Socioeconomic Inequalities in Stroke Mortality Among Middle-Aged Men

An International Overview

Anton E. Kunst, MA, PhD; Marina del Rios, BSc;
Feikje Groenhof, MA; Johan P. Mackenbach, MD, PhD;
for the European Union Working Group on Socioeconomic Inequalities in Health

Background and Purpose—Several studies observed that people from lower socioeconomic groups have higher chances of dying of stroke. There are reasons to expect that these differences are relatively small in southern European countries or in Nordic welfare states. This report therefore presents an international overview of socioeconomic differences in stroke mortality.

Methods—Unpublished data on mortality by occupational class were obtained from national longitudinal studies or cross-sectional studies. The data refer to deaths among men aged 30 to 64 years in the 1980s. A common occupational class scheme was applied to most countries. The mortality difference between manual classes and nonmanual classes was measured in relative terms (by rate ratios) and in absolute terms (by rate differences).

Results—In all countries, manual classes had higher stroke mortality rates than nonmanual classes. This difference was relatively large in England and Wales, Ireland, and Finland and relatively small in Sweden, Norway, Denmark, Italy, and Spain. Differences were intermediate in the United States, France, and Switzerland. In Portugal, mortality differences were intermediate in relative terms but large in absolute terms. In most countries, inequalities were much larger for stroke mortality than for ischemic heart disease mortality.

Conclusions—Socioeconomic differences in stroke mortality are a problem common to all countries studied. There are probably large variations, however, in the contribution that different risk factors, such as tobacco and alcohol consumption, make to the stroke mortality excess of lower socioeconomic groups. Medical services can contribute to reducing socioeconomic differences in stroke mortality. **(*Stroke*. 1998;29:2285-2291.)**

Key Words: epidemiology ■ mortality ■ social class ■ world health

Several studies have demonstrated that men and women from lower socioeconomic groups have higher chances of dying of stroke before reaching old age. Associations between socioeconomic status and stroke mortality have been observed for the United States, Australia, England and Wales (considered together), and Nordic countries.[1–11]

Higher stroke mortality rates of lower socioeconomic groups are probably related to several factors. As a general rule, lower socioeconomic groups are more frequently exposed to risk factors for stroke incidence, including hypertension, excessive alcohol consumption, tobacco consumption, and overweight.[12] In addition, it has been suggested that lower socioeconomic groups have less access to, or make less effective use of, services that are important to the early detection and control of hypertension.[13,14]

Until now, the international literature did not include reports on socioeconomic differences in stroke mortality in France, Switzerland, or Mediterranean countries. Particular to these countries is that, until the 1980s, ischemic heart disease (IHD) mortality among men aged 30 to 64 years was not clearly related to low socioeconoic status.[15–17] This situation is probably due to the lack of clear social gradients in, among other things, tobacco consumption and some dietary factors.[15,18–22] Since stroke shares several of its risk factors with IHD, socioeconomic differences in stroke mortality might also be small or even absent in southern European countries. If so, there would be a parallel with the situation in the United States and the northern part of Europe in the 1950s, when both IHD and stroke mortality rates were not yet clearly higher among lower socioeconomic groups.[23–27]

The Nordic welfare states are also of interest. Characteristic of these countries is the highly egalitarian character of their socioeconomic, healthcare, and other policies.[28–30] Egal-

Received July 29, 1998; accepted August 11, 1998.

From the Department of Public Health, Erasmus University, Rotterdam, Netherlands.

A list of members of the European Union Working Group on Socioeconomic Inequalities in Health who contributed to this article appears in Acknowledgments.

Reprint requests to Anton E. Kunst, Department of Public Health, Erasmus University, PO Box 1738, 3000 DR Rotterdam, Netherlands. E-mail kunst@mgz.fgg.eur.nl

Stroke **is available at http://www.strokeaha.org**

itarian policies in these countries might have diminished differences between socioeconomic groups in exposure to risk factors for stroke incidence and perhaps remedied a part of the remaining inequalities by securing that lower socioeconomic groups have free access to high-quality medical services.

The experience of these Nordic countries is especially interesting in the light of findings from the Hypertension Detection and Follow-up Program in the United States.[31,32] This program demonstrated the potential benefits of directing hypertension detection and control services to lower socioeconomic groups. Optimal access to, as well as compliance with, hypertension detection and control services by low as well as high socioeconomic groups was found to have resulted in diminishing socioeconomic differences in hypertension and hypertension-related mortality in the stepped care intervention group.[32] A comparable hypertension control program among 2222 hypertensive patients in Finland observed that reductions in hypertension prevalence took place uniformly in all socioeconomic groups.[33] The experience of the Nordic countries at large can show whether similar outcomes are attainable not only for specific intervention groups but for entire national populations as well.

