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Job control and the risk of incident stroke in the working population in Sweden

by Susanna Toivanen, PhD¹

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Objectives This study estimated the risk of incident stroke according to the level of job control and examined whether the association between job control and the risk of stroke varied as a function of gender.

Methods This was a register-based cohort study of nearly 3 million working people (age 30–64 years in 1990) with a 13-year follow-up (1991–2003) for incident stroke (50 114 events). Job control was aggregated to the data by a secondary data source (job-exposure matrix) in 1990. Gender-specific Cox regressions were applied.

Results The age- and workhour-adjusted hazard ratio of the lowest versus the highest job control quartile was 1.25 [95% confidence interval (95% CI) 1.17–1.32] for any stroke, 1.33 (95% CI 1.15–1.55) for intracerebral hemorrhage, and 1.22 (95% CI 1.14–1.31) for brain infarction among the women, and the corresponding figures for the men were 1.24 (95% CI 1.21–1.28), 1.30 (95% CI 1.21–1.40), 1.23 (95% CI 1.19–1.28), respectively. Adjustment for education, marital status, and income attenuated these associations to 1.07 (95% CI 1.01–1.14) for any stroke, 1.22 (95% CI 1.04–1.42) for intracerebral hemorrhage, and 1.04 (95% CI 0.97–1.12) for brain infarction for the women and to 1.08 (95% CI 1.04–1.12), 1.12 (95% CI 1.03–1.22), 1.08 (95% CI 1.04–1.13), respectively, for the men.

Conclusions The relative risk of stroke was higher in low job-control occupations. The association between job control and stroke subtypes varied as a function of gender. The relative risk of intracerebral hemorrhage was highest for the women in low job-control occupations.

Key terms cohort study; job-exposure matrix; occupational epidemiology; stroke.

There is extensive evidence showing that an adverse psychosocial work environment, as measured by low job control, increases the risk of cardiovascular disease (CVD) (1–3). Particularly the association between low job control and coronary heart disease (CHD) has been shown to be strong and consistent (3–5). Less is known about whether job control is associated with the risk of stroke, as only a few studies on the psychosocial work environment have focused on stroke as a specific CVD outcome, and the results are inconsistent (6–8). Recent findings from a cohort study of middle-aged women in Sweden suggest a weakly increased risk of ischemic stroke in association with low job control, but no such association was reported for hemorrhagic stroke (8). However, the findings were based on only a few stroke events, and subsequent statistical power problems increased the uncertainty of the results. Whether similar associations are valid for men remains unclear.

Job control, manifested as decision authority and skill discretion, refers to workers' sense of control over their tasks and performance at work (9). Decision authority is a socially agreed upon form of control over job performance, allowing employees to decide how and when their jobs are done. Skill discretion refers to control over the use of one's skills on the job. Theoretically, decision authority and skill discretion are closely related and are often combined into one measure (9).

Stroke is among the leading causes of death and long-term disability worldwide (10). In Sweden, roughly 30 000 people suffer from stroke each year, and about a fifth of them are of working age (<65 years) (7). The consequences of stroke with regard to production loss, sickness absence, disability pension, and premature death are considerable (11). Yet stroke is a preventable disease, as many of the risk factors associated with it are reversible.

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In line with previous findings on job control and CHD (3–5), we hypothesized that the risk of stroke is higher for working women and men with low job control. However, the association between job control and the risk of stroke may differ, as one stroke subtype (hemorrhage or brain infarction) may be more work-related than the other, and gender differences may exist (8). On the basis of register data on the total working population in Sweden, the aim of our study was to investigate the long-term association between job control and the risk of incident stroke (nonfatal or fatal) and to explore whether the association differs for stroke subtypes or for women versus men.

Study population and methods

Study population

The data used came from a subset of the Swedish Work and Mortality Data Base maintained at the Centre for Health Equity Studies, Stockholm University/Karolinska Institutet. The database compiles several national registers provided by Statistics Sweden, including the Total Population Register, the National Population and Housing Censuses, and the Longitudinal Data Base on Education, Income and Employment, all of which were used in our analyses. Linkages were possible using the 10-digit personal identity number, which was replaced by a serial number to ensure anonymity.

