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Trends in Socioeconomic Disparities in Stroke Mortality in Six European Countries between 1981–1985 and 1991–1995

M. Avendaño[1,2], A. E. Kunst[1], F. van Lenthe[1], V. Bos[1], G. Costa[3], T. Valkonen[4], M. Cardano[5], S. Harding[6], J-K. Borgan[7], M. Glickman[6], A. Reid[6], and J. P. Mackenbach[1]

[1] Department of Public Health, Erasmus University Medical Center, Rotterdam, the Netherlands.
[2] National Institute of Public Health and the Environment, Bilthoven, the Netherlands.
[3] Department of Public Health and Microbiology, Turin University, Turin, Italy.
[4] Department of Sociology, University of Helsinki, Helsinki, Finland.
[5] Department of Social Sciences, Turin University, Turin, Italy.
[6] Medical Statistics, Office for National Statistics, London, United Kingdom.
[7] Division for Health Statistics, Statistics Norway, Oslo, Norway.

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This study assesses whether stroke mortality trends have been less favorable among lower than among higher socioeconomic groups. Longitudinal data on mortality by socioeconomic status were obtained for Finland, Norway, Denmark, Sweden, England/Wales, and Turin, Italy. Data covered the entire population or a representative sample. Stroke mortality rates were calculated for the period 1981–1995. Changes in stroke mortality rate ratios were analyzed using Poisson regression and compared with rate ratios in ischemic heat disease mortality. Trends in stroke mortality were generally as favorable among lower as among higher socioeconomic groups, such that socioeconomic disparities in stroke mortality persisted and remained of a similar magnitude in the 1990s as in the 1980s. In Norway, however, occupational disparities in stroke mortality significantly widened, and a nonsignificant increase was observed in some countries. In contrast, disparities in ischemic heart disease mortality widened throughout this period in most populations. Improvements in hypertension prevalence and treatment may have contributed to similar stroke mortality declines in all socioeconomic groups in most countries. Socioeconomic disparities in stroke mortality generally persisted and may have widened in some populations, which fact underlines the need to improve preventive and secondary care for stroke among the lower socioeconomic groups.

cerebrovascular accident; Europe; mortality; social class

Abbreviations: ICD-9, *International Classification of Diseases*, Ninth Revision (ICD-8 and ICD-10 defined analogously).

Higher stroke mortality rates have been observed among lower as compared with higher socioeconomic groups across Europe (1, 2). However, no study has explored how these disparities developed or examined trends in socioeconomic differences in stroke mortality. A less favorable relative decline in cardiovascular disease mortality has been observed among lower than among higher socioeconomic groups (3–10). However, trends in the two main cardiovascular diseases, stroke and ischemic heart disease, differ substantially within and between populations (9, 11, 12), as does their association with socioeconomic status (1, 3, 13, 14).

During recent decades, European countries have experienced changes in the prevalence of classical cardiovascular risk factors such as smoking and hypertension (15, 16). Variations between countries exist in these trends (17, 18), and socioeconomic differences in some of these factors have recently widened (19, 20). Similarly, changes in health-care policies for stroke have occurred across Europe (21, 22). International studies on trends may point at specific policies and risk factors that may have had an impact on socioeco-

Correspondence to Mauricio Avendaño, Department of Public Health, Erasmus University Medical Center, P.O. Box 1738, Rotterdam 3000 DR, the Netherlands (e-mail: m.avendanopabon@erasmusmc.nl).

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nomic differences in stroke mortality. This may elucidate ways through which socioeconomic disparities can be reduced in order to sustain the stroke mortality decline in European countries.

The aim of this paper is to assess whether there is a common tendency among lower socioeconomic groups to experience less favorable trends in stroke mortality than do higher socioeconomic groups in European countries. This is the first longitudinal study of trends in stroke mortality according to socioeconomic status across Europe. Previous research has focused mainly on specific countries and middle-aged men and been based on cross-sectional study designs (4, 5, 23, 24). We analyzed trends among men and women in six populations, using two complementary indicators of socioeconomic status: educational level and occupational class. It has been argued that stroke and ischemic heart disease mortality share a number of risk factors. Therefore, we assessed whether trends in socioeconomic differences in these two cardiovascular diseases showed a similar pattern, which would suggest that changes over time might be related to common determinants.

MATERIALS AND METHODS

Data and subjects

Within the framework of the European Union Health Monitoring Project, longitudinal data on mortality by 5-year age group, socioeconomic status, and sex were obtained for six European populations in three separate periods: 1981–1985, 1986–1990, and 1991–1995. Data were obtained from mortality registries and linked to data on socioeconomic status from population censuses carried out in 1981, 1986 (Finland only), or 1991 for each period. Participants were enumerated during each census and followed up for different periods (table 1). Data from Finland, Norway, Denmark, and Sweden covered the entire national population. Data from England/Wales corresponded to a 1 percent representative sample of the population, whereas data from Italy were restricted to the city of Turin. Details of these data have been described elsewhere (25, 26). Table 1 shows the number of person-years and deaths observed in each population.

Socioeconomic status was defined on the basis of educational level and occupational class, as these are the most commonly used indicators of socioeconomic status (27, 28). Educational level can be applied equally to both men and women and is considered the most reliable indicator of socioeconomic status among the elderly, as it includes both economically active and economically inactive populations (28). On the other hand, occupational class also has an independent association with mortality and is sensitive to changes over the life course (27, 28). Thus, educational level and occupational class may represent different aspects of social standing and were both used as complementary measures of socioeconomic status (27, 28).