The purpose of this report is to present an international overview of socioeconomic differences in stroke mortality in the 1980s. Until recently, such a comparison would not be feasible because of poor accessibility and poor comparability of data from different countries. However, an extensive database of internationally comparable data was created recently in a large-scale international project.[15,16] This database has been used to provide international overviews of socioeconomic differences in all-cause mortality and mortality from IHD. In the present overview, we will assess the size of inequalities in stroke mortality in each country and whether these inequalities are smaller in some countries than in others.

This analysis focuses on mortality among men aged 30 to 64 years. The restriction to these men was necessitated by problems with the availability and comparability of data for women and for men in other age groups.[15] The restriction to a relatively young age group can be motivated by the fact that below the age of 65 years, stroke deaths are more often avoidable, although not always, by adequate use of hypertension detection and control services.[34,35]

Subjects and Methods

Subjects

The data sources used for this paper are presented in Table 1. Data on mortality by socioeconomic factors and cause of death were preferably obtained from longitudinal studies and otherwise from cross-sectional studies. Longitudinal studies consisted of a mortality follow-up of populations enumerated in the national population censuses of circa 1981. Most follow-up periods covered the period of circa 1980–1989, but shorter periods were covered for Sweden and Italy. The cross-sectional studies used here were of the "unlinked" type,[15] with the death registry providing the number of deaths according to occupational class as registered on death certificates, and the population census providing the corresponding number of persons at risk according to the same occupational classes. All cross-sectional studies were centered around the national population censuses of circa 1981.

Stroke deaths were defined by the underlying cause-of-death codes 430 to 438 according to the *International Classification of Diseases, Ninth Revision*.

Most studies include the entire adult national population. Longitudinal studies from the United States and England and Wales refer to a representative sample of the adult national population (sample sizes, ≈0.5% and ≈1%, respectively). Data for Italy were available from a mortality follow-up of all residents of Turin, a large city in northern Italy. Data for France and Switzerland relate to the native-born population only.

The age groups 30 to 44 and 45 to 59 years were selected for studies that classified men according to their age at death. For longitudinal studies with a follow-up period of ≈10 years, the birth cohorts aged 25 to 39 and 40 to 54 years at the start of follow-up were chosen. With a follow-up period of 10 years, it was in addition possible to study mortality differences at the age of ≈60 to 64 years

TABLE 1. Overview of Sources of Data

Country	Design	Period	Excluded Populations	Observed No. of Deahts*
United States	Longitudinal	1979–1989	None	129
England/Wales	Longitudinal	1981–1989	None	173
Ireland	Cross-sectional	1980–1982	None	437
Finland	Longitudinal	1981–1990	None	3232
Sweden	Longitudinal	1980–1986	None	2060
Norway	Longitudinal	1980–1990	None	1152
Denmark	Longitudinal	1981–1990	None	1795
France	Cross-sectional	1981–1983	French born out of France, foreigners	7275
Switzerland	Cross-sectional	1979–1982	Foreigners	555
Italy (Turin)	Longitudinal	1981–1989	None	473
Spain	Cross-sectional	1980–1982	Military	5744
Portugal	Cross-sectional	1980–1982	Military	2870

*Number of stroke deaths among men aged 30 to 59 years at death. The numbers of deaths observed in the studies for the United States and England and Wales are relatively small because these studies cover small representative samples of the national populations.

by observing men aged 55 to 59 years at the start of follow-up. For Spain, no data were available for men aged 30 to 44 years.

A common occupational class scheme, the Erikson-Goldthorpe-Portocarero (EGP) scheme, was applied to as many countries as possible.[36,37] This scheme was developed to facilitate international comparisons of social mobility and is particularly suited for our purposes. Where possible, social class 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 (eg, number of subordinates). Mortality data for Denmark, Ireland, Spain, and Portugal were available on the basis of national occupational class schemes. These national schemes could be made comparable to the EGP scheme at the level of 3 broad classes: nonmanual classes, manual classes, and agricultural classes (farmers and farm laborers). Under the EGP scheme, the nonmanual class includes all men working as professionals, administrators, managers, employers, higher-grade technicians, routine nonmanual employees (eg, clerks), service workers (eg, conductors), and sales personnel.

