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Occupational psychosocial stress and stroke risk in Sweden

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Arbetsrelaterad psykosocial stress och risk för stroke i Sverige

Sammanfattning

Introduktion: Stroke är en ledande orsak till död och funktionsnedsättning i Sverige. Forskning har påvisat samband mellan psykosocial stress och risk för hjärt-kärlsjukdom. Sambandet mellan arbetsrelaterad psykosocial stress och stroke är mindre känt. Krav-kontrollmodellens (JDC), hypotes är att höga psykosociala krav och låg kontroll är en riskfaktor för arbetsrelaterad stress.

Syfte: Syftet var att undersöka sambandet mellan arbetsrelaterad exponering för psykosocial stress och risken för stroke med fokus på JDC-modellen, samt undersöka eventuella skillnader mellan kön och region.

Metod: Registerdata med 3,4 miljoner människor användes och 4 694 strokefall inkluderades. För exponeringarna påverkansmöjligheter, psykosociala krav och krav-kontrollmodellen beräknades oddskvoter genom logistisk regressionsanalys. Exponeringsdata är från 2013 och utfallet är från 2014 och 2015.

Resultat: Resultaten visade att lägre påverkansmöjligheter, lägre psykosociala krav och passiva/spända jobb var associerade med ökad risk för stroke. Män hade ökad risk vid avspända, passiva eller spända jobb. Kvinnor hade ökad risk vid passiva jobb. Det fanns ett starkare samband mellan stroke och påverkansmöjligheter i regioner med mindre befolkning, jämfört med större regioner.

Konklusioner: Studien påvisade samband mellan arbetsrelaterad psykosocial stress och stroke, vilket tyder på att riskfaktorer i arbetsmiljön kan påverka hälsan. Förebyggande åtgärder på arbetsplatsen skulle kunna minska risken för stroke.

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Abstract

Introduction: Stroke is a leading cause of death and disability in Sweden. Research has shown associations between psychosocial stress and cardiovascular disease. However, the association between psychosocial stress and stroke is less known. The Job Demand-Control (JDC) model hypothesizes that high demands with low control increase occupational stress.

Purpose: The aim was to examine the association between occupational exposure to psychosocial stress and stroke risk, focusing on the JDC model, including gender and regional differences.

Method: The study included register data of 3.4 million people and 4,694 stroke cases. Odds ratios were estimated using logistic regression analysis for the exposure's decision authority, psychosocial demands, and job strain. Exposure is from 2013 and the outcome is from 2014/2015.

Results: An increased stroke risk was associated with lower decision authority, lower psychosocial demands, and passive/high-strain jobs. Low-strain, passive, or high-strain jobs increased the risk for men. Passive jobs increase the risk for women. The association between decision authority and stroke was stronger in smaller populations than in larger regions.

Conclusions: The study showed an association between occupational psychosocial stress and stroke, suggesting that risk factors in occupational settings may influence health. Preventative measures in the work environment may reduce the stroke risk.

CONTENTS

1 INTRODUCTION

Psychosocial stress is the combination of stress in the individual's personal life and stress caused by the conditions in the workplace. Some previous studies have identified an association between psychosocial stress and an increased risk for stroke (Reddin et al., 2022). This applies to all subtypes of stroke, including intracerebral hemorrhage, intracranial hemorrhage, unspecified stroke, cerebral infarction, or ischemic stroke. According to Reddin et al. (2022), risk factors for stroke in association with psychosocial stress are considered modifiable factors. Stress in the workplace, financially, at home, and other stressful events could increase the risk of stroke.

According to the National Board of Health and Welfare (Socialstyrelsen, 2022), approximately 25,400 people suffered a stroke in Sweden in 2021. One-fourth of all stroke events occur in people of working age, under 65 years (Socialstyrelsen, 2022). The consequences are considerable due to production loss, absence from work, disability pension, and premature death (Toivanen, 2012).

