Social Inequality by Income in Short- and Long-Term Cause-Specific Mortality after Stroke

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Goals: It is unclear whether social inequality exists for mortality after stroke. Results of studies on the relation between socioeconomic position (SEP) and mortality after stroke have been inconsistent and inconclusive. *Material and Methods:* We studied the association between SEP expressed by income and the risk of death after stroke by merging data on incident stroke from Danish registries with nationwide coverage. We identified all incident cases of stroke hospitalized in Denmark 2003-2012 (n = 60503). Patients were followed up to 9 years after stroke (median 2.6 years). Adjusting for age and sex we studied all-cause death and cause-specific death by stroke, cardiac disease, cancer, and other diseases certified by death records and stratified by income. *Results:* Of the patients 20,953 (34.6%) had died within follow-up: Death by stroke 8018 (13.2%); cardiac disease 4250 (7.0%); cancer 3060 (5.0%); other diseases 5625 (9.2%). Long-term mortality rates were inversely related to income for all causes of death. The difference in mortality between the lowest and the highest income group at 5 years after stroke was 15.5% (relative) and 5.7% (absolute). Differences in short-term mortality (1-month to 1-year) between income groups were small and clinically insignificant. *Conclusions:* Social inequality in mortality after stroke expressed by income was pronounced for long-term mortality while not for short-term mortality. It seems that social inequality is expressed in a greater risk among stroke patients with low income for the advent of new diseases subsequently leading to death rather than in their ability to survive the incident stroke.

Key Words: Stroke—mortality—income—socioeconomy

Introduction

A recent comprehensive overview of socioeconomic position (SEP) and mortality after stroke concluded that in spite of the fact that low SEP generally was found to be associated with increased risk of short-term mortality this finding was not consistent; in some studies from countries with universal healthcare systems the association was not found. Moreover, the relation between SEP and long-term mortality was found to be inconclusive.[1] This conclusion was drawn mainly from studies in high-income countries but applies to low- and middle-income countries as well.[2-4]

In a recent study on SEP and mortality after stroke in Denmark there was no association between SEP and 1-month all-cause mortality while low SEP was significantly associated with increased long-term all-cause mortality.[5]

It is common practice for the study of SEP and stroke mortality to adjust for differences between SEP groups in smoking, alcohol consumption, diabetes, and other stroke-related risk factors.[1,6] Low income has always been associated with higher incidence of cardiovascular risk factors such as smoking, alcohol consumption, diabetes, cardiovascular events, etc.[7,8] So, comparing low- and high-income groups while adjusting for differences in the occurrence of cardiovascular risk factors, inevitably leads to comparison

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of groups that do not exist in reality. We are fully aware that the known cardiovascular risk factors are individually and independently related to mortality. Thus aiming to investigate relationships between income and mortality inevitably brings one in a dilemma of choosing between studying the independent influence of the income on mortality (thus adjusting for as many confounders as possible) and the reality associated with income such as life conditions, cardiovascular risk factors, etc. and the associated mortality. We found the latter most relevant and in this study we have chosen to adjust only for differences in age and gender.

It is also common practice in studies on SEP to study mortality as all-cause mortality.[1,6] However, among causes of death after stroke the far most common cause is stroke.[9] Therefore, death by stroke will have a disproportionate influence on all-cause mortality. It is unknown whether the association between mortality and income in stroke patients only relates to death by stroke or whether it also relates to death of other causes. For this reason, in addition to all-cause mortality, we also studied cause-specific mortality by stroke, cardiac disease, cancer, and other diseases.

The aim of this study was to investigate the relation between SEP expressed by income and risk of death after stroke in Denmark. For group comparisons we adjusted for only age and sex on the assumption that it is the life circumstances and lifestyle generally associated with SEP rather than SEP per se that determines differences in survival after stroke. Moreover, in addition to all-cause mortality, we also studied cause-specific death after stroke (ie, death by stroke, cardiac disease, cancer, and other nonvascular diseases), short term as well as long term.