In most countries, ≈45% to 50% of the male working population are in nonmanual classes, approximately as many men are in manual classes, and ≈5% to 10% of all men work in agriculture.[15] Manual classes form the largest group in the United States, England and Wales, Finland, Spain, and Portugal. The proportion of men working in agriculture increases with age. In Finland, Ireland, Italy, Spain, and Portugal, >15% of all men work in agriculture.[15]

Methods

The relative mortality level of men in specific occupational classes was measured by means of standardized mortality ratios, with the national mortality rates by 5-year age group as the standard. The magnitude of inequalities in mortality was quantified by a summary index with a straightforward interpretation: the rate ratio that compares the mortality rate of manual classes to the mortality rate of nonmanual classes (including self-employed men). Rate ratios and their 95% CIs were estimated by means of Poisson regression analysis. The regression model included a term that represented the contrast between manual and (upper) nonmanual classes. A series of terms representing 5-year age groups was included in the regression model to control for different age compositions of manual and (upper) nonmanual classes. Rate ratios for the United States were also adjusted for race/ethnicity (Hispanics, other white, black, other nonwhite).

These relative measures were complemented with an absolute measure that takes into account the large variations between countries in national stroke mortality rates. By multiplying standardized mortality ratios by national rates of stroke mortality, we obtained class-specific absolute death rates standardized for age. Estimates of national stroke mortality rates were obtained from World Health Organization[38] statistics that are based on national mortality registrations.

In most countries, there was insufficient information on the former occupation of economically inactive men (eg, retired, disabled, unemployed). These men were therefore 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.[15] However, we applied a procedure that approximately corrects for this underestimation.[15] This procedure is based on a formula that calculates correction factors as a function of both the population share and the stroke mortality level of the men that were excluded from analysis. It was found to perform well in a large number of tests.[15]

Results

Table 2 presents the relative mortality level of each occupational class, as measured by standardized mortality ratios. In nearly all instances, the death rates of nonmanual classes are lower than the national average, whereas the death rates of manual classes are higher than average. The only exceptions relate to men aged 30 to 44 years in Switzerland and to men aged 60 to 64 years in Italy and the United States. In most countries, the class of farmers and farm laborers has stroke mortality rates lower than the national average. A main exception to this general rule is Portugal, where farmers and farm laborers have much higher stroke death rates than the rest of the population.

TABLE 2. Stroke Mortality by Occupational Class: Standardized Mortality Ratios for Men Aged 30–44, 45–59, and 60–64 Years at Death

Country	Age Group, y	Share of Stroke in All Deaths, %	Standardized Mortality Ratio*		
			Nonmanual Classes	Manual Classes	Agricultural Classes
United States	30–44	2.1	0.79	1.23	1.01
	45–59	4.1	0.75	1.26	1.14
	60–64	3.6	1.01	1.04	0.56
England/Wales	30–44	4.0	0.40	1.67	0.00
	45–59	5.5	0.72	1.26	1.11
	60–64	6.8	0.81	1.20	0.53
Ireland	30–44	5.1	0.94	1.25	0.64
	45–59	5.6	0.79	1.26	0.96
Finland	30–44	5.0	0.71	1.23	1.07
	45–59	6.2	0.79	1.21	0.89
	60–64	6.5	0.84	1.12	0.96
Sweden	30–44	2.4	0.83	0.90	1.30
	45–59	4.7	0.88	1.16	0.85
Norway	30–44	3.0	0.71	1.40	0.86
	45–59	4.2	0.93	1.11	0.80
	60–64	5.5	0.93	1.10	0.86
Denmark	30–44	3.1	0.79	1.30	0.73
	45–59	4.1	0.94	1.19	0.58
	60–64	4.6	0.98	1.04	0.87
France	30–44	3.1	0.86	1.17	1.00
	45–59	4.5	0.86	1.16	1.02
Switzerland	30–44	2.2	1.05	1.01	0.55
	45–59	3.5	0.84	1.20	0.99
	60–64	4.3	0.89	1.00	1.13
Italy (Turin)	30–44	5.5	0.93	1.08	...†
	45–59	7.1	0.90	1.12	...
	60–64	7.8	1.06	0.88	...
Spain	45–59	6.8	0.90	1.07	1.02
Portugal	30–44	4.2	0.73	0.98	1.89
	45–59	11.4	0.70	1.01	1.30

*National average in each age group is 1.00.

†No estimates are made for the few agricultural workers living in the city of Turin.

Table 3 presents the rate ratios that quantify the size of the mortality differences between manual and nonmanual classes. Estimates could be made for all countries only for men aged 45 to 59 years. In this age group, the mortality difference between manual and nonmanual classes is statistically significant for most countries. These differences are relatively large in England and Wales, Ireland, and Finland and relatively

TABLE 3. Stroke Mortality by Occupational Class: Manual vs Nonmanual Rate Ratios for Men Aged 30–44, 45–59, and 60–64 Years at Death