Robert Karasek developed the Job Demand-Control (JDC) model in 1979 to describe how job demands and job control affect psychological well-being. The JDC model explains the negative effects of work in connection to job demands and job control, to explain the prevalence of mental strain in a workplace context (Häusser, Mojzisch, Niesel & Schulz-Hardt, 2010). The model hypothesizes that high psychosocial demands, when combined with low control, could potentially become a risk factor for work-related stress. The interaction between high demands and low control when combined is referred to as job-strain. The likelihood of developing cardiovascular disease is substantially more likely to affect individuals in the high-strain group than the low-strain group. Previous research focusing on job-strain has been inconclusive due to studies failing to find support and available instruments to assess and target exposure to job-strain (Alves, Braga, Faerstein, Lopes & Junger, 2015).

There is a lack of evidence on psychosocial risk factors that pertain to perceived psychosocial stress, associated with the development of stroke. Previous research has shown inconsistencies in study design and measurements (Booth et al., 2015). Therefore, examining the association between work-related psychosocial stress and stroke in this study would be able to contribute new knowledge to this field.

2 BACKGROUND

2.1 Stress

Stress is a response to demands that impact the body by activating a stress reaction; the stressors' nature determines the body's reaction (Kogler et al., 2015). When people are exposed to acute stress, a series of physiological mechanisms are mobilized to protect us through increased readiness of the immune system and the locomotor system. In this way, the body concentrates on fighting against an acute threat as a response. The functions the body quickly mobilizes are necessary to protect health temporarily (Lundberg & Wentz, 2015). Physiological stress is indicated by an unpleasant sensory, emotional, and subjective experience that is associated with a threat that can potentially damage the body and its tissue (Lundberg & Wentz, 2015). Individuals are exposed to social, cognitive, and physiological stressors in various situations throughout their daily lives (Kogler et al., 2015). These stressors can be both internal and external (Lundberg & Wentz, 2004).

2.1.1 Psychosocial stress

Stress responses can be psychological and psychosocial (Kogler et al., 2015). As a result of exposure to the psychosocial environment, stress can be defined as a perceived reaction (Aronsson, Hellgren, Isaksson, Johansson, Sverke & Torbiörn, 2016). The individual's reaction to perceived stress can result in a physical reaction, where the body releases stress hormones as a response. The physical effect is an increase in blood pressure and an increase in pulse and heart rate. Stressors are often referred to as strain for the individual, in the psychosocial environment. Both stressors and stress reactions are objective or subjective to the individual's perception (Aronsson et al., 2016). After the body has experienced stress exposure, it is important that these stress responses are turned off and everything returns to normal, so the body can recover (Kogler et al., 2015). However, stress can go beyond normal, which means increased physiological and psychological strain (Lundberg & Wentz, 2004). Several different stressors can influence an individual's perception of psychosocial stress. These stressors can be found both in the individual´s personal life and in occupational settings (Booth et al., 2015).

2.1.2 Stressors and Psychosocial Work Environment

Stressors can often be found in the work environment (Mynak, 2019). An overall definition of work environment refers to the conditions under which work is carried out at a workplace (Sjöström, Bolin & Schmidt, 2019). These conditions are believed to affect employees' physical and mental health and well-being. Research on the work environment began with studies of health and safety in industrial workplaces. The focus was on physical and ergonomic work environments, such as noise, heavy lifting, chemicals, and risks of monotonous work. The way technology and design of the workplace affected the physical body was emphasized. With changes in the labor market, the focus has shifted increasingly toward the psychosocial work environment and its importance for health and ill health. The psychosocial work environment includes all aspects of the design and management of the workplace, as well as social and organizational context, which has the potential to cause psychological or physical harm to

employees (Toivanen, 2012). According to the Swedish Work Environment Authority (Arbetsmiljöverket, 2016), the psychosocial work environment can be understood as the individual's experience of the work environment, which can mainly be divided into requirements, demands, and resources in the workplace. These aspects can contribute to occupational psychosocial stress.

