Socioeconomic Position and Incidence of Ischemic Stroke in Denmark 2003–2012. A Nationwide Hospital-Based Study

Klaus Kaae Andersen, PhD; Marianne Steding-Jessen, MSc; Susanne Oksbjerg Dalton, MD; Tom Skyhøj Olsen, MD

Background—A greater burden of stroke risk factors in general is associated with a higher risk for stroke among people of lower than those of higher socioeconomic position. The relative impact of individual stroke risk factors is still unclear.

Methods and Results—We studied the relations between socioeconomic position, measured as household income and length of education, and all hospital admissions for a first ischemic stroke among 54 048 people over the age of 40 years in Denmark in 2003–2012 in comparison with the general Danish population (23.5 million person-years). We also studied the cardiovascular risk factor profile associated with socioeconomic position in stroke patients. Relative risks for stroke were estimated in log-linear Poisson regression models. The risk for hospitalization for a first ischemic stroke was almost doubled for people in the lowest income group, and the risk of those of working age (<65 years) was increased by 36% among people with the shortest education. Diabetes, obesity, smoking, and high alcohol consumption in particular and, to a lesser extent, previous myocardial infarction or intermittent arterial claudication were significantly overrepresented among stroke patients with lower socioeconomic position. Atrial fibrillation and hypertension were not.

Conclusions—In Denmark, there is a strong relation between low socioeconomic position and risk for hospitalization for stroke. Lifestyle, as indicated by smoking, obesity, and alcohol consumption, and diabetes appears to increase the risk for stroke in people with lower socioeconomic position. (*J Am Heart Assoc*.2014;3:e000762 doi: 10.1161/JAHA.113.000762)

Key Words: disposable income • education • ischemic stroke • socioeconomic position

Stroke imposes a significant economic burden on society. Health authorities around the world therefore emphasize initiatives to reduce stroke incidence. Prophylactic measures are primarily focused on lifestyle changes and primary and secondary interventions with drugs such as antihypertensive agents, statins, and platelet inhibitors.[1]

Socioeconomic position has been associated with the risk for stroke.[2–4] A larger burden of cardiovascular risk factors in lower income groups appears to explain at least part of their higher stroke risk.[3,4] The relative impact of individual risk factors on total stroke risk in different socioeconomic groups is, however, unclear. More knowledge in this area could help focus the preventive initiatives that would reduce social inequality. The impact of socioeconomic position on stroke incidence has so far been studied only in subpopulations and not at the national level. Socioeconomic position is often geographically determined; therefore, a study based on an entire nation might provide a more balanced image of social inequality in society. The aim of the study reported here was to investigate the impact of socioeconomic position on the burden of stroke in Denmark. We studied the association between the socioeconomic position of patients hospitalized for stroke after the age of 40 years in Denmark during the years of 2003–2012 and that of the general Danish population. Furthermore, we studied the cardiovascular risk factor profile associated with stroke in different socioeconomic groups.

Methods

All citizens of Denmark over the age of 40 and who had lived in Denmark during some or all of the period of 2003–2012 were included. Information on stroke outcome was obtained from the Danish Stroke Register (formerly the stroke section, Danish National Indicator Project) as described in detail elsewhere.[5,6] Danish hospitals are obliged to report a predefined set of data to the Register for all patients admitted to hospital for acute stroke, including age, sex, stroke severity

on admission measured on the Scandinavian Stroke Scale,[7] stroke subtype, and a predefined cardiovascular profile.