Materials and Methods

The data that support the findings of this study are available from the corresponding author on reasonable request. We studied the association between SEP expressed by income and the risk of death after stroke by merging data on incident stroke from Danish registries with nationwide coverage: the Danish Stroke Registry,[10-12] Statistics Denmark[13] and the Danish Registry of Causes of Death.[14] All Danish residents are assigned a unique 10-digit registration number,[13] which allows unambiguous linkage among all Danish registries. We identified all incident cases of stroke hospitalized in Denmark during the years 2003-2012.

The Danish Stroke Registry

We retrieved information on hospitalization for stroke from the Danish Stroke Registry,[10-12] which receives mandatory reports from all Danish hospitals on all patients hospitalized for acute stroke including information on age, gender, stroke subtype, and cardiovascular profile. Stroke is defined according to the criteria of the World Health Organization (WHO).[15] Ischemic and hemorrhagic strokes are distinguished by computed tomography or magnetic resonance scanning. We included only incident hospital admissions for a first stroke (ischemic or hemorrhagic). Transient ischemic attacks, subarachnoid bleeding and patients for whom scanning was not performed (1.1%) were not included.

The cardiovascular profile includes information on alcohol consumption (≤14 of 21 and >14 of 21 drinks per week for women and men, respectively, corresponding to under/over the limit set by the National Board of Health), smoking (never smoking versus current or exsmoking), body mass index, diabetes mellitus, atrial fibrillation (chronic or paroxysmal), arterial hypertension and previous myocardial infarction. In March 2012, the recommended limit for alcohol intake was lowered to 7 of 14 drinks per week for women/men. Diseases are diagnosed on current Danish standards.[10] The hospitalization rate for stroke according to the registry is 2.6 per 1000 per year, with high validity.[11,12] The registry now covers more than 89% of all admissions for stroke in Denmark.[12]

Statistics Denmark

Information on income was obtained from Statistics Denmark,[13] which is the central authority for Danish statistics. Disposable income was defined as income after taxation and interest per person and categorized into the 20th, 40th, 60th, and 80th percentiles of the age and sex-specific income distribution.[16] We did not include education in our evaluation of SEP because we previously showed that educational level in contrast to income was neither related to short-term or to long-term survival in stroke patients more than 65 years of age.[5]

The Danish National Registry on Causes of Death

Cause of death was obtained from the Danish National Registry on Causes of Death[14] and divided into the following 4 groups according to ICD10: Stroke (I60-69), heart diseases (I 00-25, I 27, I 30-51), cancer (C00-97), and other diseases. Cause of death refers to the underlying cause which—according to the WHO—is "the disease or injury which initiated the train of morbid events leading directly to death."[17]

The study protocol was approved by the board of the Danish Stroke Registry and the Danish Data Protection Agency (journal number 2012-41-0719). As data were administrative patient consent was not needed.

Statistical Analysis

Disposable income was categorized into the 20th, 40th, 60th, and 80th percentiles of the sex and age-specific distribution, that is, 5 groups from lowest to highest income. A person belonging to group 2, for example, would then have an income between the 20th and 40th percentile of the income distribution for the same sex and cohort. We estimated the prevalence of comorbid conditions and risk factors in the patients with incident stroke according to disposable income. Comparison of equal mean values

across income groups were conducted by ANOVA tests while comparison for equal proportions across income groups were conducted by chi-square tests.

For all cohort members, we applied censoring for end of follow-up or loss to follow-up, whichever came first. We used time since admission for incident stroke as the time scale and conducted both unadjusted and adjusted analyses. We estimated cumulative incidence (or risk) of cause-specific death by applying a semiparametric additive model[18] by income categories. This was done both unadjusted (not shown) and adjusted by age and gender and visualized graphically. Effect estimates were reported as cumulative incidence with 95% confidence intervals. All statistical tests were 2-sided and based on the likelihood ratio test. A significance level of 5% was applied. The statistical software R[19] was used in all analyses.