Data on educational level were available for both men and women in Finland, Denmark, Norway, and Turin. Data covered the ages of 30–74 years (age specified at the start of follow-up), except in Denmark where data on education were not available for those aged 60 years or more. Education was first coded according to national classification schemes, based on the educational level completed by participants. Following this, education was reclassified into three comparable categories based on the International Standard Classification of Education (29): levels 0–2 (preprimary, primary, and lower secondary education); level 3 (upper secondary education); and levels 4–6 (postsecondary education). The two upper levels were combined in order to obtain more precise estimates, given the small size of these education groups. In each country, the proportion of the population in the high education group was higher among men than women and increased over time. No detailed census data on educational level were available for Sweden, while data on education for England/Wales were not comparable with those collected in other countries. Therefore, no analyses on educational level were conducted for these two countries.

Data on occupational class were available for men in Finland, Sweden, Norway, Denmark, England/Wales, and Turin. Data covered the ages of 30–59 years (age specified at the start of follow-up). Men aged 60 years or more were excluded from the analysis because of lack of detailed occupational information among economically inactive men. Women were also excluded from the analysis, since it was not possible to apply an occupational classification that was both valid and comparable over time. Participants were classified into four broad occupational classes using the scheme described by Erikson and Goldthorpe (30) as a reference: nonmanual workers, manual workers, farmers, and self-employed men. For summary purposes, we report only on mortality differences between "nonmanual" and "manual" classes, excluding workers in the agricultural sector and self-employed men. The nonmanual and manual classes comprised approximately 80–90 percent of the population in all countries. The share of the manual classes decreased slightly over time, whereas the share of the nonmanual classes slightly increased.

Occupational class was determined on the basis of the occupation reported at the time of census. For some men, however, no information on occupation was available. This mostly corresponded to economically inactive men such as the disabled and retired. When possible, occupational class was assigned to these individuals on the basis of a previously held occupation, by linkage to a previous census. This was possible for part of the population in Finland and England/Wales only. Men for whom no occupation could be assigned were excluded from the analysis. Their exclusion is likely to lead to an underestimation of mortality differences between occupational classes, because economically inactive men have high mortality rates and predominantly originate from lower occupational classes (1, 28, 31). Therefore, in all countries, we applied a procedure that corrects for this underestimation and that has been shown to perform well in a large number of tests (31). This procedure calculates correction factors as a function of the population share and the mortality of men excluded from the analysis (1, 31). Correction factors were calculated separately for stroke and ischemic heart disease, for each country and age group.

In Finland, England/Wales, and Turin, Italy, the *International Classification of Diseases*, Ninth Revision (ICD-9) (ICD-8 and ICD-10 defined analogously), was used in all

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TABLE 1. Follow-up period, number of person-years at risk, and number of deaths in six European populations, 1981–1996

Population and period	Educational level*						Occupational class†		
	Men			Women			Men		
	Person-years (no.)‡	Stroke deaths (no.)	IHD§ deaths (no.)	Person-years (no.)	Stroke deaths (no.)	IHD deaths (no.)	Person-years (no.)	Stroke deaths (no.)	IHD deaths (no.)
Finland									
1981–1985	5,584	6,620	30,631	6,325	7,000	14,577	4,491	1,891	11,165
1986–1990	6,039	6,301	27,130	6,633	6,299	13,419	4,882	1,852	9,082
1991–1995	6,438	5,807	23,163	6,906	5,256	10,415	5,144	1,622	6,658
Norway									
1981–1985	4,709	4,916	22,553	4,927	4,308	8,339	3,278	707	5,550
1986–1990	4,837	4,671	21,297	5,038	3,928	8,287	3,355	606	4,697
1991–1995	5,076	3,943	16,175	5,228	3,238	6,370	3,699	379	2,858
Sweden									
1981–1985	NA§	NA	NA	NA	NA	NA	7,199	1,167	8,550
1986–1990	NA	NA	NA	NA	NA	NA	5,827	1,076	6,911
1991–1995	NA	NA	NA	NA	NA	NA	8,045	1,221	6,121
Denmark†									
1981–1985	4,042	922	6,152	4,048	693	1,397	4,360	808	5,849
1986–1990	4,248	913	5,074	4,249	731	1,228	4,457	763	4,536
1991–1995	4,553	871	3,894	4,549	705	996	4,589	710	3,317
England/Wales									
1981–1985	NA	NA	NA	NA	NA	NA	458	144	894
1986–1990	NA	NA	NA	NA	NA	NA	381	100	748
1991–1995	NA	NA	NA	NA	NA	NA	497	98	599
Turin (Italy)									
1982–1986	1,322	1,641	2,562	1,511	1,321	1,002	1,041	317	1,004
1987–1991	1,136	1,712	2,431	1,348	1,728	1,248	805	237	683
1992–1996	1,206	912	1,772	1,363	741	677	886	191	491

* Ages 30–74 years.
† Ages 30–59 years.
‡ Number of person-years at risk per 1,000.
§ IHD, ischemic heart disease; NA, not available.

periods. Stroke (cerebrovascular disease) was defined as codes 430–438 and ischemic heart disease as codes 410–414. The ICD-9 was also used in Norway, except in the first period where the ICD-8 was used. In Sweden, the ICD-8 was used in the first period, both the ICD-8 and ICD-9 in the second period, and the ICD-9 in the last period. In Denmark, the ICD-8 was used in the first two periods and both the ICD-8 and ICD-10 in the last period. From the ICD-8, codes 430–438 (stroke) and 410–414 (ischemic heart disease) were used. From the ICD-10, codes G45, G46, I60–I69 (stroke), and I20–I25 (ischemic heart disease) were used.

Methods of analyses

Age-standardized mortality rates were calculated by sex, educational level, and occupational class strata. Rates were standardized by 5-year age groups using the direct method with the European population of 1987 as the standard (32). This procedure controlled for differences in the age distribution between men and women, socioeconomic groups, countries, and periods. To assess socioeconomic differences in trends of stroke mortality, we calculated slope estimates that corresponded to the percentage of change between the first and the last period for each socioeconomic group in each country. Age-adjusted slope estimates and corresponding 95 percent confidence intervals were calculated using Poisson regression.