All people in Sweden who were 30 to 64 years of age in 1990 and had a job (employees and self-employed) at the time of the census were included (N=2 991 973). People were excluded from the analyses if they had a prior stroke diagnosis in the Hospital Discharge Register in 1980–1990 (N=4167) and if they had emigrated during the follow-up as recorded in the Total Population Register (N=41 898). After persons with missing values on job control, marital status, and income were excluded, the cohort consisted of 2 945 078 people (48.7% women).

The cohort was followed for nonfatal stroke by record linkage to the Swedish Hospital Discharge Register during 1991–2003 and for fatal stroke by linkage to the Cause of Death Register during 1991–2002. Because fatal first-ever stroke events were only 12% of the total stroke events in the period covered by both registers in 1991–2002, it was decided to end the follow-up on 31 December 2003. Consequently, information on fatal events was missing for 2003. Each participant was considered at risk from the beginning of the follow-up (1 January 1991) to the date of first stroke, death from other cause or the end of the follow-up (31 December 2003). There were 16 869 501 and 17 554 298 person-

years for the women and men, respectively, in the follow-up period.

Job control

Job control was aggregated to occupations in the 1990 census using a psychosocial job-exposure matrix. The matrix used was based on survey data from the Swedish Work Environment Survey in 1989–1997, including almost 49 000 women and men representative of the working population (12). Job control was constructed as a combined measure of decision authority (4 items) and skill discretion (3 items) (12). A total of 320 occupational categories (according to the 3-digit Nordic Occupational Classification codes) were attributed mean scores for job control as stratified by gender and age groups (30–44 and 45–64 years). In groups with too few observations (<4), the closest neighbor occupation in the classification system was used to impute the job-control score (12, p 20). Occupations were rated using the mean score for job control on a continuous scale of 0–10, and the distribution of job control was divided into four equally large groups (low, intermediate low, intermediate high, and high job control). Those within the high job-control group were used as the reference group. The most common occupations for the women in the low job-control group were shop assistants (15.7%), cleaners (15.5%), assistant nurses (9.4%), and kitchen assistants (8.9%), and, for the men, lorry and pickup drivers (18%), bus and taxi drivers (7.9%), metal machine workers (6%), and truck and conveyor operators (5.4%).

Potential confounders

Age was treated as a continuous variable in the multivariate analyses. As more men than women work full-time, the analyses were adjusted for a dichotomous variable for workhours (working full-time, yes or no). Educational level was divided into the following four categories: unknown, primary, secondary, or tertiary (reference category). Income was measured as individual disposable income, which includes both annual earnings and income transfers. The income measure was categorized by quartile values of the income distribution, and those in the highest 25% of income earners were used as the reference group. Marital status was divided into the following four categories: married (reference category), never married, divorced, or widowed.

Stroke end points

Incident stroke was defined either as a first-ever hospital admission for stroke or as death from stroke, and the following primary diagnoses at hospitalization and

underlying causes of death were used: intracerebral hemorrhage [International Classification of Diseases, ninth revision 431 (ICD-9-431), ICD-10-I61], brain (cerebral) infarction (ICD-9-434, ICD-10-I63), and undetermined pathological type (ICD-9-436, ICD-10-I64). Transient ischemic attack (ICD-9-435, ICD-10-G45) and subarachnoid hemorrhage (ICD-9-430, ICD-10-160) were excluded (13).

Statistical analyses

Gender-specific age-standardized incidence rates for stroke subtypes according to job-control quartiles were calculated per 100 000 person-years at risk (14). Direct standardization was applied using 5-year age groups and the age-specific person-years in the data as the standard population. Before multivariate regressions were applied, correlations between the included variables were studied using Spearman's rank correlation coefficients. The correlations were low to moderate (≤ 0.40 , $P < 0.05$) indicating no multicollinearity. The log-rank test was used to ensure that differences in the cumulative hazard functions were significant for the job-control groups in two age groups (30 to 52 and 53 to 64 years at baseline) and for both genders during the follow-up period.