Results

During the study period 2003-2012, 60,503 patients were registered with a first-ever-stroke in the Danish Stroke Register. Descriptive data, clinical characteristics, and mortality of the patients in the 5 income groups are shown in Table 1. There was an inverse stepwise relation between age and income. Thus stroke patients belonging to the lowest income group were on average 6 years younger than those belonging to the highest income group. The male/female ratio did not differ much between income groups 2-5, however, in the lowest income group there was only 44% women versus 48% in the highest income group. Stroke severity did not differ between groups into any clinically significant degree (<1 Scandinavian Stroke Scale (SSS) point). Among the cardiovascular risk factors smoking, alcohol consumption over the recommended level and diabetes were more prevalent among stroke patients in the lower income groups. Atrial fibrillation was more common among the higher income groups. The latter were, however, older.

During follow-up 20,953 patients (34.6%) had died. Number of deaths and causes of death according to death certificates within the 5 income groups also appear from Table 1. Patients were followed up to 9 years after stroke (median 2.6 years).

All-Cause Mortality

All-cause mortality in the 5 income groups appear from Table 2 and Figure 1. According to the death rates shown in Table 2 there was no significant difference between income groups 1 and 5 at 1 month, 3 months, and 1 year while mortality rates for income groups 2, 3, and 4 were significantly or almost significantly higher than that for income group 1. However, at 5-year poststroke there was a clear significant inverse step-wise relation between income and mortality rate; the relative and absolute difference in the mortality rate between income groups 1 and 5 being 15.5% (confidence interval 12.3; 18.5) and 5.7% (confidence interval 3.4; 7.0) respectively.

When inspecting Figure 1 a time-dependent trend for mortality rates among the 5 income groups, however, discloses. Whereas mortality rates are slightly lower for low-income patients within the first year poststroke they change gradually over time ending up being significantly higher for low-income patients than for high-income patients at 5-year poststroke.

Cause-Specific Mortality

Cause-specific mortality in the 5 income groups appear from Table 2 and Figure 1.

Cancer: Mortality rates by death from cancer did not differ significantly between the 5 income groups. However, inspection of Figure 1 suggests a trend for higher mortality rates over time for low-income patients in comparison to those of high-income patients.

Other diseases: Mortality rates by death from other diseases did not differ significantly at 1 month, 3 months, and 1 year poststroke but at 5-year poststroke mortality rates were significantly higher for low-income patients. Inspecting Figure 1 reveals higher mortality rate for low-income patients increasing gradually over time when compared to those of the other income groups.

Cardiac disease: Mortality rates by cardiac disease were significantly lower for low-income groups at 1 month, 3 months, and 1 year after stroke while at 5 years the reverse was seen; the mortality rate being significantly higher for low-income patients. Inspection of Figure 1 confirms this 2-phased pattern.

Stroke: Mortality rates by stroke did not differ significantly between income groups at 1 month, 3 months, and 1 year after stroke while at 5 years the mortality rate was significantly higher for low-income patients when compared to high-income patients. Inspection of Figure 1 showed a 2-phased pattern similar to that found for death by cardiac disease, that is, slightly lower mortality rate for low-income patients throughout the first 1-2 years after stroke replaced by a subsequent phase wherein the mortality rate was highest for lower income patients.

Discussion

This study lends further support to the existence of social inequality in stroke mortality.[1-6] SEP expressed by income was associated with risk of death after stroke no matter cause of death. However, the association was not uniform for all causes of death. For death by cancer and other diseases risk was generally higher for patients with low income than patients with high income. However, for death by stroke and cardiac disease a 2-phased course was seen. During the first 1-2 years after the incident stroke risk of death by stroke and cardiac disease was lower for low-income patients than for higher income patients while this pattern reversed during subsequent years wherein low-income patients became at increasingly higher risk of death by stroke and cardiac disease than higher income patients.