2.1.3 Occupational Psychosocial Stress and the Job Demand-Control Model

Two crucial characteristics of occupational psychosocial stress are job demand and job control (Van der Doef & Maes, 1999). These aspects make up Karasek's Job Demand-Control (JDC) model, which is one of the most influential models in research on work-related stress and the relationship between work and health. The JDC-model focuses on situational workplace characteristics in terms of psychological demands and job control and their influence on employees' health (Toivanen, 2012). Psychological demands refer to workload, time pressure, and mental load. Job control comprises two components: skill discretion and decision authority. Skill discretion refers to the possibility of using one's initiative and skills on the job. Decision authority is a form of control over job performance, allowing the employee to decide how and when the job is performed (Toivanen, 2012). Job control and job demand can be combined into four categories (table 1).

Table 1. The JDC - model (Van der Doef & Maes, 1999).

Passive	low demands/low control
Low strain	low demands/high control
High strain	high demands/low control
Active	high demands/high control

The JDC-model consists of different hypotheses. One of these is the strain hypothesis which states the most adverse reactions of psychological and physical stress and illness are expected in a high-strain job, i.e., a job with high demands and low control (Van der Doef & Maes, 1999). To explain the prevalence of mental strain in the workplace, the JDC model describes the negative impacts of labor in relation to job demands and job control (Häusser et al., 2010). Another hypothesis is that a job that consists of high demands in combination with high control leads to increased motivation, learning, and skill development. The buffer hypothesis relates to the interaction between demands and control, where control is expected to lessen (buffer) the adverse effect of job demands on wellbeing. The strain theory can be thought of as a variation of the buffer hypothesis (Van der Doef & Maes, 1999).

In a study by Bonsaksen, Thørrisen, Skogen & Aas (2019), Norwegian employee's psychosocial conditions were examined. The study focused on the job demands and control categories, and the associations between sociodemographic factors and job descriptions. Passive jobs were more common among older individuals, with lower education levels, and individuals with part-time and regular employment levels. High-strain jobs were more common

among younger individuals, women, those with lower education levels, and individuals not working regular daytime hours or who worked outside the regular workplace. Low-strain jobs were more common among all age groups, men, individuals with higher education, and those who worked daytime hours in a regular workplace. Active jobs were frequent among younger age groups, women, those with higher education levels, and full-time jobs. Having an active job was also more frequent among those with working hours that deviated from ordinary daytime work and who only worked in the regular workplace. The results showed clear differences between genders and psychosocial working conditions (Bonsaksen et al., 2019).

2.1.4 Regional differences

In a study by Tham (2022), psychosocial stress among healthcare workers in metropolitan and rural areas was compared during the COVID-19 pandemic. Healthcare workers were impacted differently when examining psychosocial stress, depending on their location rural and metropolitan. The study shows differences in stress factors in rural areas due to limited resources. The results showed that rural healthcare workers were older and had worked longer in their profession than their metropolitan counterparts. Rural participants reported higher levels of burnout and lower reported help-seeking behaviors. While the levels of resilience were similar between rural and metropolitan healthcare workers, there was a significantly higher prevalence of pre-existing mental illness in the rural workforce (Tham et al., 2022). In a study by Kim and Hopkins (2016) child welfare workers in rural agencies reported lower levels of job stress and higher growth, and role clarity compared to workers in urban agencies. There is a lack of research investigating differences in psychosocial stress between rural and urban areas. A study by de Smet et al. (2005) focused on differences in psychosocial stress between European countries. The study showed that the Swedish data reported a higher mean on demands and control, compared with data from Italy and Spain. However, the study does not focus on rural and urban areas.

2.1.5 Consequences of Psychosocial Stress

Consequences of long-term stress exposure for individuals can result in health issues and disease (Aronsson et al., 2016). Long-term and repeated exposure to stressors is associated with high blood pressure and narrowing of blood vessels. Once the blood vessels are affected the body becomes more vulnerable to other diseases. As psychosocial stressors can affect the individual and productivity, strategies to prevent and reduce stress can be implemented using flexible organizational structures (Aronsson et al., 2016).