The Scandinavian Stroke Scale is a validated neurological scale of stroke severity from 0 to 58, lower scores indicating more severe strokes.[7] Ischemic stroke was distinguished from hemorrhagic stroke by computed tomography or magnetic resonance scanning. The cardiovascular profile included information on alcohol consumption ($\leq$14/21 >14/21 drinks per week for women and men, respectively [under/over the limit set by the by the Danish National Board of Health]), current daily smoking, body mass index (weight/height^2), diabetes mellitus, atrial fibrillation (AF) (chronic or paroxystic), arterial hypertension, previous myocardial infarction, previous stroke, and intermittent arterial claudication. By March 2012 the recommended alcohol intake limit was lowered to 7/14 drinks per week for women and men, respectively. Diabetes, AF, arterial hypertension, previous myocardial infarction, previous stroke, and intermittent arterial claudication were diagnosed on current Danish standards[6] and were either known before the onset of stroke or diagnosed during hospitalization. Stroke was defined according to World Health Organization criteria.[8]

For all people in the study population, we obtained information on level of education and disposable income, as described in.[9] Here, education was grouped into 3 categories, from basic to high: (1) basic/high school, defined as 7 to 12 years of primary, secondary, and grammar-school education; (2) vocational, defined as 10 to 12 years of education including vocational training; and (3) higher, defined as 13 or more years of education. People for whom information on education was missing were not included (14%). Disposable income was defined as household income after taxation and interest per person, adjusted for the number of people in the household and deflated according to the 2000 value of the Danish crown (DKK). People with a high negative income due to debt and interest on debt (>50 000 DKK per year) were excluded from all analyses. For the analyses, disposable income was categorized into the first to fifth quintile of income distribution.

We included incident hospital admissions for first ischemic stroke between January 1, 2003, when the Danish Stroke Register was fully established, and July 28, 2012. For patients with multiple hospital admissions, only the first admission was included. Information on previous stroke was obtained from the patient, his/her care persons or from hospital records available on the acute admission or from the Danish Stroke Register. Patients with recorded history of previous stroke (either ischemic or hemorrhagic) were excluded; however, patients with previous transient ischemic attacks (TIA) were not excluded. Patients registered with hemorrhagic stroke between 2003 and 2012 were excluded from the study. TIAs are not registered in the Danish Stroke Register (ie, not an outcome of the study). Hence, we studied only incidence of

hospitalization for first-ever ischemic stroke in the Danish population between 2003 and 2012. Patients <40 years were excluded from the study, as were patients for whom scanning was not performed (0.4%) or for whom the results were not available (0.7%). The coverage of the Stroke Register is currently estimated (by professional consensus) to be about 80% of all stroke admissions in Denmark.[10] Most stroke patients are admitted to the hospital (90%), as access to hospital care is free in Denmark.[11] The study protocol was approved by the institutional review board of the Danish Stroke Register and the Danish Data Protection Agency (journal number 2012-41-0719).

Statistical Analysis

First, incidence rates were estimated for the 3 educational levels and 5 income levels separately by calculating the incidence of ischemic strokes registered in the Danish Stroke Register for all ages and calendar times for each level of education and income and dividing by the corresponding person-years. The person-years were calculated by summing up time at risk for each person by calendar year, age, and socioeconomic position. Persons did only contribute with person time for the period living in Denmark, ie, follow-up was censored at dates of death, disappearance, or emigration. We used log-linear Poisson regression models to estimate incidence rate ratios for education and disposable income, with 95% confidence intervals (CIs) for each factor. These analyses were adjusted for calendar time, age, and sex, with the accumulated person-time for each grouping as offset. Both age and calendar time were grouped into 1-year periods and included continuously as restricted cubic splines in the model. After the analysis of incidence, we investigated the association between socioeconomic position and cardiovascular risk factors for stroke. This analysis was restricted to stroke patients only, as vascular risk factor profile was only available for patients already having suffered stroke. The analysis was done by estimating the prevalence, with 95% CIs, of comorbid conditions and risk factors for the stroke patients. Then, for comorbid conditions and risk factors separately, we applied logistic regression models to estimate the relative risk in relation to education and disposable income. All tests were 2-sided and based on the likelihood ratio test. A significance level of 5% was applied. The statistical software R[12] was used in all analysis.