	30–44 Years		45–59 Years		60–64 Years	
Country	Rate Ratio	95% CI	Rate Ratio	95% CI	Rate Ratio	95% CI
United States	1.56	(0.65–3.74)	1.42	(0.95–2.20)	1.02	(0.63–1.70)
England/Wales	4.23	(1.53–12.3)	1.74	(1.23–2.48)	1.51	(1.10–2.10)
Ireland	1.33	(0.85–2.13)	1.57	(1.23–2.03)	...	...*
Finland	1.75	(1.50–2.06)	1.55	(1.40–1.71)	1.33	(1.15–1.55)
Sweden	1.18	(0.86–1.63)	1.31	(1.18–1.45)	...	...*
Norway	2.01	(1.49–2.73)	1.21	(1.04–1.41)	1.19	(1.02–1.38)
Denmark	1.66	(1.35–2.06)	1.28	(1.14–1.43)	1.06	(0.93–1.20)
France	1.36	(1.21–1.53)	1.35	(1.27–1.43)	...	...*
Switzerland	0.97	(0.62–1.52)	1.43	(1.18–1.74)	1.27	(1.02–1.59)
Italy (Turin)	1.16	(0.69–2.00)	1.24	(1.00–1.54)	0.82	(0.61–1.17)
Spain	...	...*	1.18	(1.10–1.27)	...	...*
Portugal	1.34	(1.03–1.77)	1.44	(1.29–1.61)	...	...*

*No data were available for these age groups.

small in Sweden, Norway, Denmark, Italy, and Spain. Nearly all CIs overlap, implying that variations between countries cannot be demonstrated with statistical significance.

Rate ratios are generally larger for men aged 30 to 44 years and smaller for men aged 60 to 64 years. Approximately the same international pattern is observed for each age group. The strong age dependencies that are observed for Norway and the United States might be due to chance fluctuations.

Table 4 presents estimates of absolute levels of stroke mortality among men 45 to 59 years. Countries are ordered by their national stroke death rate, which is between ≈30 and 50 per 100 000 person-years in most countries but lower in Switzerland (22) and higher in Finland (68) and Portugal (100). The death rates of manual classes are higher: between 37 and 57 per 100 000 person-years in most countries but smaller in Switzerland (26) and higher in Finland (82) and Portugal (101). Within Portugal, farmers and farm workers have the highest death rate (130; not given in Table 4). Most important for the present analysis is the absolute difference between manual and nonmanual classes shown in Table 4. The largest differences are observed for Ireland, England and Wales, Finland, and Portugal.

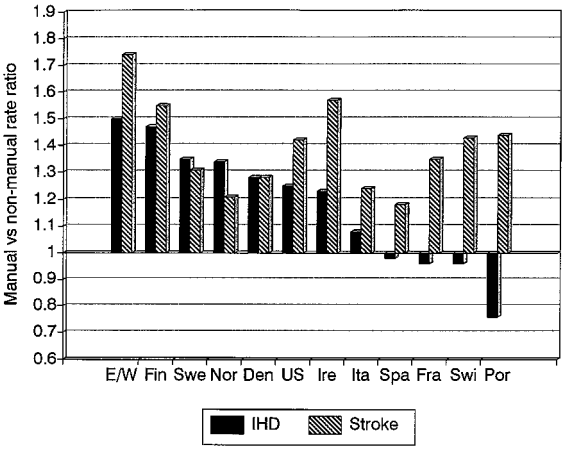
TABLE 4. Stroke Mortality by Occupational Class: Absolute Rates for Men Age 45–59 Years at Death

	Death Rate per 100 000 Person-Years			Absolute Manual vs Nonmanual Difference
Country	National Population*	Nonmanual Classes†	Manual Classes†	
Switzerland	22	18	26	8
Sweden	32	28	37	9
Norway	32	30	36	6
United States	33	27	39	12
Denmark	35	33	42	9
Ireland	40	32	51	19
France	43	36	49	13
England/Wales	45	33	57	24
Spain	49	45	53	8
Italy	51	46	57	11
Finland	68	54	82	28
Portugal	100	70	101	31

*Source: World Health Organization[38] and own calculations.

†Estimated by multiplying national rates by the standardized mortality ratios given in Table 2.

In the Figure, a comparison is made between stroke and IHD. Countries are ordered according to the rate ratios that were estimated for IHD in a manner identical to that for stroke.[15,17] Socioeconomic differences in IHD mortality showed a strong north-south gradient within Europe, with a clear mortality excess of manual classes in northern European countries but not in France and more southern countries. In Portugal, IHD mortality was even higher among nonmanual classes. Such a clear north-south gradient cannot be observed for stroke mortality. In contrast to IHD mortality, stroke



Manual versus nonmanual rate ratios for stroke mortality compared with those for ischemic heart disease (IHD) mortality. Rates are for men aged 45 to 59 years at death. E/W indicates England and Wales; Fin, Finland; Swe, Sweden; Nor, Norway; Den, Denmark; Ire, Ireland; Ita, Italy; Spa, Spain; Fra, France; Swi, Switzerland; and Por, Portugal.

mortality is higher in manual classes in all countries included in the overview. In nearly all countries, socioeconomic differences are substantially larger for stroke mortality than for IHD mortality.