Table 1. *Descriptive data, clinical characteristics, and mortality of the patients in the 5 income groups*

Variable		Income* 0%-20%	Income 20%-40%	Income 40%-60%	Income 60%-80%	Income 80%-100%	*P* value
Number of patients		12577	13724	12656	11315	10231	
Age (mean (SD))		67.39 (12.79)	70.51 (13.67)	71.98 (13.66)	72.39 (13.69)	73.31 (13.61)	<.001
Sex (%)	Female	5612 (44.6)	6506 (47.4)	6159 (48.7)	5390 (47.6)	5008 (48.9)	<.001
	Male	6965 (55.4)	7218 (52.6)	6497 (51.3)	5925 (52.4)	5223 (51.1)	
Scandinavian Stroke Scale (SSS (mean (SD)))		43.44 (15.77)	43.24 (15.87)	43.24 (16.05)	43.60 (16.09)	44.24 (16.01)	<.001
BMI (mean (SD))		26.28 (5.37)	26.16 (5.22)	25.84 (5.01)	25.62 (4.82)	25.09 (4.44)	<.001
Alcohol consumption (%)	Over limit	1545 (12.3)	1025 (7.5)	789 (6.2)	653 (5.8)	656 (6.4)	<.001
	Under limit	9538 (75.8)	10920 (79.6)	10343 (81.7)	9300 (82.2)	8392 (82.0)	
	Unknown	1494 (11.9)	1779 (13.0)	1524 (12.0)	1362 (12.0)	1183 (11.6)	
Smoking (%)	Never	3124 (24.8)	3855 (28.1)	3993 (31.6)	3812 (33.7)	3897 (38.1)	<.001
	Ex-smoker	2175 (17.3)	2736 (19.9)	2729 (21.6)	2501 (22.1)	2412 (23.6)	
	Smoker	5677 (45.1)	5199 (37.9)	4140 (32.7)	3325 (29.4)	2371 (23.2)	
	Unknown	1601 (12.7)	1934 (14.1)	1794 (14.2)	1677 (14.8)	1551 (15.2)	
Diabetes (%)	Yes	1921 (15.3)	1931 (14.1)	1532 (12.1)	1201 (10.6)	878 (8.6)	<.001
	No	10540 (83.8)	11645 (84.9)	10999 (86.9)	9975 (88.2)	9218 (90.1)	
	Unknown	116 (0.9)	148 (1.1)	125 (1.0)	139 (1.2)	135 (1.3)	
Atrial Fibrillation (%)	Yes	1584 (12.8)	2025 (15.0)	1973 (15.8)	1884 (16.9)	1859 (18.5)	
	No	10813 (87.2)	11472 (85.0)	10482 (84.2)	9263 (83.1)	8205 (81.5)	<.001
	Unknown	180 (1.4)	227 (1.7)	201 (1.6)	168 (1.5)	167 (1.6)	
Previous myocardial infarct (%)	Yes	1028 (8.2)	1232 (9.0)	1086 (8.6)	944 (8.3)	764 (7.5)	.008
	No	11347 (90.2)	12250 (89.3)	11346 (89.6)	10168 (89.9)	9281 (90.7)	
	Unknown	202 (1.6)	242 (1.8)	224 (1.8)	203 (1.8)	186 (1.8)	
Hypertension (%)	Yes	5931 (47.2)	6635 (48.3)	6118 (48.3)	5477 (48.4)	4889 (47.8)	.062
	No	6369 (50.6)	6743 (49.1)	6200 (49.0)	5560 (49.1)	5069 (49.5)	
	Unknown	277 (2.2)	346 (2.5)	338 (2.7)	278 (2.5)	273 (2.7)	
Stroke type (%)	Hemorrhagic	1020 (8.1)	1097 (8.0)	1031 (8.1)	883 (7.8)	831 (8.1)	.001
	Ischemic	11557 (91.9)	12627 (92.0)	11625 (91.9)	10432 (92.2)	9400 (91.9)	
Cause of death (%)	Other diseases	1182 (9.4)	1292 (9.4)	1254 (9.9)	1064 (9.4)	833 (8.1)	<.001
	Heart	724 (5.8)	990 (7.2)	970 (7.7)	856 (7.6)	710 (6.9)	
	Stroke	1507 (12.0)	1860 (13.6)	1704 (13.5)	1566 (13.8)	1381 (13.5)	
	Cancer	615 (4.9)	730 (5.3)	664 (5.2)	573 (5.1)	478 (4.7)	
	Censored	8549 (68.0)	8852 (64.5)	8064 (63.7)	7256 (64.1)	6829 (66.7)	
Mortality (%)	Dead	4028 (32.0)	4872 (35.5)	4592 (36.3)	4059 (35.9)	3402 (33.3)	<.001

Abbreviations: BMI, body mass index; SD, standard deviation.