Results

In total, 54 048 Danes over the age of 40 years were registered in the Stroke Register as having been hospitalized for a first ischemic stroke during the 9.5-year study period. The mean age was 71.9 years, 47.5% were women, and the mean

Table 1. Prevalence of Comorbid Conditions and Risk Factors in Ischemic Stroke Patients Over 40 Years by Length of Education and Disposable Income, 2003–2012

Risk Factor	Education, N (%)			Income Group, N (%)				
	Basic	Vocational	Higher	1	2	3	4	5
Diabetes	2963 (15)	3053 (13)	727 (10)	1891 (15)	2378 (15)	1088 (13)	743 (11)	643 (9)
Atrial fibrillation	3372 (17)	2927 (12)	976 (13)	2123 (17)	2510 (16)	1081 (12)	751 (11)	810 (11)
Previous myocardial infarction	1945 (10)	1916 (8)	512 (7)	1239 (10)	1508 (10)	723 (8)	449 (7)	454 (6)
Hypertension	10 402 (51)	11 568 (48)	3379 (46)	6328 (50)	8172 (51)	4290 (49)	3209 (46)	3350 (45)
Intermittent claudication	647 (3)	633 (3)	151 (2)	383 (3)	537 (3)	222 (3)	171 (3)	118 (2)
Smoking	5911 (29)	6461 (27)	2455 (34)	3381 (27)	4319 (27)	2449 (28)	2100 (30)	2578 (34)
Alcohol	1255 (6)	2453 (10)	759 (10)	1017 (8)	1327 (8)	765 (9)	612 (9)	746 (10)
Obesity*	2914 (20)	3185 (18)	685 (13)	1606 (18)	2176 (19)	1181 (19)	908 (18)	913 (17)

*Defined as body mass index >30; information available for only 73% of stroke patients.

Scandinavian Stroke Scale score was 44.1. A total of 23 517 408 person-years contributed to the analysis, corresponding to all Danes over 40 years of age and resident in Denmark during the study period. The incidence rates of stroke in the study population were 2.0 per 1000 person-years for women and 2.6 per 1000 person-years for men. Table 1 shows the distribution of comorbid conditions and risk factors among the stroke patients by income and education.

Incidence

The risk ratios of hospitalization for stroke associated with disposable income are shown in Table 2 (both unadjusted and adjusted for age, sex, calendar year, and length of education).

A highly significant stepwise relation was found between income and risk for hospitalization for stroke, the risk being almost twice as high in the lowest income group than in the highest. Analyses for people over and under 65 years gave similar results (not shown).

The risks for hospitalization for stroke associated with length of education are also shown in Table 2 (both unadjusted and adjusted for age, sex, calendar year, and income). In the adjusted analysis, the risk of stroke hospitalization of the higher education groups was lower than in the vocational and short education group (P<0.001). Only a borderline significant difference in the risk of stroke hospitalization (P=0.05) was found between the short and vocational education group. Associations were attenuated

Table 2. Incidence Rates Per 1000 Person-Years and Relative Risks of Hospitalization for Ischemic Stroke in the Danish Population Over 40 Years by Length of Education and Disposable Income, 2003–2012

Variable	1000 Person-Years	% of Total	Incident Cases of Ischemic Stroke	Incidence Rate	Relative Risk (95% CI) Unadjusted	Relative Risk (95% CI) Adjusted*
Education						
Basic	5258.3	22.3	21 214	4.03	1 (reference)	1 (reference)
Vocational	12 522.4	53.2	25 096	2.00	0.49 (0.48 to 0.50)	0.99 (0.97 to 1.00)
Higher	5736.7	24.5	7738	1.35	0.33 (0.32 to 0.34)	0.85 (0.82 to 0.87)
Income						
1	3354.8	14.2	15 274	4.55	1 (reference)	1 (reference)
2	4759.6	20.2	16 152	3.39	0.75 (0.73 to 0.76)	0.83 (0.81 to 0.85)
3	4248.3	18.0	8705	2.05	0.45 (0.44 to 0.46)	0.76 (0.74 to 0.78)
4	4858.8	20.6	6739	1.39	0.31 (0.30 to 0.32)	0.66 (0.64 to 0.68)
5	6295.9	27.0	7178	1.14	0.25 (0.24 to 0.26)	0.56 (0.54 to 0.58)