Discussion

Evaluation of Data Problems

Elsewhere, we carefully evaluated the results against problems with the reliability and international comparability of data on mortality by occupational class.[15] We identified 3 principal data problems: the use of occupational class schemes other than the EGP scheme, our approximate correction for the exclusion of economically inactive men, and the "numerator/denominator" bias that is inherent to the unlinked cross-sectional studies.[15] We quantified the potential effect of these data problems on estimates of manual versus nonmanual mortality rate ratios. The potential size of error in the estimates for Sweden and England and Wales was ≤10%. This implies that a rate ratio of, for example, 1.40 is underestimated or overestimated by maximally 0.14 U. The potential size of error is also modest for Finland, Norway, Denmark, and the United States (≤15%); slightly larger for France, Switzerland, and Italy (≈≤20%); and the largest for Ireland, Spain; and Portugal (≈≤35%). The numerator/denominator bias could be especially large in these latter countries.[15]

For all countries, data were obtained from studies that are based on national death registries. The use of this source of information is necessary to estimate the magnitude of socioeconomic differences in stroke mortality at ages <65 years with reasonable precision (no large CIs). A potential problem with national death registries relates to the quality of the registration of the underlying cause of death. A part of deaths with stroke as the underlying cause may be assigned to other cardiovascular diseases or vague categories such as sudden death. Conversely, deaths from other causes may be coded with stroke as underlying cause of death. Misclassification would bias our manual versus nonmanual rate ratios only if the degree of misclassification varies by occupational class. Some differential misclassification is possible, but it is unlikely that this has substantially biased the rate ratios presented in Tables 2 and 3. There is a larger potential for bias, however, in the estimates of the absolute manual versus nonmanual mortality difference that are given in Table 4, since this absolute difference is also sensitive to a country's overall (nondifferential) level of misclassification.

A final concern relates to differences in study period. Whereas data for the United States and most northern European countries relate to circa 1985 (1980–1989), the data from most southern European countries relate to circa 1981 (1980–1982). This 4-year difference would bias comparisons between countries if mortality differences strongly change over time. With respect to all-cause mortality, trend estimates from different European countries suggest that manual versus nonmanual rate ratios have increased by ≈0.10 U during the early 1980s.[15] A similar increase may have occurred with stroke mortality. This increase would not be negligible, but taking into account this increase would not substantially alter the international patterns observed in this study.

Occupational Class as a Measure of Socioeconomic Status

Occupational class is generally considered the most comprehensive indicator of the socioeconomic status of people.[39] However, there are substantial differences within occupational classes according to, among other factors, educational levels and income. This raises the question of the results that would have been obtained if an alternative socioeconomic measure had been used. A measure often used, especially in the United States, is educational level. Nationally representative data on the association between educational level and stroke mortality are available for Finland, Norway, Denmark, Italy, and the United States.[16] Analyses of these data showed that the relative position of these countries was approximately the same for education as for occupational class. We calculated mortality rate ratios comparing men with at most lower secondary education to men with higher levels of education. For men aged 20 to 74 years, these ratios were largest for the United States and Finland (≈1.45) and smallest for Norway, Denmark, and Italy (≈1.25).

The manual versus nonmanual distinction applied in this report is not entirely hierarchical because many nonmanual workers (eg, service and sales workers) have a socioeconomic position similar to that of manual workers or self-employed men.[36] A clearly hierarchical distinction is obtained, however, by comparing manual workers only with upper nonmanual workers (professionals, administrators, managers, and employers of large numbers of subordinates).[15] For a number of countries, we could calculate rate ratios on the basis of this comparison. For stroke mortality, this measure revealed larger socioeconomic differences than those reported in this article. Compared with upper nonmanual workers, manual workers had in general ≈2 times the risk of dying of stroke at ages 30 to 44 years and ≥1.5 times the risk of dying of stroke at ages 45 to 59 years. Most important to the present study, however, is that the relative position of countries was found to be the same as the positions observed in this report by using the manual versus nonmanual rate ratio (A.E. Kunst, PhD, et al, unpublished data, 1997).