*Income was categorized into the 20th, 40th, 60th, and 80th percentiles of the sex and age-specific distribution, that is, 5 groups from lowest to highest income.

Table 2. *Mortality rates at 1 month, 3 months, 1 year, and 5 years in 5 income groups adjusted for age and sex*

Income %[†]	Mortality			
	1 month	3 months	1 year	5 year
		Death from cancer		
<20	0.34 (0.24-0.44)	0.75 (0.60-0.90)	1.84 (1.61-2.07)	4.57 (4.22-4.92)
20-40	0.38 (0.28-0.48)	0.87 (0.72-1.03)	2.01 (1.78-2.24)	4.91 (4.54-5.27)
40-60	0.40 (0.29-0.51)	0.93 (0.75-1.10)	2.16 (1.90-2.43)	4.76 (4.38-5.14)
60-80	0.44 (0.32-0.56)	0.86 (0.69-1.03)	1.89 (1.64-2.15)	4.57 (4.19-4.95)
>80	0.31 (0.20-0.41)	0.77 (0.60-0.93)	1.83 (1.57-2.09)	3.93 (3.55-4.30)*
		Death from other diseases		
<20	0.96 (0.80-1.13)	1.70 (1.48-1.92)	3.49 (3.19-3.80)	10.10 (9.64-10.56)
20-40	0.92 (0.76-1.08)	1.67 (1.46-1.87)	3.30 (3.00-3.59)	9.07 (8.62-9.52)
40-60	1.01 (0.83-1.19)	1.67 (1.44-1.90)	3.38 (3.05-3.71)	9.02 (8.54-9.50)
60-80	0.79 (0.63-0.95)	1.54 (1.32-1.76)	3.09 (2.78-3.40)	8.27 (7.80-8.75)
>80	0.78 (0.61-0.95)	1.33 (1.10-1.55)	2.79 (2.47-3.11)	6.87 (6.40-7.34)*
		Death from heart diseases		
<20	1.00 (0.83-1.17)	1.53 (1.33-1.73)	2.77 (2.51-3.04)	7.34 (6.94-7.74)
20-40	1.47 (1.26-1.69)	2.25 (1.99-2.51)	3.49 (3.17-3.81)	7.47 (7.04-7.90)
40-60	1.58 (1.36-1.80)	2.40 (2.13-2.67)	3.89 (3.57-4.22)	7.49 (7.06-7.92)
60-80	1.43 (1.20-1.65)	2.14 (1.87-2.40)	3.51 (3.17-3.85)	7.04 (6.60-7.48)
>80	1.42 (1.19-1.65)	2.09 (1.81-2.36)	3.50 (3.14-3.85)	6.23 (5.77-6.69)*
		Death from stroke		
<20	5.07 (4.69-5.46)	6.47 (6.05-6.90)	8.77 (8.29-9.26)	14.85 (14.28-15.41)
20-40	5.64 (5.25-6.02)	7.39 (6.96-7.82)	9.40 (8.93-9.87)	14.57 (14.03-15.10)
40-60	5.38 (4.99-5.77)	7.33 (6.88-7.78)	9.26 (8.77-9.75)	13.42 (12.88-13.97)
60-80	5.80 (5.37-6.24)	7.63 (7.14-8.12)	9.71 (9.16-10.25)	13.68 (13.08-14.27)
>80	5.42 (4.96-5.88)	6.90 (6.40-7.41)	8.79 (8.23-9.36)	12.69 (12.07-13.32)*
		Death from all causes		
<20	7.39 (6.93-7.84)	10.46 (9.93-10.98)	16.81 (16.19-17.43)	37.07 (36.34-37.81)
20-40	8.41 (7.93-8.89)	12.15 (11.60-12.70)	18.04 (17.42-18.67)	36.60 (35.88-37.31)
40-60	8.37 (7.88-8.85)	12.28 (11.70-12.86)	18.52 (17.87-19.18)	35.39 (34.63-36.15)
60-80	8.45 (7.93-8.98)	12.12 (11.53-12.71)	18.01 (17.35-18.68)	34.50 (33.76-35.24)
>80	7.91 (7.36-8.47)	11.05 (10.42-11.68)	16.78 (16.05-17.51)	31.34 (30.52-32.16)*