*For age, sex, calendar year, and income/education. Income group 1 to 5 corresponds to income group first to fifth quintile.

by covariate adjustment, primarily because income, education and age are correlated. In a sub-analysis of people under 65 years, a significant stepwise relation was found between length of education and hospitalization for stroke, the risk being 36% higher for people with short education than for those with higher education (vocational education, RR 0.85, 95% CI 0.82 to 0.89; higher education, RR 0.64 95% CI 0.61 to 0.68; reference, basic education) while adjusting for covariates. In the sub-analysis of people over 65 years, no difference was found by length of education (not shown).

Risk Factors

Table 3 shows the risk estimates for each comorbid condition and risk factor separately, by income and length of education and adjusted for age, sex, and calendar time. Men had significantly more risk factors, except for AF, hypertension, and obesity, which were generally equally represented in men and women. The prevalence of risk factors increased with age, except for smoking, excessive alcohol consumption, and obesity, the prevalence of all of which decreased with age.

The adjusted analysis showed that diabetes, intermittent arterial claudication, smoking, excessive alcohol consumption, and, to a lesser degree, previous myocardial infarction and obesity were significantly more prevalent in the lower than in the higher income group. While AF was slightly more prevalent among stroke patients in the highest income group, the prevalence of hypertension did not differ by income.

Diabetes, previous myocardial infarction, intermittent arterial claudication, smoking, and obesity were significantly more prevalent among stroke patients with shorter than with higher education. The differences were particularly large for smoking, obesity, and diabetes. Excessive alcohol consumption was remarkably more prevalent among patients with higher than patients with short education.

Discussion

This study of the entire Danish population aged ≥40 years of age revealed marked social inequality with respect to ischemic stroke. The risk for hospitalization with a first ischemic stroke was almost doubled for people in the lowest income group as compared with people in the highest income group. Length of education also influenced the risk for ischemic stroke, although to a lesser degree than income. In people of working age (<65 years), the risk was 36% higher for those with short education than for those with the highest education. Our study confirms that the association between socioeconomic position and risk for stroke documented in a large number of studies on subpopulations[2-4] is also present at the national level, in this case in Denmark.

The finding that risk factors for stroke were more prevalent in stroke patients with lower income could partly explain the difference in risk for stroke by income. This was true especially for associations between diabetes, excessive alcohol consumption, and smoking and intermittent arterial claudication, and, to a lesser degree, that between obesity and previous myocardial infarction; associations were not seen with AF or hypertension. A relation between risk factors for stroke and income was reported from a recent meta-analysis, which concluded that smoking cessation and management of blood pressure and other vascular risk factors should be priorities in areas of low socioeconomic status.[3,4] The results of our study indicate, however, that only some of the known classical risk factors for stroke were overrepresented in lower socioeconomic groups, others were not. Smoking, high alcohol consumption, and obesity as proxies for the lifestyle of stroke patients in lower income groups probably partly explain their higher risk for stroke, and the marked overrepresentation of diabetes is also likely to contribute. The 2 medically amenable classical risk factors for stroke, hypertension and AF, were not overrepresented among stroke patients with lower incomes. A similar observation was made in a Dutch study on the risk of women for stroke.[13] As hypertension, AF, and diabetes were registered in the Danish Stroke Register if they were known before the stroke or diagnosed during hospitalization, patients being treated for these conditions were included in our study. In Denmark, more than 90% of stroke patients are already known to have hypertension, AF, and diabetes before their stroke.[14] While the risk for stroke is markedly reduced by antihypertensive agents, antithrombotic agents, and anticoagulants, there is no evidence that better glycemic control by anti-diabetic agents alone reduces the risk of people with diabetes for stroke.[1] This may explain why diabetes but not hypertension or AF was related to social inequality in the risk for stroke.