Differences in mortality rates according to socioeconomic status were estimated for each period. For this purpose, age-adjusted rate ratios and corresponding 95 percent confidence intervals were calculated using Poisson regression. For educational level, this summary index compared the mortality rate of the low education group with the combined rate of the middle/high education group, using the latter as the referent category. For occupational class, rate ratios compared the mortality rate of manual and nonmanual classes, using the latter as the referent category.

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TABLE 2. Stroke mortality rates and change in the periods 1981–1985, 1986–1990, and 1991–1995 by educational level among men and women aged 30–74 years in four European populations

Population, sex, and level of education	Stroke mortality rate			Change between 1981–1985 and 1991–1995		
	1981–1985	1986–1990	1991–1995	Absolute change	% of change	95% confidence interval
Finland						
Male						
Mid/high	92.2	80.2	76.7	–15.5	–17.2	–23.4, –10.6
Low	116.6	107.3	96.7	–19.9	–17.4	–20.6, –14.0
Female						
Mid/high	51.7	48.5	41.6	–10.1	–20.4	–27.3, –12.7
Low	74.5	68.4	58.6	–15.9	–21.2	–24.3, –18.1
Norway						
Male						
Mid/high	65.3	62.4	51.8	–13.5	–20.3	–25.2, –15.0
Low	79.6	80.1	69.3	–10.3	–14.7	–19.3, –9.7
Female						
Mid/high	40.3	36.4	31.8	–8.5	–21.3	–27.5, –14.5
Low	57.5	51.9	44.5	–13.0	–23.3	–27.4, –18.9
Denmark*						
Male						
Mid/high	15.2	16.8	16.3	1.1	5.1	–10.9, 24.1
Low	21.6	21.5	18.9	–2.7	–12.2	–21.7, –1.5
Female						
Mid/high	11.9	11.8	12.1	0.2	4.3	–12.8, 24.8
Low	16.1	17.3	15.3	–0.8	–7.2	–18.8, 6.1
Turin, Italy						
Male						
Mid/high	100.7	96.7	56.2	–44.5	–43.3	–50.1, –35.4
Low	122.1	106.7	71.5	–50.6	–41.6	–47.4, –35.0
Female						
Mid/high	45.9	49.0	33.1	–12.8	–26.7	–38.4, –12.7
Low	68.2	62.4	40.5	–27.7	–41.7	–47.6, –35.1

* Data available for ages 30–59 years only.

Finally, estimates of change in rate ratios between the first and the last periods were calculated to assess differences between stroke and ischemic heart disease mortality trends in each country; 95 percent confidence intervals for these estimates were calculated by pooling standard errors from period-specific rate ratios for each country. Analyses were performed using SAS, version 6.12, software (SAS Institute, Inc., Cary, North Carolina).

RESULTS

The age-standardized stroke mortality rate declined steadily among both men and women in most countries throughout the periods 1981–1985, 1986–1990, and 1991–1995. A similar stroke mortality decline occurred among lower and higher socioeconomic groups in most countries, in both relative and absolute terms (tables 2 and 3). This pattern was consistent for educational level in all countries (table 2). In contrast, relative declines in stroke mortality tended to be slightly larger among nonmanual than among manual classes in Norway, Finland, Denmark, and England/Wales (table 3). Nevertheless, the only significant differential (relative) decline by occupational class was observed for Norway. Absolute stroke mortality declines were larger among lower than among higher socioeconomic groups in several populations, but these differences were not statistically significant.

Rate ratios for stroke and ischemic heart disease mortality of low compared with middle/high socioeconomic groups in the first (1981–1985) and last (1991–1995) study periods are presented in figure 1 (educational level) and figure 2 (occupational class). Overall, both indicators of socioeconomic status showed a similar pattern. Men and women with a low

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TABLE 3. Stroke mortality rates and change in the periods 1981–1985, 1986–1990, and 1991–1995 by occupational class among men aged 30–59 years in six European populations

Population and occupational class	Stroke mortality rate			Change between 1981–1985 and 1991–1995		
	1981–1985	1986–1990	1991–1995	Absolute change	% of change	95% confidence interval
Finland						
Nonmanual	29.4	22.6	21.3	–8.1	–28.8	–38.3, –17.9
Manual	44.3	41.8	37.3	–7.0	–15.6	–22.6, –8.0
Norway						
Nonmanual	16.6	15.0	8.4	–8.2	–49.2	–59.4, –36.5
Manual	21.1	19.2	20.1	–1.0	–8.4	–23.0, 9.0
Sweden						
Nonmanual	14.7	17.3*	12.3	–2.4	–16.3	–26.7, –4.5
Manual	22.2	22.3*	18.4	–3.8	–17.7	–26.8, –7.6
Denmark						
Nonmanual	17.1	15.7	14.9	–2.2	–16.3	–29.4, –0.8
Manual	23.4	26.2	22.0	–1.4	–5.9	–19.7, 10.3
England/Wales						
Nonmanual	23.5	14.6*	13.9	–9.6	–38.8	–62.6, 0.1
Manual	32.9	30.0*	22.0	–10.9	–35.4	–54.2, –9.0
Turin, Italy						
Nonmanual	23.1	21.4*	16.4	–6.7	–26.3	–46.7, 1.9
Manual	30.7	28.6*	20.3	–10.4	–35.8	–50.0, –17.7

* Data cover the age group 35–59 years only.

socioeconomic status had significantly higher stroke mortality rates compared with those with a middle/high socioeconomic status throughout both periods in all populations. However, confidence intervals were wide for Turin and England/Wales. Educational disparities in stroke mortality persisted and remained of a similar magnitude in the 1990s as in the 1980s among both men and women (figure 1). Occupational differences in stroke mortality showed a slight tendency to widen in Norway, Finland, Denmark, and England/Wales (figure 2). However, this increase was significant only in Norway, whereas changes in other populations were not significant.