[†]Income was categorized into the 20th, 40th, 60th, and 80th percentiles of the sex and age-specific distribution, that is, 5 groups from lowest (<20%) to highest (>80%) income. Numbers in brackets are 95% confidence limits. Statistical significant tests ($P < .05$) for trend by income quintile are provided with an asterisk (*).

Thus for death by stroke and cardiac disease inequality in short-term mortality appeared to have the opposite direction of that in long-term mortality.

Almost all previous studies on SEP and mortality after stroke have been on all-cause death.[1-6] In a Swedish study on mortality after stroke lower SEP was associated with higher short- and long-term stroke-specific mortality but deaths during hospitalization (more than half of deaths in the study cohort) were excluded from the study.[20] Our study is the first to investigate the impact of SEP on cause-specific death after stroke in an unselected stroke population. As stroke and cardiac disease causes more than 2 of 3 deaths after stroke within the first year this also led to a similar 2-phase course for all-cause mortality wherein lower income was associated with a slightly lower short-term but clearly higher long-term risk of all-cause death.

Our finding of lower short-term risk of death after stroke among low-income stroke patients is surprising because lower SEP is known to be associated with adverse health.[1] In our study diabetes, smoking, and alcohol consumption over the recommended level were markedly more prevalent among patients with lower income. In addition the low-income stroke patients were mean 6 years younger than stroke patients in the highest income group indicating that low-income persons experience stroke much earlier in life than high-income patients. Higher short-term mortality for low-income stroke patients would have been a plausible finding while the opposite appears meaningless at first sight. However, we do not believe that our finding can be taken to indicate lower short-term mortality among low-income stroke patients as such. Instead we propose it is the result of a