Occupational psychosocial stress can contribute to the development of diseases. Individuals working in environments with psychosocial stress have an increased risk of developing cardiovascular disease (Johnson, Hall & Theorell, 1989). Cardiovascular diseases are a group of disorders that affect the heart and blood vessels (WHO, 2023). Cardiovascular diseases have a correlation with cardiovascular outcomes, including cerebrovascular disease or stroke. Cardiovascular risk factors are linked to psychosocial and general stress, which are modifiable factors that can contribute to stroke. These risk factors include smoking, high blood pressure,

obesity, and physical inactivity (Henderson, Milner, Geoffroy-Perez, Coutrot, LaMontagne & Chastang, 2013).

Studies have also found associations between job strain and cardiovascular mortality. When it comes to the prevalence of exposure to job strain, studies indicate that women have a higher risk of exposure in the workplace. However cardiovascular mortality rates related to job-strain are more common among men than women (Niedhammer et al., 2015). According to Booth et al. (2015), there is modest to moderate evidence of the association between work-related psychosocial stress and cardiovascular outcomes. However, the research is less conclusive about the association between psychosocial stress and stroke, compared with other cardiovascular diseases (Booth et al., 2015).

2.2 Stroke

Stroke is a leading cause of disability and death worldwide, as it affects one in four people during their lifetime (Campbell & Khatri, 2020). Stroke causes a neurological deficit resulting in acute focal damage to the central nervous system that impacts the brain, retina, and spinal cord, by affecting the blood vessels. The most common cause of stroke is blockage or reduced blood flow due to arterial occlusion, so-called ischemic stroke, or cerebral infarction. Stroke can also be caused by hemorrhages due to rupture of cerebral arteries- that are either intracerebral or subarachnoid. Intracerebral stroke can be caused by high blood pressure which can lead to cerebral microbleeds. Subarachnoid hemorrhage is often a result of a ruptured aneurysm (Campbell & Khatri, 2020). High blood pressure, also known as hypertension, is the leading medical risk factor for stroke, accounting for 50% of ischemic stroke cases and 70% of hemorrhagic stroke cases (Kumar, Bishayee, Park, Lee & Kim, 2023).

2.2.1 Stroke Statistics

Stroke affects about 15 million people worldwide yearly (Qureshi, Mendelow & Hanley, 2009). Approximately 25,400 people suffered a stroke in Sweden in 2021 (Socialstyrelsen, 2022). This includes both cerebral infarction and brain hemorrhage, as well as unspecified stroke. More men than women suffer from stroke. Among both men and women, the incidence and mortality have decreased by 50 % since the year 2000. However, the reduction is somewhat greater among women compared to men. Stroke is more common among older people than younger people. In 2021, only 3 % of those who suffered a stroke were under 50 years of age. Three out of four people who suffered a stroke were over 70 years old. Of those who were registered as deceased in 2021, around 5,900 people had a stroke as the cause of death. Nine out of ten stroke-related deaths impact people over the age of 70 (Socialstyrelsen, 2022).

Worldwide, the number of fatalities caused by stroke is projected to increase to over 24 million annually by 2030 (Toivanen, 2012). Regardless of medical advances, reducing socioeconomic disparities in health and focusing on prevention rather than just cure, will impact a possible decline in stroke-related mortality and disability. Societal factors such as urbanization and rapid socioeconomic changes affect the risk of stroke, as they lead to changes in people’s lifestyles, working conditions, and occupational stress (Toivanen, 2012).

2.2.2 Stroke and Gender

Stroke is more common among men, but women tend to be more severely ill after a stroke (Toivanen, 2012). Many aspects of stroke are similar in both men and women, including how stroke clinically presents, risk factors, and how stroke subtypes are distributed. However, women with risk factors are more likely to suffer a stroke than men with the same amount of risk factors. Furthermore, evidence shows that women are not offered acute stroke treatment as frequently as men and are more likely to die from stroke than men (Toivanen, 2012).