Socioeconomic differences in ischemic heart disease mortality were observed in all populations but Turin during both periods among men and women (figures 1 and 2). In contrast to those for stroke, socioeconomic differentials for ischemic heart disease mortality significantly widened during the study period in most countries among men (figures 1 and 2). However, occupational disparities in ischemic heart disease mortality remained of a similar magnitude in Turin, and confidence intervals for occupational class overlapped in Denmark and England/Wales (figure 2). Among women, educational differences in ischemic heart disease mortality significantly increased in Finland and Norway, whereas they remained relatively stable in Denmark and Turin (figure 1). Despite these variations, socioeconomic differences in ischemic heart disease mortality showed a general tendency to increase in most countries.

To assess whether trends in socioeconomic disparities in stroke and ischemic heart disease mortality were significantly different, we formally compared estimates of change in rate ratios for these two causes of death. Whereas rate ratio change estimates generally indicated a significant increase in socioeconomic disparities in ischemic heart disease mortality, no significant change was observed in rate ratios for stroke mortality in most countries (figures 1 and 2); 95 percent confidence intervals of rate ratio change estimates for stroke and ischemic heart disease mortality overlapped in most populations (results not shown). However, differences in rate ratio change estimates between these two causes of death were generally of borderline significance.

DISCUSSION

Stroke mortality has generally declined in all socioeconomic groups among both men and women. Declines in stroke mortality were generally similar among lower and higher socioeconomic groups, such that socioeconomic disparities in stroke mortality persisted and were of a similar magnitude in the 1990s as in the 1980s. For some northern European countries, occupational differences in stroke mortality showed a slight tendency to widen. However, this increase was significant only in Norway, whereas increases observed in other populations were not significant. In contrast, socioeconomic differences in ischemic heart disease mortality showed a general tendency to widen in most countries during the same period.

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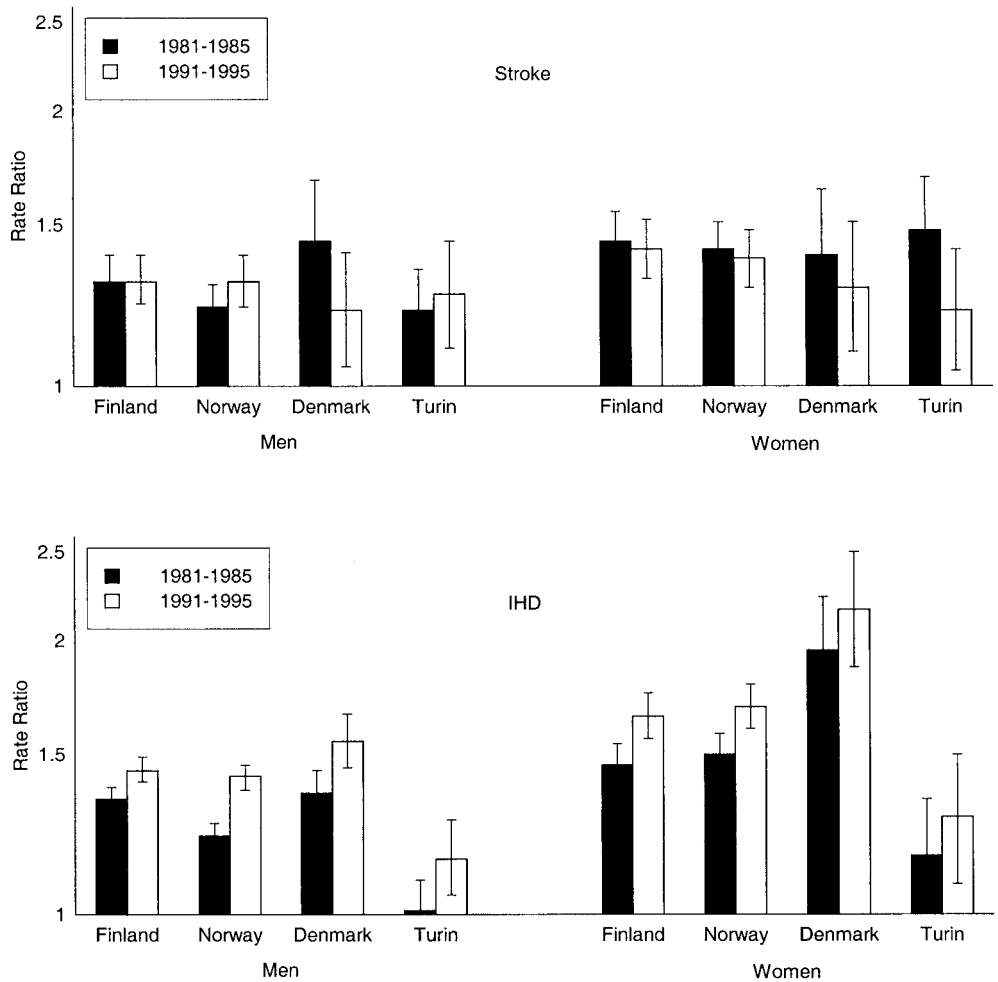

FIGURE 1. Rate ratio between low and middle/high educational levels for stroke and ischemic heart disease (IHD) mortality in the periods 1981–1985 and 1991–1995 among men and women in Finland, Norway, Denmark (ages 30–59 years), and Turin, Italy (ages 30–74 years). The 95% confidence interval of the estimate of change in rate ratio does not include zero for Finland, Norway, Denmark, and Turin among men (IHD) and for Finland and Norway among women (IHD).