To estimate the relative risk of incident stroke by level of job control, hazard ratios (HR) with 95% confidence intervals (95% CI) were calculated using Cox's proportional hazards models with length of follow-up as the time variable (14). Risk estimates were adjusted for age and workhours in the base model, and for education, marital status, and income one at a time, as well as for all of the confounders in the fully adjusted model. To test for linear trends in the association between job control and the risk of stroke, the median values for the job-control quartiles were treated hierarchically. Because the distribution of job control differed remarkably by gender (table 1) and because the estimates of some of the confounders were the opposite for the women and men, all of the analyses were stratified by gender.

Results

The women in occupations characterized by low job control were older, a larger proportion of them were married, and they were more likely to have a primary education than were the women in occupations with high job control (table 1). The men with low job control were slightly younger, a smaller proportion of them was married, and they were more likely to have a primary education than were the men with high job control. The proportion of women in occupations characterized both by low job control and by low income was 52%, and

the corresponding proportion for the men was 16%. In occupations with low job control, 48% of the women worked full-time versus 89% of the men. However, most part-time working women in Sweden spend 30 rather than 15 hours per week in paid work (15).

During the follow-up, 17 399 (9.8% fatal) stroke events occurred among the women, and 32 715 (10.9% fatal) took place among the men. Of these events, 2861 (30.3% fatal) were intracerebral hemorrhage, 12 513 were brain infarction (4.2% fatal), and 2025 were undetermined pathological types (8.9% fatal) among the women; and 5395 (29.5% fatal) were intracerebral hemorrhage, 23 637 were brain infarction (5.1% fatal), and 3683 were undetermined pathological types (10.1% fatal) among the men. Incidence rates of any stroke (intracerebral hemorrhage, brain infarction or undetermined pathological type) and of stroke subtypes were higher in the lowest job-control quartile than in the highest quartile (table 2). There appeared to be a threshold association between job control and intracerebral hemorrhage (lowest job control versus other levels), and a linear association between job control and brain infarction among the men. Among the women, these associations were less apparent.

The age- and workhour-adjusted risk for any stroke was significantly higher in the three lowest job-control groups than in high job-control group among the women (table 3). These associations decreased strongly after adjustment for education. Adjusting for marital status did not affect the estimates, but income attenuated the estimates slightly. The fully adjusted model showed significantly higher risk (7%) for any incident stroke among the women with low job control than among those with high job control.

The risk of intracerebral hemorrhage was higher among the women (33%) with low job control, and there seemed to be a gradient for the risk of intracerebral hemorrhage according to job control. The effects of the confounders were in the same direction as for any stroke, except for education, which did not decrease the estimates for intracerebral hemorrhage as much as for any stroke. When all the confounding factors were adjusted for simultaneously, the women with low job control had a higher risk (22%) of intracerebral hemorrhage than did the women with high job control.

Job control was clearly less associated with brain infarction than with intracerebral hemorrhage. All of the three lowest job-control quartiles initially showed higher risks of brain infarction among the women. With respect to the confounders, the results for brain infarction were in line with those for any stroke. However, when fully adjusted, there was no significant association between job control and the risk of brain infarction among the women.

Table 1. Baseline characteristics for working women and men in Sweden in 1990 by the level of job control (quartiles). (SEK = Swedish kronor)