2.2.3 Stroke and Regional Differences

A study by Kapral et al. (2019) focuses on the disparities in cardiovascular risk factors and healthcare access between rural and urban locations in Canada, as well as the impact of these differences on stroke incidence and mortality. According to the study findings, rural residents are at higher stroke risk and mortality due to a variety of variables such as higher rates of smoking, obesity, heavy alcohol consumption, and poor cardiovascular health. Additionally, rural areas have limited access to healthcare services and acute stroke care interventions. As a result, rural areas have lower rates of attendance at healthcare appointments, and higher rates of stroke and mortality. The study emphasizes the importance of addressing healthcare disparities in healthcare access and risk factors to improve stroke outcomes in rural areas (Kapral et al., 2019).

2.3 Psychosocial Stress and Stroke

2.3.1 Occupational Risk Factors

Psychosocial risk factors in the work environment in association with the individual's perceived level of psychosocial stress, can potentially lead to an increased stroke risk (Booth et al., 2015). Perceived psychosocial stress has been linked to cardiovascular outcomes, including ischemic and hemorrhagic stroke outcomes. Psychosocial stressors in and outside the work environment can impact the perceived stress level. The individual's ability to cope with psychosocial stress impacts stroke risk, where coping skills can increase or decrease the level of stress (Booth et al., 2015). According to Toivanen (2012) international studies have identified psychosocial stress as a modifiable risk factor for stroke. Stressors originating in the psychosocial work environment are shown to be particularly harmful to cardiovascular health, for individuals of working age.

The association between psychosocial work environment and ischemic stroke among construction workers in Sweden was examined in a study by Schiöler et al. (2015). The psychosocial work environment was measured by job strain as described in the JDC model. The study showed no significant association between ischemic stroke and psychosocial work environment. However, in a follow-up study job control was associated with ischemic stroke. A meta-analysis by Fransson et al. (2015) supported the findings that job strain may be associated with an increased risk of ischemic stroke. The JDC - model is often used to study workplace-related stress, which suggests that high job demands and low decision latitude lead to high strain and increase the risk of cardiovascular diseases (Booth et al., 2015).

2.3.2 Gender differences

The evidence between occupational exposure to psychosocial stress and stroke has less evidence of association, with some studies showing a slightly increased risk associated with low control or job strain, particularly in men (Torén, Schiöler, Giang, Novak, Söderberg & Rosengren, 2014). There is some evidence that occupational stress may be a more powerful predictor of stroke in women than in men. In particular, low job control seems to be a more severe work environment factor for women's stroke risk than men's (Toivanen, 2012). These differences could be associated with segregation by gender in the labor markets, where women and men work in different sectors and environments. More women than men have a low occupational class, and the share of work stress is usually higher in occupations dominated by women (Toivanen, 2012). Gender differences in perceived psychosocial stress can be a factor that affects the outcome (Booth et al., 2015). According to Toivanen (2012), there is some evidence that high psychological demands, low control, and job strain are associated with an increased risk of stroke in both women and men. However, occupational stress may be a more powerful predictor of stroke in women than men.

In a study by Magnusson Hanson et al., (2018), psychosocial environments and job-strain in Sweden were compared with three other European countries. The study aimed to examine psychosocial environments associated with poor health and disease, including stroke. The study found that job strain was associated with a shorter life expectancy due to poor health. Although the association was consistently seen in both genders, it was more prevalent in men and among those in lower occupational positions. However, this study does not specify the results for individual diseases, including stroke (Magnusson Hanson et al., 2018).

3 PURPOSE

The purpose of the study is to examine the relationship between occupational exposure to psychosocial stress by assessing job control, job demands, and job strain in association with stroke risk. The study also aims to determine whether there are any gender differences or regional differences in the association between occupational exposure to psychosocial stress and stroke risk. Overall, the study aims to provide insight into the potential impact of psychosocial stress on stroke risk, and its effect across different groups.