Explanations

One of the purposes of this international overview was to assess the possibility that, parallel to what has been observed for IHD and some cardiovascular risk factors,[15–22] socioeconomic differences in stroke mortality in southern Europe are small or even absent. Relative small mortality differences were indeed observed for Italy and Spain but not for France, Switzerland, and Portugal. It is uncertain why the latter countries have relatively large socioeconomic differences in stroke mortality. One of the contributing factors may be excessive alcohol consumption by manual workers in these countries. Excessive alcohol consumption enhances the chance of dying of ischemic stroke.[40–42] Suggestive of its contribution to inequalities in stroke mortality are the large inequalities in mortality from other alcohol-related diseases in France and some other southern European countries[17] and

the relatively steep socioeconomic gradients in weekly alcohol consumption as reported in national surveys from France and Portugal.[18]

Characteristic of both Portugal and Finland is that large mortality differences (in relative terms) coincide with high national rates of stroke mortality. This suggests that some of the risk factors that are specific to these countries affected lower socioeconomic groups disproportionately. Excessive alcohol consumption may have contributed to the large mortality differences in Finland as well as in Portugal. Alcohol-related deaths in Finland are responsible for a large proportion of premature deaths at the national level[43] as well as the large class differences in premature death.[44] International comparisons suggest that the high national death rates of Portugal are related to high levels of sodium intake.[45,46] Similarly, dietary factors may have contributed to the exceptionally high mortality rates of farmers and farm workers in Portugal.

Another group of countries of special interest are the Nordic welfare states. In most of these countries, except Finland, mortality differences appeared to be small, especially when expressed in absolute terms (Table 4) or in comparison to differences in IHD mortality (Figure). These small differences might in part reflect a beneficial effect of egalitarian health care and other policies in Nordic countries. Since part of stroke deaths at ages <65 years is avoidable through hypertension detection and control services,[34,35] optimal use of these services by lower socioeconomic groups may help to reduce their risk of dying of stroke. Egalitarian policies with respect to health care have removed financial barriers to the access of these services,[29] while egalitarian policies in other fields may have contributed to diminish barriers of social, cultural, or psychological nature.[47]

A wider international perspective shows that the magnitude of stroke mortality differences is not clearly associated with the egalitarian character of healthcare systems. Socioeconomic differences in stroke mortality were relatively large in England and Wales in the 1980s, despite 4 decades of National Health Service.[48] On the other extreme is the United States, where many disadvantaged people are not insured or are only partially insured for medical care. This has led, among other things, to "reverse targeting" in hypertension detection and control: those who would benefit most are least attended by the relevant medical services.[49] Despite these inequalities in access to health care, stroke mortality differences in the United States do not appear to be consistently larger than in European countries.

Implications

Socioeconomic differences in stroke mortality among men aged 30 to 59 years were observed for each country for which data were available. In each country, closing the gap between low and high socioeconomic groups offers a large potential for lowering stroke mortality rates in the nation at large.

Developing effective methods of risk factor reduction in lower socioeconomic groups should be a top priority in stroke prevention. Preventive actions should be based on empirical evidence on the contribution that different risk factors, such as tobacco and alcohol consumption, make to the excess stroke mortality of lower socioeconomic groups. Since the relative importance of different risk factors seems to vary strongly between countries, future explanatory studies would greatly benefit from international concertedness of research.

The healthcare sector has an important contribution to make to the reduction of inequalities in stroke mortality. An English study observed shortcomings in the medical services delivered to patients dying of stroke and hypertensive disease.[34] Future studies should assess whether these shortcomings are more common among patients from lower socioeconomic groups and should find ways to eliminate any inequalities observed.

The experience of England and Wales illustrates that the removal of financial barriers is not sufficient to achieve small socioeconomic differences in stroke mortality. The experience of most Nordic countries suggests that these mortality differences might be reduced by removing not only financial barriers but also other barriers to the effective use of medical services.

Acknowledgments

This study was supported by a grant from the European Union's Biomed-1 program (CT92–1068). The central statistical offices of all participating countries gave permission for the use of unpublished data from national mortality registries. Data for the United States were obtained from the public use file of the National Longitudinal Mortality Study (1979–1989). The following members of the European Union Working Group on Socioeconomic Inequalities in Health have contributed to this article: O. Andersen, Danmarks Statistik, Copenhagen, Denmark; J.-K. Borgan, Statistics Norway, Oslo, Norway; G. Costa, MD, Environmental Protection Agency, Piedmont Region, Italy; G. Desplanques, INSEE, Lyon, France; F. Faggiano, University of Torino, Turin, Italy; M. do R. Giraldes, MA, PhD, National School of Public Health, Lisbon, Portugal; S. Harding, MSc, Office for National Statistics, London, United Kingdom; C. Junker, University of Bern, Bern, Switzerland; P. Martikainen, MA, PhD, University of Helsinki, Helsinki, Finland; C. Minder, University of Bern, Bern, Switzerland; B. Nolan, MA, PhD, Economic and Social Research Council, Dublin, Ireland; E. Regidor, MD, PhD, Ministry of Health, Madrid, Spain; D. Vågerö, MA, PhD, Stockholm University, Stockholm, Sweden; T. Valkonen, MA, PhD, University of Helsinki, Helsinki, Finland.