Characteristic	Level of job control (quartiles)															
	Low				Low intermediate				High intermediate				High			
	Mean	SD	%	Median	Mean	SD	%	Median	Mean	SD	%	Median	Mean	SD	%	Median
<i>Women, N=1 433 932 (100%)</i>	.	.	32.3	.	.	.	32.2	.	.	.	25.6	.	.	.	9.9	.
Age (years)	46.73	9.27			45.12	9.07			42.86	8.62			43.48	8.54		
Workhours, full-time																
Yes	.	.	47.7	.	.	.	51.4	.	.	.	60.4	.	.	.	68	.
No	.	.	52.3	.	.	.	48.6	.	.	.	39.6	.	.	.	32	.
Marital status																
Married	.	.	66.6	.	.	.	68.6	.	.	.	68.5	.	.	.	62.8	.
Never married	.	.	15.2	.	.	.	15.7	.	.	.	18.3	.	.	.	20.7	.
Divorced	.	.	13.9	.	.	.	12.6	.	.	.	11.2	.	.	.	14.3	.
Widowed	.	.	4.3	.	.	.	3.1	.	.	.	2.0	.	.	.	2.2	.
Education																
Unknown	.	.	0.2	.	.	.	0.1	.	.	.	0.1	.	.	.	0.1	.
Primary	.	.	51.9	.	.	.	22.1	.	.	.	19.0	.	.	.	11.1	.
Secondary	.	.	41.5	.	.	.	47.6	.	.	.	46.2	.	.	.	30.0	.
Tertiary	.	.	6.4	.	.	.	30.2	.	.	.	34.7	.	.	.	58.9	.
Disposable income, quartiles																
1 (lowest)	.	.	51.9	.	.	.	35.1	.	.	.	33.9	.	.	.	19.7	.
2	.	.	28.4	.	.	.	31.0	.	.	.	32.3	.	.	.	25.7	.
3	.	.	13.7	.	.	.	21.6	.	.	.	22.2	.	.	.	28.2	.
4 (highest)	.	.	6.0	.	.	.	12.3	.	.	.	11.6	.	.	.	26.4	.
Disposable income in 1000s SEK	.	30	.	91	.	35	.	101	.	35	.	102	.	56	.	117
<i>Men, N= 1 511 146 (100%)</i>	.	.	18.5	.	.	.	17.9	.	.	.	24.6	.	.	.	39.0	.
Age (years)	44.57	9.30			44.30	9.36			45.34	9.32			45.26	8.94		
Workhours, full-time																
Yes	.	.	89	.	.	.	88.4	.	.	.	89.3	.	.	.	93.3	.
No	.	.	11	.	.	.	11.6	.	.	.	10.7	.	.	.	6.7	.
Marital status																
Married	.	.	58.5	.	.	.	59.9	.	.	.	66.7	.	.	.	72.8	.
Never married	.	.	29.9	.	.	.	29.1	.	.	.	23.4	.	.	.	17.8	.
Divorced	.	.	10.7	.	.	.	10.2	.	.	.	9.0	.	.	.	8.6	.
Widowed	.	.	0.9	.	.	.	0.8	.	.	.	0.9	.	.	.	0.8	.
Education																
Unknown	.	.	0.3	.	.	.	0.3	.	.	.	0.1	.	.	.	0.1	.
Primary	.	.	57.0	.	.	.	46.9	.	.	.	36.8	.	.	.	16.5	.
Secondary	.	.	38.5	.	.	.	41.9	.	.	.	43.5	.	.	.	42.7	.
Tertiary	.	.	4.2	.	.	.	10.9	.	.	.	19.6	.	.	.	40.7	.
Disposable income, quartiles																
1 (lowest)	.	.	16.0	.	.	.	14.8	.	.	.	17.0	.	.	.	6.0	.
2	.	.	31.2	.	.	.	29.5	.	.	.	21.9	.	.	.	10.0	.
3	.	.	35.0	.	.	.	33.8	.	.	.	31.5	.	.	.	24.4	.
4 (highest)	.	.	17.8	.	.	.	21.9	.	.	.	29.6	.	.	.	59.6	.
Disposable income in 1000s SEK	.	36	.	115	.	37	.	117	.	49	.	121	.	103	.	146

For the men, the results for any stroke were initially similar to those of the women; the age- and workhour-adjusted risk for any stroke was significantly higher in the three lowest job-control quartiles (table 3). The effect of the confounders differed between the genders so that, after adjustment for education, the gradient for job control still existed among the men. Adjusting for marital status and income, respectively, decreased the estimates. The risk of any incident stroke was significantly

higher (8%) among the men with low job control than among those with high job control when the estimates were fully adjusted.