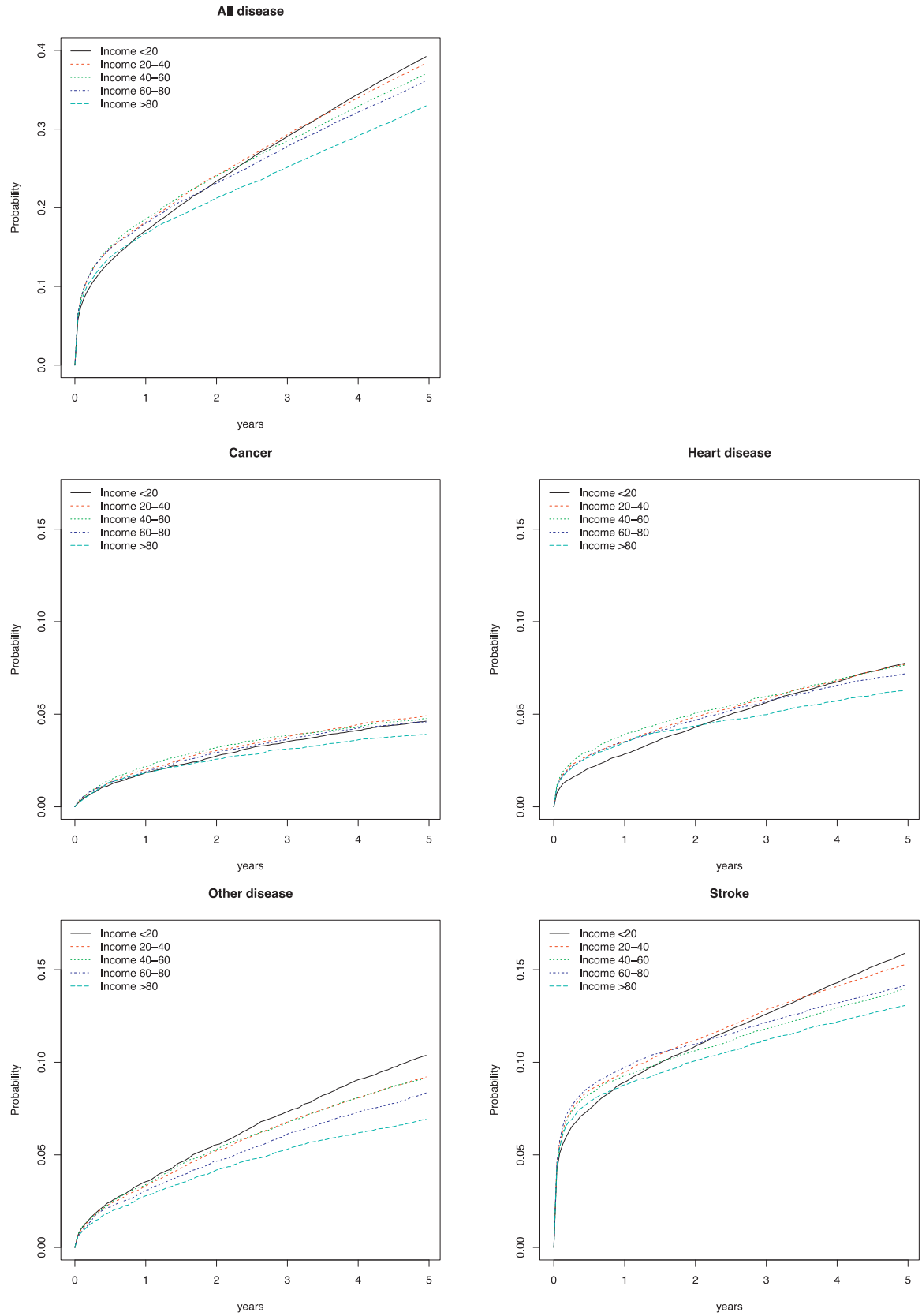

Figure 1. *Cumulative mortality rate by income group, adjusted for age and sex. Death by all causes, stroke, heart diseases, cancer, and other diseases.*

selection phenomenon similar to that brought about by so-called "mortality displacement" well known in environmental research.[21] If a population is subject to a temporary increase in the mortality rate, for example, attributable to environmental phenomena such as heat waves, cold spells, epidemics, and pandemics, one can in a subsequent period, observe a reduced mortality ratio in the population. Such short-term forward shift in mortality rate is also referred to as" harvesting effect". The most fragile individuals in the population are the first to subcome as a result of a given incident. The mortality rate in the population will subsequently decrease for a period during which survivability of the population appears to have increased due to elimination of the most fragile patients. A similar phenomenon may manifest when comparing short-term mortality in low- and high-income stroke patients:

Mortality displacement may affect the income strata because income is closely related to life expectancy and thus mortality in the different income strata. In Denmark life expectancy is 9.9/6.2 years shorter for low-income men/women than for their high-income counterparts.[22] In USA life expectancy for the 1% poorest is 15 years shorter than that of the 1% richest persons.[23] It follows that diseases leading to death are expressed several years earlier in low-income persons. Hence relative to higher income persons low-income persons are the more fragile. As a result of selection by mortality displacement low-income persons, therefore, will turn up being superior in regard to survival when compared to their age and sex matched higher income counterparts already at the time of inclusion in the study.