References

1. Modan B, Wagener DK. Some epidemiological aspects of stroke: mortality/morbidity trends. *Stroke*. 1992;23:1230–1236.
2. Khaw KT, Barrett-Connor E, Suarez L, Criqui MH. Predictors of stroke-associated mortality in the elderly. *Stroke*. 1984;15:244–248.
3. Howard G, Russell GB, Anderson R, Evans GW, Morgan T, Howard VJ, Burke GL. Role of social class in excess black stroke mortality. *Stroke*. 1995;26:1759–1763.
4. DiPietro L, Ostfeld AM, Rosner GL. Adiposity and stroke among older adults of low socioeconomic status: the Chicago Stroke Study. *Am J Public Health*. 1994;84:14–19.
5. Siegel D, Kuller L, Lazarus NB, Black D, Feigal D, Hughes G, Schoenberger JA, Hulley SB. Predictors of cardiovascular events and mortality in the Systolic Hypertension in the Elderly Program pilot project. *Am J Epidemiol*. 1987;126:385–399.
6. Rogot E, Hrubec Z. Trends in mortality from coronary heart disease and stroke among U. S. veterans. *J Clin Epidemiol*. 1989;42:245–256.
7. Bennett S. Socioeconomic inequalities in coronary heart disease and stroke mortality among Australian men, 1979–1993. *Int J Epidemiol*. 1996;25:266–275.
8. Marmot MG, Shipley MG, Rose G. Inequalities in death: specific explanations of a general pattern? *Lancet*. 1984;1:1003–1006.
9. Salonen JT. Socioeconomic status and risk of cancer, cerebral stroke, and death due to coronary heart disease and any disease: a longitudinal study in eastern Finland. *J Epidemiol Community Health*. 1982;36:294–297.

