each of the 4 studies, the proportion of inactive men is 2 times as large in lower than in higher educational groups.
[b]By adjustment, Equations (3b)–(c) with $P_{\text{all}}^{\text{inactive}}$ and $\text{RR}_{\text{all}}^{\text{inactive/active}}$ measured for each follow–up period separately.

those given in column 2 for education (active men only), with again an increase over time that is unlikely strong. Application of the adjustment factor (column 5) results in a close correspondence to the rate ratios given in column 1 for education (for all men), with the same moderate increase over time.

This test, together with other tests we made, strongly suggested that by applying the correction rule, observed inequality estimates (made while excluding a part of economically inactive men) are brought closer to the real inequalities estimates (made while including all men). The residual bias is likely to be small.