Our results for long-term mortality indicate that lower SEP in general is associated with higher long-term mortality after stroke no matter cause of death. The lower short-term mortality rate we observed for lower income patients can be considered the result of selection by mortality displacement when adjusting for age and sex. This artifact, driven by statistics, may become especially prominent when cause of death is identical to the disease which is subject of investigation, here stroke. The artifact may also appear when investigating cardiac death after stroke as cardiac disease and stroke both belong to the same disease entity (cardiovascular disease) thus sharing the same etiological background. The artificial phenomenon can only be expected to occur temporarily because the increased risk for stroke and cardiac disease associated with low income will continue to rise with time more for low income than for high-income patients (due the higher prevalence of cardiovascular risk factors) so that the increasing advent of new strokes/cardiac diseases over time will ultimately result in increased death rate by stroke/cardiac diseases that will overshadow the superiority in survival of low-income patients artificially brought about when low- and high-income persons are matched for age.

Mortality displacement is expected to influence less the mortality rates by cancer and other diseases because the disease causing death and that defining the cohort (here stroke) are not identical.

Overall, we interpret our results as follows: Low income is associated with higher long-term risk of death regardless of cause of death. This is also the case for short-term risk of death by cancer and other nonvascular diseases. We cannot draw firm conclusion as to the short-term risk of death by stroke and cardiac disease because of methodological issues. However, we find it most plausible to assume that lower income stroke patient's short-term risk for death by stroke and cardiac disease does not differ much from that of higher income stroke patients. In contrast to long-term mortality differences between income groups in short-term mortality were, however, small and hardly of clinical significance.

Despite considerable variation in design and in the type and number of adjusted confounders low SEP is generally associated with higher short-term all-cause mortality in most (but not all) studies while studies on the association with long-term all-cause mortality are considered inconclusive.[1] Thus the result of our study is in contrast to most other studies on short-term survival after stroke.[1] However, in a previous study on 56,581 stroke patients in the Danish Stroke Register[5] in which we adjusted for stroke severity, age, sex, and cardiovascular risk factors we found no significant association between SEP and 1-month stroke mortality as also found in our present study. However, in that study long-term all-cause mortality (mean follow-up 3.1 years) was significantly (30%) higher for patients with low SEP than for patients with high SEP[5]; also in line with our present study.

For this study we decided not to adjust for confounders other than age and sex. Life circumstances are different for the rich and the poor as is also life style and the health indicator/risk factor profile associated with life circumstances and life style. Adjusting for risk factors, life style indicators etc. would in our opinion only lead to comparison of groups not existing in real life. Therefore, we believe that our design provides the most realistic picture of the consequence of social inequality for stroke survival. Although our study may indicate social inequality in both in short- and long-term outcome, differences between the 5 income groups in short-term outcome were small and hardly measurable whereas for long-term outcome they were obvious. It therefore seems that social inequality is rather expressed in a greater risk for the advent of new diseases among patients with low SEP (recurrent strokes, cardiac disease, etc) than in their ability to survive disease as such.

A major strength of this study was the large dataset extracted from a high quality stroke registry with national coverage. Information on income from Statistics Denmark was complete. We had survival data including causes of death recorded on death certificates on nearly all patients,

with less than 0.2% lost to follow-up. Although useful in determining cause of death[24] death certificates are subject to some uncertainty and miscoding may occur.[25] However, Danish death records contain obligatory information on both the immediate cause of death and of the underlying cause of death (these are not necessarily identical). In this study cause of death refer to the underlying cause of death according to the recommendations of the WHO.[17]

Moreover, re-evaluation of the accuracy of death certificates in another Scandinavian study[26] revealed disagreement of 45% at the 4-digit ICD-10 level but only 12%-13% at the 3-digit level (the ICD-10 level used in this study). We had no information on treatments or interventions that might have influenced survival such as treatment of prevalent cancer, cardiac diseases etc. As the data are for patients hospitalized with stroke, our conclusions pertain only to the hospitalized Danish stroke population.

Conclusions

Our study strongly suggests the existence of social inequality in mortality after stroke. Social inequality appeared in the risk of death not only of stroke but in the risk of death of other diseases as well. Inequality is expressed primarily in long-term mortality as all-cause mortality 5 years after stroke was 15% higher for patients in the lowest than in the highest income group. On the other hand we found no clinically significant association between income and short-term mortality after stroke no matter cause of death.

Disclosures

None.

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