Evaluation of data

International comparisons may be biased by differences between countries in the accuracy of death registrations and socioeconomic classifications. However, we did not strictly compare countries but analyzed changes over time within each population.

Changes in the classification of causes of death may influence analyses of trends. However, in most countries, the ICD-9 code was used in all periods. It is unlikely that the late adoption of the ICD-9 in some countries influenced death rates, because the overall stroke category is essentially the same in the ICD-8 and ICD-9 (33). Furthermore, our results would be biased only if deaths from stroke were classified differently by socioeconomic status. There is no evidence suggesting that this has occurred, and any bias due to this problem is likely to be small.

The classification of education and occupation used in our study remained unchanged. However, although changes in the occupational class distribution were small, the proportion of the population in the low educational category decreased considerably over time. This decline may have influenced our results by either obscuring or inflating changes in socioeconomic differences in stroke mortality. To assess the impact of these changes, we analyzed trends using the relative index of inequality (34) (results not shown). This measure assesses differences in mortality by adjusting for changes in the distribution of education in the population over time and by taking into account mortality differences among the three educational levels. The pattern based on the relative index of inequality corresponded with that based on the rate ratio: Educational differences in stroke mortality persisted and remained relatively stable over time in most countries, whereas educational disparities in ischemic heart disease mortality widened in most populations. Furthermore, results based on the relative index of inequality indicate that educational disparities in stroke mortality have significantly widened in Norway among men. This is consistent with the

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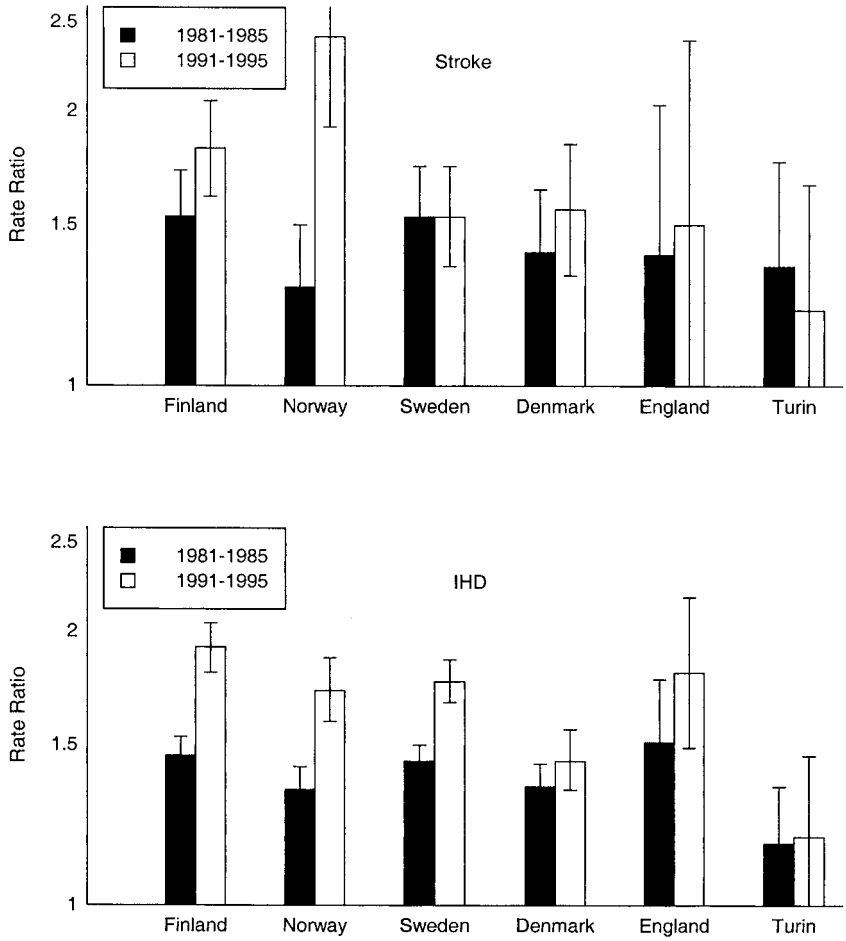

FIGURE 2. Rate ratio between manual and nonmanual occupational classes for stroke and ischemic heart disease (IHD) mortality in the periods 1981–1985 and 1991–1995 among men in Finland, Norway, Sweden, Denmark, England/Wales, and Turin, Italy (ages 30–59 years). The 95% confidence interval of the estimate of change in rate ratio does not include zero for Norway (stroke) and for Finland, Norway, and Sweden (IHD).

pattern observed for occupational class and suggests that socioeconomic disparities in stroke mortality have increased in this population.

Data for educational level comprised individuals aged 30–74 years, whereas occupational data covered the age range of 30–59 years only. Thus, results for these two socioeconomic indicators may not be fully comparable. However, separate analyses for educational level were performed for those aged 30–59 years and those aged 60–74 years (results not shown). The overall patterns for these two groups were identical and were therefore combined in the analysis.

Comparison with previous studies

Previous studies reported a faster proportional decline in cardiovascular disease mortality among the higher socioeconomic groups in European countries, resulting in widening socioeconomic differences in cardiovascular mortality (10, 35, 36). Our results suggest that this pattern generally occurred in ischemic heart disease mortality in most populations. However, we did not observe the same pattern for stroke mortality. This supports previous evidence that suggests that differences exist between trends in stroke and ischemic heart disease mortality (11, 37). Similarly, socioeconomic disparities in stroke and ischemic heart disease mortality have shown a different international pattern across Europe (1, 14).