Identification of stroke risk factors is a prime focus in primary health care in Denmark. Free, equal access to health care services in Denmark ensures that income is not an obstacle to receiving preventive treatment, even for lower income groups. Hence, the effects of hypertension and AF may be reduced by preventive treatment, independent of income. However, glycemic treatment, which is also free of charge, does not in itself reduce the risk for stroke in diabetes. The form of diabetes among stroke patients in the Danish Stroke Register is usually type 2 and thus often lifestyle mediated; this may explain the marked overrepresentation of diabetes among stroke patients in lower-income groups. Hence, our study indicates that lifestyle modification rather than medical prevention of classical stroke risk factors is the way to overcome social inequality in respect of risk for stroke. This conclusion, however, is applicable only to countries with a highly developed social security system with free, equal access to health care. In countries with less

Table 3. Odds Ratios (95% CI) for Comorbid Conditions and Risk Factors in Ischemic Stroke Patients Over 40 Years by Length of Education and Disposable Income, 2003-2012

Risk Factor	Education, OR (95% CI)		Income Group, OR (95% CI)				Male Sex, OR (95% CI)	Age, OR (95% CI) Per 10 Years
	Vocational	Higher	2	3	4	5		
Diabetes	0.93 (0.88 to 0.99)	0.81 (0.74 to 0.90)	1.02 (0.95 to 1.09)	0.84 (0.77 to 0.99)	0.72 (0.65 to 0.79)	0.57 (0.52 to 0.63)	1.36 (1.29 to 1.43)	1.02 (0.99 to 1.04)
Atrial fibrillation	1.01 (0.96 to 1.07)	1.06 (0.97 to 1.16)	1.03 (0.96 to 1.10)	0.97 (0.90 to 1.06)	1.07 (0.97 to 1.18)	1.14 (1.03 to 1.26)	0.97 (0.92 to 1.02)	2.04 (1.97 to 2.10)
Acute myocardial infarction	0.94 (0.88 to 1.01)	0.85 (0.76 to 0.95)	1.05 (0.97 to 1.14)	1.01 (0.92 to 1.12)	0.85 (0.76 to 0.96)	0.81 (0.72 to 0.92)	2.13 (1.99 to 2.28)	1.39 (1.34 to 1.43)
Hypertension	1.05 (1.01 to 1.10)	0.97 (0.91 to 1.02)	1.09 (1.04 to 1.14)	1.10 (1.04 to 1.16)	1.06 (1.00 to 1.13)	1.02 (0.96 to 1.09)	0.92 (0.89 to 0.95)	1.25 (1.23 to 1.27)
Intermittent claudication	0.92 (0.82 to 1.03)	0.82 (0.67 to 0.99)	1.17 (1.02 to 1.34)	0.93 (0.78 to 1.10)	0.95 (0.78 to 1.15)	0.61 (0.50 to 0.77)	1.46 (1.30 to 1.62)	1.14 (1.08 to 1.20)
Smoking	0.91 (0.87 to 0.95)	0.69 (0.64 to 0.74)	0.96 (0.91 to 1.01)	0.81 (0.76 to 0.86)	0.66 (0.62 to 0.71)	0.51 (0.47 to 0.54)	1.24 (1.20 to 1.29)	0.55 (0.54 to 0.56)
Alcohol	1.31 (1.21 to 1.41)	1.51 (1.36 to 1.67)	0.96 (0.88 to 1.05)	0.78 (0.70 to 0.86)	0.64 (0.57 to 0.71)	0.67 (0.60 to 0.75)	3.30 (3.05 to 3.56)	0.67 (0.65 to 0.68)
Obesity*	0.74 (0.70 to 0.79)	0.53 (0.48 to 0.59)	1.03 (0.96 to 1.11)	0.95 (0.87 to 1.04)	0.86 (0.78 to 0.95)	0.88 (0.79 to 0.97)	0.98 (0.93 to 1.03)	0.72 (0.70 to 0.73)

Adjusted by sex, age, and calendar year; reference categories, basic education and income group 1.
*Information available for only 73% of stroke patients.

developed social security systems without equal access to prevention and treatment of stroke risk factors, hypertension and AF might have significant effects on socioeconomic differences in the risk for stroke.