The aim is to answer the following research questions:

1. Is there an association between occupational exposure to psychosocial stress and stroke risk?
2. Are there any gender differences in the association between occupational exposure to psychosocial stress and stroke risk?
3. Are there any regional differences in the association between occupational exposure to psychosocial stress and stroke risk?

4 MATERIALS AND METHODS

4.1 Data sources

In this study, the Swedish National Cohort on Work and Health (SNOW) was used (Lissåker, Albin, Bodin, Sjöström & Selander, 2023). The cohort was created by using data from the Swedish Total Population Register. The individuals included in the study were born between 1930 and 1990 and resided in Sweden between 1968 and 2017. Data obtained for the study included: year and month of birth, gender, and marital status. Swedish identification numbers were used to match individuals to register sources. Additional data were obtained from the Income and Taxation Register, including total taxable income, income from work, and pension between 1968 and 2017. The National Patient Registers were also used to collect data on stroke diagnosis between 1964 and 2017 from inpatient and outpatient clinics, but primary care diagnostic codes were not available. The outcome of stroke was extracted between 2014 and 2015. Occupational data were gathered from the Longitudinal Integration Database for Health Insurance and Labor Market Studies (LISA), between 1990 and 2017. Educational data were also obtained from LISA (Lissåker et al., 2023).

4.1.1 Study population

In this study 3,402,312 individuals were included for psychosocial stress exposure in 2013, 51.2% were men, while 48.8% were women. In 2014, there were 2,483 cases of stroke, while in 2015, there were 2,211 cases of stroke. We used exposure data from 2013 as it is the most recent year the coding system was available. The stroke cases were from 2014 and 2015, a short follow-up time could minimize the risk of other factors impacting the outcome of stroke.

4.2 Occupational data

The job exposure matrix (JEM) that was used in this study was only available in the coding system up until 2013. The exposure data used in this study is from 2013. Occupations in the data set are categorized according to the Swedish Occupational Classification version 1996, also known as SSYK96 (Lissåker et al., 2023). SSYK is a system for grouping individuals' occupations or tasks, it is used in the labor market and individual statistics (SCB, 2023). Individuals with no taxable income and reported income below the median income for their occupation and gender were excluded. To account for partially retired individuals, that may have an occupation reported, job codes for those whose income from pension accounted for over 50% of their total income were excluded.

4.3 Exposures

The exposure, psychosocial stress, was measured using the Swedish Job Exposure Matrix (JEM), which measures psychosocial workload based on information from the Swedish Work Environment Surveys (1997–2013). The JEM in this study assesses the combined experience of different aspects of the work environment for men and women in different occupations. The JEM was matched to occupational codes in the SNOW cohort. The data were collected from approximately 75,000 participants with scores based on occupation classification in the LISA register in 2005 (Almroth, Hemmingsson, Wallin, Kjellberg, Burström & Falkstedt, 2021). To evaluate psychosocial stress, two aspects were measured; job control and job demands. Job control is measured based on questions regarding decision authority, measured: as the amount of influence people have over the way their work is done. The questions focus on the aspects of the ability to determine which tasks to do, work pace, when to take breaks, and the structure of the work. Job demands were determined by measuring aspects of stress with questions regarding time and level of concentration of the job (Almroth, et al., 2021). The translated items are shown in Table 2 (see Appendix 1 for the items in Swedish).

For decision authority and psychosocial demands, we divided the individuals into quintiles based on the result their occupational code had on the JEM. The quintiles are low, medium-low, medium, medium-high, and high. For job strain individuals above the median were considered as highly exposed and those below the median as low exposed to decision authority and psychosocial demands. These were then combined into four different categories according to the JDC model.