This is the first study to report more favorable trends in stroke mortality among higher than among lower socioeconomic groups among men in Norway. The pattern for this population may resemble that for countries such as the United States (9, 23) and some parts of Australia (4), where a larger relative decline in stroke mortality has been observed among higher than among lower socioeconomic groups. A previous study in Finland reported a similar absolute decline in stroke mortality by occupational class but a larger relative decline among nonmanual than among manual classes (5). Although this resembles the pattern that we have observed, socioeconomic differences in the relative decline in stroke mortality in Finland were not significant.

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Noteworthy is the pattern for Turin, Italy, where educational disparities in stroke mortality remained of a similar magnitude and where educational disparities in ischemic heart disease mortality showed an increase. This is consistent with the pattern that has been observed in other Mediterranean countries such as Spain (3). Similarly, a previous study in France reported similar stroke mortality declines across socioeconomic groups, accompanied by diverging trends in mortality from ischemic heart disease (37).

Overall, similar results were observed for occupational class and educational level. However, a sharper widening of disparities in stroke mortality generally occurred for occupational class than for educational level in some populations. This discrepancy suggests that differences may exist in the effect of these two indicators of socioeconomic status on mortality (27, 28). Educational level might reflect gradual changes in factors such as health behavior and access to health information, which may influence mortality differentials over a long period. Instead, trends in occupational disparities may reflect changes in factors such as the physical and psychosocial dimensions of work (27). Despite these discrepancies, results from this study indicate that, overall, similar trends have occurred for educational level and occupational class in most populations.

Explanation of results

Hypertension is involved in nearly 70 percent of strokes (38). Recent evidence shows that hypertension prevalence and blood pressure levels have generally declined in all socioeconomic groups in Finland (19), Denmark (20), Sweden (39), and Italy (40). However, it still remains unclear to what extent these changes are due to improvements in hypertension treatment or diet. Significant improvements in the awareness, treatment, and control of hypertension have occurred in countries such as Finland (41) and Spain (16). Within the United Kingdom, significant improvements in hypertension management across all socioeconomic groups have been observed in Scotland (42). Hypertension management among diabetic patients has also improved significantly in many European populations (43). Thus, improvements in access to hypertension treatment—detection and management—have probably contributed to similar stroke mortality declines in all socioeconomic groups. Furthermore, improvements in dietary salt and fat intake have been observed in all socioeconomic groups in several European countries (44–46). Population-based strategies, such as policies and legislation on salt concentrations in processed food, introduced in countries such as Finland may have contributed to this pattern (47, 48). Additionally, similar declines in cholesterol level across social classes have been observed in Finland (19, 49), Denmark (20), Sweden (39), and Italy (40). These factors may have contributed to stroke mortality declines of a similar magnitude across socioeconomic groups in Europe.

Stroke and ischemic heart disease share several risk factors. However, socioeconomic differences in stroke mortality remained relatively stable, whereas disparities in ischemic heart disease mortality widened over time in most countries. Recent trends in risk factors such as smoking and overweight may have substantially contributed to the pattern observed for ischemic heart disease. Most Nordic countries and the United Kingdom have generally experienced declining trends in smoking prevalence among the higher classes, accompanied by increasing trends in the lower socioeconomic groups (15, 19, 20, 39, 49, 50). Similarly, the prevalence of overweight and obesity has shown more favorable trends among higher than among lower socioeconomic groups (19, 51). These trends may partly explain the widening of socioeconomic differences in ischemic heart disease mortality across Europe. On the other hand, trends in socioeconomic differences in stroke mortality may have been more influenced by factors such as hypertension.

As shown in previous studies (14), we observed smaller socioeconomic disparities in ischemic heart disease mortality in Turin than in northern European countries. Nevertheless, trends in inequalities in stroke and ischemic heart disease mortality in Turin were similar to trends in other populations: Educational disparities in stroke mortality remained of a similar magnitude, whereas educational disparities in ischemic heart disease mortality tended to increase. Widening smoking inequalities in Italy may have contributed to the pattern for ischemic heart disease mortality, whereas factors such as diet and hypertension may have contributed to the pattern for stroke mortality (40, 52).

Finally, research indicates that declines in case-fatality rates have also contributed to declines in stroke mortality (53), which fact underlines the role of improvements in medical care. Socioeconomic disparities in stroke mortality persisted from the 1980s to the 1990s in all populations, which may indicate that socioeconomic disparities in healthcare utilization remain. This is supported by recent evidence of socioeconomic differences in specialist care and diagnostic procedures even in countries with universal healthcare systems such as Finland (13, 54) and Sweden (55). Furthermore, the higher socioeconomic groups may have had access to some surgical procedures earlier than the lower socioeconomic groups (54, 56). This may have contributed to widening socioeconomic differences in ischemic heart disease and stroke mortality in some countries. Similarly, despite favorable hypertension trends overall, socioeconomic disparities in blood pressure levels and hypertension care still remain (57, 58). These factors may have contributed to persisting or widening socioeconomic inequalities in stroke mortality in Europe.

Implications

Results from this study suggest that stroke mortality trends in all socioeconomic groups have generally been responsive to favorable changes in important risk factors such as hypertension. However, the persistence of socioeconomic inequalities in stroke mortality in most populations and the widening of these disparities in Norway indicate that recent changes in policies and risk factors have not been sufficient. Improvements in the quality of preventive care for factors such as hypertension and in the quality of hospital care for stroke can substantially improve survival among individuals with a low socioeconomic status (13, 58). Furthermore, population-based prevention strategies, such as policies and

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legislation to stimulate a reduction in salt intake, raise awareness of hypertension, and decrease smoking prevalence, can potentially benefit individuals in all socioeconomic groups (59). Our results indicate that focusing interventions on the lower socioeconomic groups may help sustain the stroke mortality decline in European countries.