Income was associated with risk for hospitalization for stroke at any age, while education was associated with hospitalization only for people of working age. The observation is supported in the literature. Another Danish study of a sub-population of 20 000 people in Copenhagen found an inverse association between the risk for stroke and income but no association with length of education.[15] In other studies, the inverse association between stroke risk and socioeconomic position varied with age, being weaker or absent in the elderly.[4] The decrease in the prevalence of smoking and excessive alcohol consumption with age, also demonstrated in this study, may contribute to the absence of a correlation between education and risk for stroke in the elderly. Likewise, the finding that high alcohol consumption was more prevalent among stroke patients with higher education than those with short education might have contributed to the weaker association.

A history of previous myocardial infarction and intermittent arterial claudication was significantly more prevalent among stroke patients in lower socioeconomic groups, suggesting that they have more atherosclerosis. Although this finding is independent of the other stroke risk factors examined in this study, it may reflect a greater frequency of poorer lifestyle indicators among stroke patients in lower socioeconomic groups.

A major strength of this study was the very large dataset, with complete information on age, sex, disposable income, and length of education for the entire Danish population. Furthermore, the personal identification number that identifies each person living in Denmark allowed linkage to the Danish Stroke Register, which includes more than 80% of patients hospitalized for stroke in Denmark since 2003, with no limitation by age, sex, or stroke severity. The completeness of data on diabetes, previous myocardial infarction, AF, and hypertension for more than 50 000 patients registered with a first ischemic stroke was >97%, and that for alcohol consumption, smoking, and intermittent arterial claudication it was >85%. Moreover, treatment would have been uniform, as 96% of patients were treated in a stroke unit. Missing values were associated with increasing age, although we do not find patterns in missingness conditional on age. Therefore, we consider our study population to be representative of the Danish population hospitalized for stroke, and have conducted complete case analysis.

More than 90% of patients with acute stroke are hospitalized in Denmark.[11] Although our observations therefore apply to the majority of stroke patients, they apply only to those who are hospitalized. A limitation of the study is thus that hospitalization rates are not reflecting true incidence of

stroke. We do not have data to analyze whether this affects the estimated risk ratios, ie, whether missing stroke registration is associated with socioeconomic status. Data on risk factors were collected on admission to hospital. We had no information on individual vascular risk factors pre stroke.

Conclusion

This study presents novel information about social inequality in the risk of stroke based on a nationwide data. Although Denmark has a highly developed social security system, with free, equal access to health care services, there is considerable social inequality in relation to the risk for stroke. In comparison with people with the highest income, those with the lowest had a 2-fold higher risk of being hospitalized for stroke. Among people of working age, those with the shortest education had a 36% higher risk for stroke than those with the longest education. Among patients with stroke obesity, smoking, and high alcohol consumption were significantly overrepresented in patients in a lower socioeconomic position. Lifestyle, therefore appears to play an essential role for inequality in the risk for stroke and should remain a main target of preventive measures. Our study provides new insights into the role of medically treatable risk factors for social inequality in risk of stroke. Diabetes was almost two times more common among stroke patients in the lowest income group indicating that prevention of diabetes is crucial to social inequality in risk of stroke. Medically amenable classical stroke risk factors such as hypertension and AF appeared to be less important suggesting that consequences of an unhealthy lifestyle in the strict sense cannot be eliminated by medical intervention. Our study indicates that a focus on lifestyle and prevention of diabetes is a precondition for reducing social inequality in stroke in Denmark.