The risk of intracerebral hemorrhage was higher (30%) for the men with low job control than for those with high job control, and there seemed to be a dichotomous association between job control (low job control versus the other job-control quartiles) and the risk of intracerebral hemorrhage. The estimates decreased to

Table 2. Number of events and gender-specific age-standardized incidence rates for any incident stroke ^a, intracerebral hemorrhage (ICH) ^b, and brain infarction (BI) ^c by job control quartiles per 100 000 person-years at risk (1991–2003) for working women and men in Sweden. (ICD-9 = International Classification of Diseases, ninth revision)

Job control quartile	Women						Men					
	Any stroke		ICH		BI		Any stroke		ICH		BI	
	Events (N)	Incidence rate										
Low job control	7 243	113.15	1 183	19.01	5156	86.26	6 665	213.27	1 174	37.36	4 770	152.73
Low intermediate job control	5 454	98.42	901	16.31	3908	70.49	5 815	196.00	891	29.82	4 229	142.74
High intermediate job control	3 412	97.86	568	15.48	2512	72.60	8 262	183.24	1 323	29.57	5 967	132.33
High job control	1 290	91.99	209	14.15	937	67.16	11 973	172.41	2 007	28.83	8 671	124.91
Total number of events	17 399	102.97	2 861	16.91	12 513	73.97	32 715	186.65	5 395	30.79	23 637	134.89

^a ICD-9-431, 434, 436; ICD-10-I61, I63, I64.

^b ICD-9-431; ICD-10-I61.

^c ICD-9-434; ICD-10-I63.

Table 3. Hazard ratios (HR) and 95% confidence intervals (95% CI) for any incident stroke ^a, intracerebral hemorrhage (ICH) ^b, and brain infarction (BI) ^c by job control quartiles, adjusted for confounders (1990, follow-up 1991–2003), for working women and men in Sweden. (ICD-9 = International Classification of Diseases, ninth revision)

Confounder	Women						Men					
	Any stroke		ICH		BI		Any stroke		ICH		BI	
	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI	HR	95% CI
Age and workhours												
Low job control	1.25	1.17–1.32	1.33	1.15–1.55	1.22	1.14–1.31	1.24	1.21–1.28	1.30	1.21–1.40	1.23	1.19–1.28
Low intermediate job control	1.09	1.02–1.16	1.15	0.99–1.34	1.07	1.00–1.15	1.13	1.10–1.17	1.03	0.95–1.11	1.14	1.10–1.18
High intermediate job control	1.07	1.00–1.14	1.09	0.93–1.28	1.09	1.00–1.17	1.06	1.03–1.09	1.02	0.95–1.09	1.05	1.02–1.09
High job control	1		1		1		1		1		1	
Test for trend		P=0.000		P=0.000		P=0.000		P=0.000		P=0.000		P=0.000
Age, workhours and education												
Low job control	1.08	1.00–1.13	1.23	1.06–1.44	1.04	0.97–1.12	1.14	1.10–1.18	1.23	1.14–1.33	1.13	1.08–1.17
Low intermediate job control	1.00	0.93–1.06	1.10	0.95–1.29	0.98	0.91–1.05	1.06	1.02–1.09	0.99	0.91–1.07	1.06	1.02–1.11
High intermediate job control	1.02	0.95–1.08	1.06	0.90–1.24	1.03	0.95–1.11	1.00	0.98–1.03	0.99	0.92–1.06	1.00	0.97–1.04
High job control	1		1		1		1		1		1	
Test for trend		P=0.001		P=0.000		P=0.336		P=0.000		P=0.000		P=0.000
Age, workhours and marital status												
Low job control	1.25	1.17–1.33	1.33	1.15–1.55	1.22	1.14–1.31	1.21	1.18–1.25	1.24	1.15–1.33	1.21	1.17–1.25
Low intermediate job control	1.10	1.03–1.16	1.15	1.00–1.34	1.08	1.00–1.16	1.11	1.07–1.14	0.99	0.91–1.07	1.12	1.08–1.16
High intermediate job control	1.08	1.01–1.15	1.10	0.94–1.29	1.10	1.02–1.18	1.05	1.02–1.08	1.00	0.93–1.07	1.05	1.01–1.08
High job control	1		1		1		1		1		1	
Test for trend		P=0.000		P=0.000		P=0.000		P=0.000		P=0.000		P=0.000
Age, workhours and income												
Low job control	1.21	1.14–1.29	1.29	1.11–1.51	1.19	1.11–1.28	1.15	1.11–1.19	1.17	1.08–1.26	1.15	1.11–1.20
Low intermediate job control	1.07	1.00–1.14	1.13	0.97–1.32	1.06	0.98–1.13	1.06	1.02–1.09	0.94	0.86–1.02	1.07	1.03–1.12
High intermediate job control	1.05	0.98–1.12	1.07	0.91–1.25	1.07	1.00–1.15	0.99	0.96–1.02	0.93	0.86–1.00	1.00	0.96–1.03
High job control	1		1		1		1		1		1	
Test for trend		P=0.000		P=0.000		P=0.000		P=0.000		P=0.000		P=0.000
Fully adjusted												
Low job control	1.07	1.01–1.14	1.22	1.04–1.42	1.04	0.97–1.12	1.08	1.04–1.12	1.12	1.03–1.22	1.08	1.04–1.13
Low intermediate job control	1.00	0.94–1.07	1.10	0.94–1.29	0.98	0.91–1.06	1.01	0.98–1.04	0.91	0.83–1.00	1.03	1.00–1.07
High intermediate job control	1.02	0.96–1.09	1.06	0.90–1.24	1.04	0.96–1.12	0.96	0.93–1.00	0.91	0.85–1.00	0.97	0.94–1.00
High job control	1		1		1		1		1		1	
Test for trend		P=0.002		P=0.001		P=0.274		P=0.000		P=0.006		P=0.000