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REFERENCES

1. Kunst AE, del Rios M, Groenhof F, et al. Socioeconomic inequalities in stroke mortality among middle-aged men: an international overview. European Union Working Group on Socioeconomic Inequalities in Health. Stroke 1998;29:2285–91.
2. Avendano M, Kunst AE, Huisman M, et al. Educational level and stroke mortality: a comparison of 10 European populations during the 1990s. Stroke 2004;35:432–7.
3. Lostao L, Regidor E, Aiach P, et al. Social inequalities in ischaemic heart and cerebrovascular disease mortality in men: Spain and France, 1980–1982 and 1988–1990. Soc Sci Med 2001;52:1879–87.
4. Burnley IH, Rintoul D. Inequalities in the transition of cerebrovascular disease mortality in New South Wales, Australia, 1969–1996. Soc Sci Med 2002;54:545–59.
5. Valkonen T, Martikainen P, Jalovaara M, et al. Changes in socioeconomic inequalities in mortality during an economic boom and recession among middle-aged men and women in Finland. Eur J Public Health 2000;10:274–80.
6. Forssas E, Keskimaki I, Reunanen A, et al. Widening socioeconomic mortality disparity among diabetic people in Finland. Eur J Public Health 2003;13:38–43.
7. Singh GK, Siahpush M. Increasing inequalities in all-cause and cardiovascular mortality among US adults aged 25–64 years by area socioeconomic status, 1969–1998. Int J Epidemiol 2002;31:600–13.
8. Turrell G, Mathers C. Socioeconomic inequalities in all-cause and specific-cause mortality in Australia: 1985–1987 and 1995–1997. Int J Epidemiol 2001;30:231–9.
9. Cooper R, Cutler J, Desvigne-Nickens P, et al. Trends and disparities in coronary heart disease, stroke, and other cardiovascular diseases in the United States: findings of the national conference on cardiovascular disease prevention. Circulation 2000;102:3137–47.
10. Mackenbach JP, Bos V, Andersen O, et al. Widening socioeconomic inequalities in mortality in six Western European countries. Int J Epidemiol 2003;32:830–7.
11. Truelsen T, Mahonen M, Tolonen H, et al. Trends in stroke and coronary heart disease in the WHO MONICA Project. Stroke 2003;34:1346–52.
12. Reed D. The paradox of high risk of stroke in populations with low risk of coronary heart disease. Am J Epidemiol 1990;131:579–88.
13. Jakovljevic D, Sarti C, Sivenius J, et al. Socioeconomic status and ischemic stroke: the FINMONICA Stroke Register. Stroke 2001;32:1492–8.
14. Kunst AE, Groenhof F, Andersen O, et al. Occupational class and ischemic heart disease mortality in the United States and 11 European countries. Am J Public Health 1999;89:47–53.
15. Pierce JP. International comparisons of trends in cigarette smoking prevalence. Am J Public Health 1989;79:152–7.
16. Sans S, Paluzie G, Balana L, et al. Tendencias de la prevalencia, conocimiento, tratamiento y control de la hipertension arterial entre 1986 y 1996: estudio MONICA-Cataluna. (In Spanish). Med Clin (Barc) 2001;117:246–53.
17. Cavelaars AE, Kunst AE, Geurts JJ, et al. Educational differences in smoking: international comparison. BMJ 2000;320:1102–7.
18. Cavelaars A, Kunst A, Mackenbach JP. Socio-economic differences in risk factors for morbidity and mortality in the European Community: an international comparison. J Health Psychol 1997;2:353–72.
19. Pekkanen J, Uutela A, Valkonen T, et al. Coronary risk factor levels: differences between educational groups in 1972–87 in eastern Finland. J Epidemiol Community Health 1995;49:144–9.
20. Osler M, Gerdes LU, Davidsen M, et al. Socioeconomic status and trends in risk factors for cardiovascular diseases in the Danish MONICA population, 1982–1992. J Epidemiol Community Health 2000;54:108–13.
21. van Doorslaer E, Wagstaff A, van der Burg H, et al. Equity in the delivery of health care in Europe and the US. J Health Econ 2000;19:553–83.
22. Moon L. Stroke treatment and care: a comparison of approaches in OECD countries. In: Organization for Economic Cooperation and Development (OECD), ed. A disease-based comparison of health systems. Paris, France: Organization for Economic Cooperation and Development, 2003:53–75.
23. Steenland K, Henley J, Thun M. All-cause and cause-specific death rates by educational status for two million people in two American Cancer Society cohorts, 1959–1996. Am J Epidemiol 2002;156:11–21.
24. Borrell C, Plasencia A, Pasarin I, et al. Widening social inequalities in mortality: the case of Barcelona, a southern European city. J Epidemiol Community Health 1997;51:659–67.
25. Harding S. Social class differences in mortality of men: recent evidence from the OPCS Longitudinal Study. Office of Population Censuses and Surveys. Popul Trends 1995;summer:31–7.
26. Cardano M, Costa G, Demaria M. Social mobility and health in the Turin longitudinal study. Soc Sci Med 2004;58:1563–74.
27. Daly MC, Duncan GJ, McDonough P, et al. Optimal indicators of socioeconomic status for health research. Am J Public Health 2002;92:1151–7.
28. Valkonen T. Problems in the measurement and international comparisons of socioeconomic differences in mortality. Soc Sci Med 1993;36:409–18.
29. United Nations Educational Scientific and Cultural Organization (UNESCO). International Standard Classification of Education—ISCED 1997. Paris, France: UNESCO, 1997. (http://www.uis.unesco.org/TEMPLATE/pdf/isced/ISCED_A.pdf).
30. Erikson E, Goldthorpe JH. The constant flux. Oxford, United Kingdom: Clarendon Press, 1992.
31. Kunst AE, Groenhof F, Mackenbach JP. Mortality by occupational class among men 30–64 years in 11 European countries. EU Working Group on Socioeconomic Inequalities in Health. Soc Sci Med 1998;46:1459–76.
32. Eurostat. Demographic statistics 1987. Luxembourg: Eurostat