Sources of Funding

Disclosures

None.

References

1. Sacco RL, Adams R, Albers G, Alberts MJ, Benavente O, Furie K, Goldstein LB, Gorelick P, Halperin J, Harbaugh R, Johnston SC, Katzan I, Kelly-Hayes M, Kenton EJ, Marks M, Schwamm LH, Tomsick T. Guidelines for prevention of stroke in patients with ischemic stroke or transient ischemic attack: a statement for healthcare professionals from the American Heart Association/American Stroke Association Council on Stroke. *Stroke*. 2006;37:577–617.

2. Kerr GD, Slavin H, Clark D, Coupar F, Langhorne P, Stott DJ. Do vascular risk factors explain the association between socioeconomic status and stroke incidence: a meta-analysis. *Cerebrovasc Dis*. 2011;31:57–63.

3. Cox AM, McKevitt C, Rudd AG, Wolfe CDA. Socioeconomic status and stroke. *Lancet Neurol*. 2006;5:181–188.

4. Addo J, Ayerbe L, Mohan KM, Cricton S, Sheldenkar A, Chen R, Wolfe CDA, McKevitt C. Socioeconomic status and stroke. An updated review. *Stroke*. 2012;43:1186–1191.

5. Olsen TS, Dehlendorff C, Andersen KK. Sex-related time-dependent variations in poststroke survival—evidence of a female stroke survival advantage. *Neuroepidemiology*. 2007;29:218–225.

6. Mainz J, Krog BR, Bjørnshave B, Bartels P. Nationwide continuous quality improvement using clinical indicators: the Danish National Indicator Project. *Int J Qual Health Care*. 2004;16(suppl I):145–150.

7. Lindenstrøm E, Boysen G, Christiansen LW, á Rogvi-Hansen B, Nielsen BW. Reliability of Scandinavian Stroke Scale. *Cerebrovasc Dis*. 1991;1:103–107.

8. Report of the WHO Task Force on Stroke and other Cerebrovascular Disorders: stroke—1989: recommendations on stroke prevention, diagnosis, and therapy. *Stroke*. 1989;20:1407–1431.

9. Dalton SO, Steding-Jessen M, Gislum M, Frederiksen K, Engholm G, Schuz J. Social inequality and incidence of and survival from cancer in a population-based study in Denmark, 1994–2003: background, aims, material and methods. *Eur J Cancer*. 2008;44:1938–1949.

10. NIP-apopleksi. National auditrapport 2010. Version 3. March, 24. 2011. Available at: https://www.sundhed.dk/content/cms/69/4669_2010_apopleksi_nat_sfa.pdf. Accessed October 23, 2013.

11. Jørgensen HS, Plesner AM, Hübbe P, Larsen K. Marked increase of stroke incidence in men between 1972 and 1990 in Frederiksberg, Denmark. *Stroke*. 1992;23:1701–1704.

12. R Development Core Team. *R: A language and Environment for Statistical Computing*. Vienna: R Foundation for Statistical Computing; 2010. Available at: http://www.R-project.org/. Accessed October 23, 2013.

13. van Rossum CTM, van de Mheen H, Breteler MMB, Grobbee DE, Mackenbach JP. Socioeconomic differences in stroke among Dutch elderly women: the Rotterdam Study. *Stroke*. 1999;30:357–362.

14. Olsen TS, Rasmussen BH, Kammersgaard LP. Undetected hypertension, diabetes, atrial fibrillation and hypercholesterolaemia in patients with first-ever stroke. A community based study. *Int J Stroke*. 2008;3(suppl 1):378–379.

15. Boysen G, Nyboe J, Appleyard M, Sørensen PS, Boas J, Somnier F, Jensen G, Schnor P. Stroke incidence and risk factors for stroke in Copenhagen, Denmark. *Stroke*. 1988;19:1345–1353.