10. Rosengren A, Wedel H, Wilhelmsen L. Coronary heart disease and mortality in middle aged men from different occupational classes in Sweden. *BMJ*. 1988;297:1497–1500.
11. Valkonen T, Martelin T, Rimpelä A, Notkola V, Savela S. *Socio-economic Mortality Differences in Finland 1981–90*. Helsinki, Finland: Central Statistical Office of Finland; 1993.
12. Kaplan GA, Keil JE. Socioeconomic factors and cardiovascular disease: a review of the literature. *Circulation*. 1993;88:1973–1997.
13. Casper M, Wing S, Strogatz D, Davis CE, Tyroler HA. Antihypertensive treatment and US trends in stroke mortality, 1962 to 1980. *Am J Public Health*. 1992;82:1600–1606.
14. O'Brian Smith E, Curb JD, Hardy RJ, Hawkins MC, Tyroler HA. Clinic attendance in the Hypertension Detection and Follow-up Program. *Hypertension*. 1982;4:710–715.
15. Kunst AE, Groenhof F, Mackenbach JP, and EU Working Group on Socio-economic Inequalities in Health. Occupational class and mortality among men 30 to 64 years in 11 European countries. *Soc Sci Med*. 1998;46:1459–1476.
16. Mackenbach JP, Kunst AE, Cavelaars AEJM, Groenhof F, Geurts JJM, for the EU Working Group on Socio-Economic Inequalities in Health. Socio-economic inequalities in morbidity and mortality in western Europe: a comparative study. *Lancet*. 1997;349:1655–1659.
17. Kunst AE, Groenhof F, Mackenbach JP, for the EU Working Group on Socioeconomic Inequalities in Health. Occupational class and cause-specific mortality among men in 11 European countries: comparison of population-based studies. *BMJ*. 1998;316:1636–1642.
18. Cavelaars AEJM, Kunst AE, Mackenbach JP. Socio-economic inequalities in risk factors of morbidity and mortality in the European Community: an international comparison. *J Health Psychol*. 1997;2:353–372.
19. Sasco AJ, Grizeau D, Pobel D, Chatard O, Danzon M. Tabagisme et classe social en France de 1974 à 1991. *Bull Cancer*. 1994;81:355–359.
20. La Vecchia C, Decarli A, Pagano R. Education and prevalence of smoking in Italian men and women. *Int J Epidemiol*. 1986;15:279. Abstract.
21. La Vecchia C, Gutzweiler F, Wietlisbach V. Sociocultural influences on smoking habits in Switzerland. *Int J Epidemiol*. 1987;16:624–626.
22. Regidor E, Rodríguez C, Gutiérrez-Fisac JL. *Indicadores de Salud: tercera evaluación en España del programa regional europea 'Salud para todos.'* Madrid, Spain: Ministry of Health; 1995.
23. Breslow L, Buell P. Mortality from coronary heart disease and physical activity of work in California. *J Chronic Dis*. 1960;11:421–444.
24. Guralnick L. Mortality by occupational level and cause of death among men 20–64 years of age, United States, 1950. *Vital Stat Special Rep*. 1963;53:452–486.
25. Kunst AE, Looman CWN, Mackenbach JP. Socio-economic mortality differences in the Netherlands in 1950–1984: a regional study of cause-specific mortality. *Soc Sci Med*. 1990;31:141–152.
26. OPCS. *Occupational Mortality: Decennial Supplement 1950–52, England and Wales*. London, England: HMSO; 1958.
27. Vågerö D, Lundberg O. Socio-economic mortality differentials among adults in Sweden. In: Lopez AD, Casselli G, Valkonen T, eds. *Adult Mortality in Developed Countries: From Description to Explanation*. Oxford, England: Clarendon Press; 1995:223–242.
28. Atkinson AB, Rainwater L, Smeeding TM. *Income Distribution in OECD Countries*. Paris, France: OECD; 1995.
29. van Doorslaer E, Wagstaff A, Rutten F. *Equity in the Finance and Delivery of Health Care: An International Perspective*. Oxford, England: Oxford University Press; 1992.
30. Esping Andersen G. *Three Worlds of Welfare Capitalism*. Oxford, England: Polity Press; 1990.
31. HDFP Group (Hypertension Detection and Follow-up Program Cooperative Group). Mortality findings for stepped-care and referred-care participants in the Hypertension Detection and Follow-up Program, stratified by other risk factors. *Prev Med*. 1985;14:312–335.
32. HDFP Group (Hypertension Detection and Follow-up Program Cooperative Group). Educational level and 5-year all-cause mortality in the Hypertension Detection and Follow-up Program. *Hypertension*. 1987;9:641–646.
33. Nissinen A, Tuomilehto J, Salonen JT, Kottke TE, Piha T. The influence of socio-economic factors on blood pressure control during a community-based hypertension control program. *Acta Cardiol*. 1986;41:99–109.
34. Payne JN, Milner PC, Saul C, Bowns IR, Hannay DR, Ramsay LE. Local confidential inquiry into avoidable factors in deaths from stroke and hypertensive disease. *BMJ*. 1993;307:1027–1030.
35. Rutstein DD, Berenberg W, Chalmers TC, Child CG, Fishman AP, Perrin EB. Measuring the quality of medical care. *N Engl J Med*. 1976;11:582–588.
36. Erikson E, Goldthorpe JH. *The Constant Flux*. Oxford, England: Clarendon Press; 1992.
37. Bartley M, Carpenter L, Dunnell K, Fitzpatrick R. Measuring inequalities in health: an analysis of mortality patterns using two social classifications. *Sociol Health Illness*. 1996;18:455–475.
38. World Health Organisation. *World Health Statistics Annual*. Geneva, Switzerland: WHO; 1988.
39. Krieger N, Williams DR, Moss NE. Measuring social class in US public health research: concepts, methodologies and guidelines. *Ann Rev Public Health*. 1997;18:341–378.
40. Holman CD, English DR, Milne E, Winter MG. Meta-analysis of alcohol and all-cause mortality. *Med J Aust*. 1996;164:141–145.
41. Camargo CA. Case-control and cohort studies of moderate alcohol consumption and stroke. *Clin Chim Acta*. 1996;246:107–119.
42. Wannamethee SG, Shaper AG. Patterns of alcohol intake and risk of stroke in middle-aged British men. *Stroke*. 1996;27:1033–1039.
43. Mäkelä P, Valkonen T, Martelin T. Alcohol-related mortality by age and sex and its impact on life expectancy: estimates based on the Finnish Death Register. *Eur J Public Health*. 1998;8:43–51.
44. Mäkelä P, Valkonen T, Martelin T. Contribution of deaths related to alcohol use to socio-economic variation in mortality: register-based follow-up study. *BMJ*. 1997;315:211–216.
45. Carrageta MO, Negrao L, de Padua F. Community-based stroke prevention: a Portuguese challenge. *Health Rep*. 1994;6:189–195.
46. Sasaki S, Zhang XH, Kesteloot H. Dietary sodium, potassium, saturated fat, alcohol, and stroke mortality. *Stroke*. 1995;26:783–789.
47. Adler NE, Boyce T, Chesney MA. Socioeconomic status and health: the challenge of the gradient. *Am Psychol*. 1994;49:15–24.
48. Blaxter M. The significance of socioeconomic factors for medical care and the National Health Service. In: Blane D, Brunner E, Wilkinson R, eds. *Health and Social Organisation*. London, England: Routledge; 1996:32–41.
49. Woolhandler S, Himmelstein DU. Reverse targeting of preventive care due to lack of health insurance. *JAMA*. 1988;259:2872–2874.