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Office for Official Publications of the European Communities, 1987.
33. Sarti C, Rastenyte D, Cepaitis Z, et al. International trends in mortality from stroke, 1968 to 1994. Stroke 2000;31:1588–601.
34. Mackenbach JP, Kunst AE. Measuring the magnitude of socioeconomic inequalities in health: an overview of available measures illustrated with two examples from Europe. Soc Sci Med 1997;44:757–71.
35. Diderichsen F, Hallqvist J. Trends in occupational mortality among middle-aged men in Sweden 1961–1990. Int J Epidemiol 1997;26:782–7.
36. White C, Van Galen F, Chow YH. Trends in social class differences in mortality by cause, 1986 to 2000. Health Stat Q 2003; 20:25–37.
37. Lang T, Ducimetiere P. Premature cardiovascular mortality in France: divergent evolution between social categories from 1970 to 1990. Int J Epidemiol 1995;24:331–9.
38. Bronner LL, Kanter DS, Manson JE. Primary prevention of stroke. N Engl J Med 1995;333:1392–400.
39. Peltonen M, Huhtasaari F, Stegmayr B, et al. Secular trends in social patterning of cardiovascular risk factor levels in Sweden. The Northern Sweden MONICA Study 1986–1994. Multinational Monitoring of Trends and Determinants in Cardiovascular Disease. J Intern Med 1998;244:1–9.
40. Ferrario M, Sega R, Chatenoud L, et al. Time trends of major coronary risk factors in a northern Italian population (1986–1994). How remarkable are socioeconomic differences in an industrialized low CHD incidence country? Int J Epidemiol 2001;30:285–97.
41. Kastarinen MJ, Salomaa VV, Vartiainen EA, et al. Trends in blood pressure levels and control of hypertension in Finland from 1982 to 1997. J Hypertens 1998;16:1379–87.
42. Chen R, Tunstall-Pedoe H, Morrison C, et al. Trends and social factors in blood pressure control in Scottish MONICA surveys 1986–1995: the rule of halves revisited. J Hum Hypertens 2003; 17:751–9.
43. Soedamah-Muthu SS, Colhoun HM, Abrahamian H, et al. Trends in hypertension management in type I diabetes across Europe, 1989/1990–1997/1999. Diabetologia 2002;45:1362–71.
44. Osler M, Heitmann BL, Schroll M. Ten year trends in the dietary habits of Danish men and women. Cohort and cross-sectional data. Eur J Clin Nutr 1997;51:535–41.
45. Groth MV, Fagt S. Udviklingen i kostvaner i Danmark og Sverige siden 1960'erne. (In Danish). Ugeskr Laeger 2001;163: 425–9.
46. Perrin AE, Simon C, Hedelin G, et al. Ten-year trends of dietary intake in a middle-aged French population: relationship with educational level. Eur J Clin Nutr 2002;56:393–401.
47. Karppanen H, Mervaala E. Adherence to and population impact of non-pharmacological and pharmacological antihypertensive therapy. J Hum Hypertens 1996;10(suppl 1):S57–61.
48. Narhinen M, Cernerud L. Salt and public health—policies for dietary salt in the Nordic countries. Scand J Prim Health Care 1995;13:300–6.
49. Vartiainen E, Pekkanen J, Koskinen S, et al. Do changes in cardiovascular risk factors explain the increasing socioeconomic difference in mortality from ischaemic heart disease in Finland? J Epidemiol Community Health 1998;52:416–19.
50. Pride NB, Soriano JB. Chronic obstructive pulmonary disease in the United Kingdom: trends in mortality, morbidity, and smoking. Curr Opin Pulm Med 2002;8:95–101.
51. Molarius A, Seidell JC, Sans S, et al. Educational level, relative body weight, and changes in their association over 10 years: an international perspective from the WHO MONICA Project. Am J Public Health 2000;90:1260–8.
52. Faggiano F, Versino E, Lemma P. Decennial trends of social differentials in smoking habits in Italy. Cancer Causes Control 2001;12:665–71.
53. Sarti C, Stegmayr B, Tolonen H, et al. Are changes in mortality from stroke caused by changes in stroke event rates or case fatality? Results from the WHO MONICA Project. Stroke 2003;34:1833–40.
54. Hetemaa T, Keskimaki I, Manderbacka K, et al. How did the recent increase in the supply of coronary operations in Finland affect socioeconomic and gender equity in their use? J Epidemiol Community Health 2003;57:178–85.
55. Peltonen M, Rosen M, Lundberg V, et al. Social patterning of myocardial infarction and stroke in Sweden: incidence and survival. Am J Epidemiol 2000;151:283–92.
56. Keskimäki I, Koskinen S, Salinto M, et al. Socioeconomic and gender inequalities in access to coronary artery bypass grafting in Finland. Eur J Public Health 1997;7:392–7.
57. de Gaudemaris R, Lang T, Chatellier G, et al. Socioeconomic inequalities in hypertension prevalence and care: the IHPAF Study. Hypertension 2002;39:1119–25.
58. de Koning JS, Klazinga NS, Koudstaal PJ, et al. Deprivation and systematic stroke prevention in general practice: an audit among general practitioners in the Rotterdam region, the Netherlands. Eur J Public Health 2003;13:340–6.
59. Murray CJ, Lauer JA, Hutubessy RC, et al. Effectiveness and costs of interventions to lower systolic blood pressure and cholesterol: a global and regional analysis on reduction of cardiovascular-disease risk. Lancet 2003;361:717–25.

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