^a ICD-9-431, 434, 436; ICD-10-I61, I63, I64.

^b ICD-9-431; ICD-10-I61.

^c ICD-9-434; ICD-10-I63.

the same degree when adjusted for education and marital status, and somewhat more strongly when adjusted for income. In the fully adjusted model, a higher risk (12%) of intracerebral hemorrhage remained for the men with low job control.

In the age- and workhour-adjusted model, all of the three lowest job-control groups showed higher risks of brain infarction. As for the women, the effects of the confounders on the risk of brain infarction were similar to those on the risk of any stroke among the men. In the fully adjusted model, the risk of brain infarction was higher (3–8%) for the men in the two lowest job-control groups than in those with high job control.

Discussion

This 13-year follow-up study of the total working population in Sweden indicated that the risk of stroke was higher for the women and men in occupations with low job control than for those with high job control. When adjusted for education, marital status, and income, the association between low job control and the risk of intracerebral hemorrhage was stronger than the one between low job control and the risk of brain infarction. Moreover, the association between low job control and stroke subtypes differed as a function of gender. The relative risk of intracerebral hemorrhage was highest for the women in low job-control occupations, while there was no significant association between low job control and the risk of brain infarction among the women. For the men, there was an association between low job control and the risk of both intracerebral hemorrhage and brain infarction.

Effects of the study design on the findings

Job control was measured at baseline using a psychosocial job-exposure matrix, which is frequently applied in population-based register studies. Yet one disadvantage of such matrices is that they are a rather crude method of exposure assessment, in that they assume that everyone with the same job title has the same level of job control. The strongest risk estimates were found for the low job-control group, while the estimates for the intermediate groups were less stable. The level of job control varied more within the low job-control group than within the intermediate groups. Consequently, low job-control occupations are more heterogeneous than intermediate job-control occupations with respect to the level of job control and other work environment exposures. Moreover, the job-exposure matrix is susceptible to the ecological fallacy bias that occurs when analyses at the group level are used to make inferences at the individual level (16). The

job-exposure matrix used by us is, however, highly correlated with self-reports and expert assessments of job control, particularly among blue-collar workers (17).

Our data did not allow for a cumulative assessment of job control. A previous study on cumulative exposure to low job control (assessed by a job-exposure matrix) and the risk of cardiovascular mortality indicated that the risk increased with 5-year cumulative exposure periods up to 15 years, and then slightly decreased from 20 years onward (18). Our follow-up period of 13 years may have complicated the picture. People may have changed jobs during the follow-up, and a portion of the study population may have retired. Thus different alternatives for the age span and follow-up period were initially tested. As the results were similar, the present analyses were chosen because they provided the most robust estimates. Moreover, follow-up times similar in length to that of our study are not unusual (8, 19, 20).

