Brief Report

Job Strain and the Risk of Stroke: An Individual-Participant Data Meta-analysis

Running head: Job strain and the risk of stroke

Eleonor I Fransson; Solja T Nyberg; Katriina Heikkilä; Lars Alfredsson; Jakob B Bjorner; Marianne Borritz; Hermann Burr; Nico Dragano; Goedele Geuskens; Marcel Goldberg; Mark Hamer PhD; Wendela Hooftman; Irene Houtman; Matti Joensuu; Markus Jokela; Anders Knutsson; Markku Koskenvuo; Aki Koskinen; Meena Kumari; Constanze Leineweber; Thorsten Lunau; Ida EH Madsen; Linda Magnusson Hanson; Martin L Nielsen; Maria Nordin; Tuula Oksanen; Jaana Pentti; Jan H Peijtersen; Reiner Rugulies; Paula Salo; Martin J Shipley; Johannes Siegrist; Andrew Steptoe; Sakari B Suominen; Töres Theorell; Salla Toppinen-Tanner; Jussi Vahtera; Marianna Virtanen; Ari Väänänen; Peter JW Westerholm; Hugo Westerlund; Marie Zins; Annie Britton; Eric J Brunner; Archana Singh-Manoux; G David Batty; Mika Kivimäki, for the IPD-Work Consortium.

Affiliations of the authors are provided in Appendix.

Corresponding author: Eleonor Fransson, School of Health Sciences, Jönköping University, Box 1026, SE-551 11 Jönköping, Sweden. E-mail: eleonor.fransson@hhj.hj.se, phone: +46 36 101287, mobile phone: +46 708 875322, fax: +46 36 101180

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Abstract

Background and Purpose: Psychosocial stress at work has been proposed to be a risk factor for cardiovascular disease. However, its role as a risk factor for stroke is uncertain.

Methods: We conducted an individual-participant-data meta-analysis of 196,380 men and women from 14 European cohort studies to investigate the association between job strain, a measure of work-related stress, and incident stroke.

Results: In 1.8 million person-years at risk (mean follow-up 9.2 years), 2023 first-time stroke events were recorded. The age- and sex-adjusted hazard ratio for job strain relative to no job strain was 1.24 (95%CI 1.05;1.47) for ischemic stroke, 1.01 (95%CI 0.75;1.36) for hemorrhagic stroke and 1.09 (95%CI 0.94;1.26) for overall stroke. The association with ischemic stroke was robust to further adjustment for socioeconomic status.

Conclusion: Job strain may be associated with an increased risk of ischaemic stroke, but further research is needed to determine whether interventions targeting job strain would reduce stroke risk beyond existing preventive strategies.
Introduction

Stroke is a major cause of morbidity, mortality and disability world-wide. Psychosocial stress may increase the risk of developing stroke, although prospective evidence to confirm this is scarce. Job strain, for example, is one of the most widely studied measures of psychosocial stress and has been linked to an increased risk of coronary heart disease. However, an association between job strain, or its components (i.e. high job demands and low job control), and stroke has been observed only in part of the studies. To increase understanding about stress and stroke, we conducted an individual-participant-data meta-analysis examining the association between job strain, stroke and its subtypes in more than 190,000 employed men and women from 6 European countries.

Material and Methods

We used data provided by investigators from 14 prospective cohort studies (baseline examination between 1985 and 2008) of the Individual-Participant-Data meta-analysis in Working populations (IPD-Work) Consortium (Appendix-eTable). Job strain at baseline was defined according to demand-control (job strain) questionnaires. Individuals exposed to job strain (i.e. reporting high job demands in combination with low control over the work situation) were compared to all others. Socioeconomic status (SES) served as a proxy marker of stroke risk factors. Data on standard stroke risk factors, such as diabetes, hypertension, smoking, and heavy alcohol consumption, were available from 3 studies (Appendix).
We defined incident stroke using national hospital admission and death registries (ICD-10 codes I60, I61, I63, I64, or the corresponding ICD-9 or ICD-8 codes)(for alternative definitions in 2 studies, see Appendix). We excluded participants with a history of stroke at baseline (transient ischemic attacks were not considered). Data on stroke subtypes, ischemic (ICD-10 I63) and hemorrhagic (I60, I61), were available from 13 studies (Appendix).

The participants were followed up from their assessment of job strain at baseline to the first stroke event, death, or end of follow-up – whichever came first. Using Cox proportional hazard regression we estimated hazard ratios and 95% confidence intervals (CI) to quantify the associations of job strain with overall, ischemic and hemorrhagic stroke in each study. All analyses were adjusted for age and sex, with a further adjustment for SES and, in sensitivity analyses based on 3 cohorts, standard stroke risk factors. We pooled the study-specific effect estimates in random-effects meta-analyses.

**Results**

A total of 196,380 participants (mean age 42.4 years, 53% female) had not experienced a stroke event before the study baseline and had complete data on age, sex, SES, job strain and incident stroke events, the analytical sample. The proportion exposed to job strain ranged from 13% to 22%, depending on the study (Table 1).

During 1,815,848 person-years at risk (mean follow-up 9.2 years), 2023 stroke events were recorded. The age- and sex-adjusted pooled hazard ratio of overall stroke for the job strain group compared to those not exposed to job strain was not statistically significant (1.09, 95%
CI 0.94;1.26) with little heterogeneity in estimates between the studies ($I^2 = 21.6\%$, $p=0.22$) ([Figure 1](#)).