In summary, the crude exposure assessment, only one assessment point of exposure, and a relatively long follow-up period of 13 years most likely resulted in increased random errors and subsequently small risk estimates (14, 21). In addition, selection bias in terms of a healthy worker effect may have led to an underestimation of the risks, as people with the highest risk of stroke had probably already left worklife (unemployed or on disability pension) (14).

Stroke events were identified from hospital-discharge and death records. A validation study from Sweden, which compared routine registers with the population-based MONICA stroke register, concluded that official mortality statistics give a reasonably good estimate of fatal stroke events, whereas hospital-discharge records poorly reflect the incidence of stroke in the population (22). Hospital-discharge data may overestimate stroke incidence in the population if the diagnoses are not limited to ICD-9 codes 430, 431, 434, and 436 (13). In order to avoid the misclassification of outcomes, we focused on these diagnoses and omitted ICD-9 430, as the etiology of subarachnoid hemorrhage differs from that of intracerebral hemorrhage and cerebral infarction.

Another shortcoming was the lack of information on traditional risk factors for stroke, such as hypertension, smoking, physical inactivity, obesity, or high levels of cholesterol—factors that may have been important to the association between job control and the risk of stroke. Findings from the Whitehall II study indicate that the association between low job control and incident coronary heart disease could not be explained by employment grade, negative affectivity, or traditional coronary risk factors (23). Generally, traditional risk factors tend to explain only part of the social gradient in the relative risk of coronary heart disease (24). Traditional risk factors, in turn, have a complex set of determinants, many of which are of psychosocial origin (2). Some of

the traditional risk factors may be responses to a stressful work environment. Blood pressure, for instance, is higher for participants reporting low, as opposed to high, job control (25). Thus adjusting for blood pressure in analyses of the association between job control and stroke may be questionable, as it could lead to the masking of a true effect (1).

The findings in relation to previous studies on job control and stroke

Few previous studies on psychosocial work environments have focused on stroke. In a small case-control study, an active job (high psychological demands and high job control) reduced the risk of incident stroke (7). High psychological demands for both women and men and low job control for women were associated with an increased risk of cardiovascular events, including stroke, in a cohort of treated hypertensive workers (6). Contrary to our findings, low job control seemed to be weakly associated with the risk of ischemic stroke in a cohort of middle-aged women in Sweden, but no such association was found between low job control and the risk of hemorrhagic stroke (8). In our study, the association between low job control and the risk of any stroke appeared to be similar for the women and men, but the association between low job control and stroke subtypes differed as a function of gender. One explanation for the gender difference may be that the Swedish labor market is gender segregated (26), and more women than men are exposed to low job control (table 1).

The magnitude of the risk estimates of our study were in line with those from previous studies in which job control was measured on an aggregate level (by a job-exposure matrix) in relation to cardiovascular outcomes. In a cohort study of young men in Sweden, the age-adjusted hazard ratio was 1.55 between low job control and incident coronary heart disease (20). For a large cohort of men in Finland, the rate ratio was 1.19 between low job control and cerebrovascular mortality, adjusted for education, marital status, and income (19).

It has been argued that the association between job control and health may be a result of residual confounding by social class or other social circumstances (27). Childhood circumstances are suggested to be a significant determinant of stroke in adulthood (28), particularly of hemorrhagic stroke (29). Our results showed that the association between job control and the risk of stroke is independent when adjusted for education and income, which are two socioeconomic indicators from different stages of the life course. Other investigators have convincingly showed that the association between work stress (job strain and effort-reward imbalance) and mortality from cardiovascular disease is not explained by

confounding from socioeconomic circumstances (childhood factors, education, occupational group, salary) over the life course (30, 31). Additional evidence has been provided elsewhere showing that the association between job control and stroke mortality is independent of socioeconomic factors (education, occupational class, marital status) (32).

Concluding remarks and implications for future studies

This study provided new prospective findings indicating that the risk of stroke is higher in occupations with low job control. As there are only a few epidemiologic studies on work conditions and the risk of stroke, further work is required to examine the associations in different settings, preferably using individual-level data, comparing various methods of exposure assessment, and classifying stroke by subtypes. Gender-specific analyses are recommended, as the impact of low job control may be different for women and men.

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