In analysis of stroke subtypes ([Figure 1](#), [Appendix eFigures 1-3](#)), job strain was associated with an increased risk of incident ischemic stroke (hazard ratio 1.24, 95% CI 1.05;1.47) but not hemorrhagic stroke (1.01, 95% CI 0.75;1.36). Further adjustment for SES yielded a hazard ratio of 1.18 (95% CI 1.00;1.39) for ischemic stroke and 0.95 (95% CI 0.72;1.27) for hemorrhagic stroke (sensitivity analyses in [Appendix](#)).

**Discussion**

In this individual-participant data meta-analysis of 190,000 working men and women in Europe, job strain was associated with an approximately 20% increased risk of acute ischemic stroke. No association with the risk of overall stroke or hemorrhagic stroke was observed.

Previous smaller-scale studies on job strain, and the risk of stroke\(^6\text{-}^{8},10\text{-}^{12}\) were underpowered to detect a 20% elevated risk. The strength of the association between job strain and ischemic stroke found in the present study corresponds to the association observed in our previous meta-analysis on job strain and coronary heart disease.\(^5\) The etiology of coronary heart disease and ischemic stroke is partially overlapping, with atherosclerosis as the major common factor. Job strain might have an effect on the cardiovascular system through activation of the neuroendocrine stress response, dysregulation of the hypothalamic-pituitary-adrenal axis, the metabolic syndrome, or indirectly via unhealthy behaviors, such as physical inactivity and poor diet.\(^14\)
We did not have complete data on standard stroke risk factors leaving residual confounding as a potential alternative explanation for the results. Although our sample size was large, the number of ischemic and hemorrhagic stroke events was relatively low and the diagnoses were not always confirmed by brain imaging; thus, further research is needed to confirm the findings. Additional research should also examine the mechanisms underlying the association between job strain and ischemic stroke and determine the extent to which interventions targeting job strain might reduce stroke risk beyond existing preventive strategies.

Acknowledgement

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Disclosures

No potential conflict of interests declared by the authors.

References


Figure legends

Figure 1. Age- and sex-adjusted association between job strain and subtypes of stroke.

<table>
<thead>
<tr>
<th>Stroke subtypes, adjusted for sex and age</th>
<th>HR</th>
<th>95%-CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>All strokes</td>
<td>1.09</td>
<td>[0.94; 1.26]</td>
</tr>
<tr>
<td>Ischemic</td>
<td>1.24</td>
<td>[1.05; 1.47]</td>
</tr>
<tr>
<td>Hemorrhagic</td>
<td>1.01</td>
<td>[0.75; 1.36]</td>
</tr>
</tbody>
</table>
Table 1. Characteristics of participants in 14 cohort studies, IPD-Work Consortium

<table>
<thead>
<tr>
<th>Study*, country</th>
<th>Baseline years</th>
<th>Number of participants</th>
<th>Number (%) participants with job strain</th>
<th>Total number of stroke events (incidence per 10,000 person-years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whitehall II, UK</td>
<td>1985-1988</td>
<td>10,261</td>
<td>1438 (14)</td>
<td>193 (9.9)</td>
</tr>
<tr>
<td>Still Working, Finland</td>
<td>1986</td>
<td>9,137</td>
<td>1420 (16)</td>
<td>471 (24.2)</td>
</tr>
<tr>
<td>IPAW, Denmark</td>
<td>1996-1997</td>
<td>2,027</td>
<td>356 (18)</td>
<td>55 (21.4)</td>
</tr>
<tr>
<td>WOLF-N, Sweden</td>
<td>1996-1998</td>
<td>4,683</td>
<td>599 (13)</td>
<td>95 (17.6)</td>
</tr>
<tr>
<td>COPSOQ-I, Denmark</td>
<td>1997</td>
<td>1,769</td>
<td>361 (20)</td>
<td>33 (16.0)</td>
</tr>
<tr>
<td>Gazel, France</td>
<td>1997</td>
<td>11,260</td>
<td>1630 (14)</td>
<td>312 (20.5)</td>
</tr>
<tr>
<td>POLS, Netherlands</td>
<td>1997-2002</td>
<td>24,521</td>
<td>3911 (16)</td>
<td>110 (4.6)</td>
</tr>
<tr>
<td>HeSSup, Finland</td>
<td>1998</td>
<td>16,404</td>
<td>2875 (18)</td>
<td>75 (6.6)</td>
</tr>
<tr>
<td>PUMA, Denmark</td>
<td>1999-2000</td>
<td>1,839</td>
<td>278 (15)</td>
<td>30 (16.4)</td>
</tr>
<tr>
<td>DWECs, Denmark</td>
<td>2000</td>
<td>5,547</td>
<td>1231 (22)</td>
<td>77 (15.8)</td>
</tr>
<tr>
<td>FPS, Finland</td>
<td>2000</td>
<td>47,302</td>
<td>7,710 (16)</td>
<td>351 (7.7)</td>
</tr>
<tr>
<td>NWCS, Netherlands</td>
<td>2005-2006</td>
<td>45,052</td>
<td>5,610 (13)</td>
<td>62 (3.8)</td>
</tr>
<tr>
<td>SLOSH, Sweden</td>
<td>2006-2008</td>
<td>10,930</td>
<td>2,147 (20)</td>
<td>55 (11.0)</td>
</tr>
<tr>
<td>Total</td>
<td>1985-2008</td>
<td>196,380</td>
<td>30,481 (16)</td>
<td>2023 (11.1)</td>
</tr>
</tbody>
</table>

*For study abbreviations and further details, see Appendix