Table 2. Translated items – psychosocial JEM. Decision authority, psychosocial demands (Almroth et al., 2021; Fredlund, Hallqvist & Diderichsen, 2000).

JEM	Question
Decision authority	Can you partially decide when tasks should be done? (1)
	Do you have the opportunity to decide your own pace of work? (2)
	Can you take short breaks to talk at any time? (2)
	Are you ever involved in deciding how your work is organized? (1)
Psychosocial demands	Are you sometimes so stressed that you do not have time to talk or think about something else besides work? (2)
	Do you sometimes have so much work to do that you have to work during lunch, work overtime, or take work home? (3)
	Does your work require all your attention and concentration? (2)

1. Never, mostly not, mostly, always.
2. Not at all, occasionally, roughly ¼ of the time, half the time, roughly ¾, of the time, almost all the time.
3. Not at all, a few days per month, one day per week, one day per week, a few days per week, every day.

4.4 Outcome

4.4.1 Stroke and ICD-10

The outcome of this study was a stroke. Stroke was measured using diagnosis codes according to ICD-10 (International Statistical Classification of Diseases and Related Health Problems). ICD-10 was developed by the World Health Organization (WHO). Its purpose is to enable the classification and statistical description of diseases and other health problems that cause people's death or contact with healthcare (Socialstyrelsen, 2023). Cerebrovascular diseases are found in Chapter IX under the segment “diseases of the circulatory system” - the ICD-codes are I60-I69 (WHO, 2023). In this study, we used ICD codes I61-I64.

I61 - Intracerebral hemorrhage

Intracerebral hemorrhage is a type of stroke that is linked to 10-15 % of strokes every year. (Qureshi, Mendelow & Hanley, 2009). Intracerebral hemorrhage occurs when blood vessels in the brain rupture. It affects the central lobes, basal ganglia, thalamus, cerebellum, and brainstem. The blood vessel rupturing is a result of high blood pressure causing damage to the blood vessels or cerebral amyloid angiopathy. Cerebral amyloid angiopathy is a condition where protein cells (amyloid-β peptide accumulates in the blood vessels of the brain and causes bleeding within the brain (Qureshi et al., 2009)

I62 - Other nontraumatic intracranial hemorrhages
Nontraumatic intracranial hemorrhage (ICH) is a type of stroke linked to 10-15 % of stroke diagnoses that occur every year. Non-traumatic ICH has a high morbidity and mortality rate (Rajashekar & Liang, 2022). Underdeveloped countries, lack of knowledge about prevention, limited access to medical care, and demographic factors such as age and gender, contribute to a higher risk of stroke in certain populations. Non-traumatic Intracerebral hemorrhage has two stages, primary and secondary, with risk factors including chronic hypertension, amyloid angiopathy, anticoagulation medications, vascular malformations, and hemorrhage caused by bleeding diathesis, neoplasms, hemorrhagic conversion of an ischemic stroke, and drug abuse (Rajashekar & Liang, 2022).

I63 - Cerebral infarction
Cerebral infarction, or ischemic stroke is the most common type of stroke (Campbell & Khatri, 2020). It is caused by a blockage or reduced blood flow on account of arterial occlusion or embolism- either from atherosclerotic plaque in the aortic arch, cervical arteries, or from the heart. Intracranial atherosclerosis with in-situ thrombosis is also an important mechanism of stroke. When a cerebral artery is occluded and blood flow decreases below a critical level, neuronal electrical function ceases and a clinical deficit develops (Campbell & Khatri, 2020).

I64 - Stroke, not specified as hemorrhage or infarction.
Stroke without a subtype, that is not specified as cerebral hemorrhage or cerebral infarction is referred to as unspecified (Cheng, Chang, Lin, Ke & Kawachi, 2012). More than half of stroke deaths in the United States are unspecified. This trend can be seen in other countries, for example, the United Kingdom. Magnetic resonance imaging (MRI) or a computerized tomography (CT) scan; is required to verify the stroke subtype. Accessibility to imaging equipment can be a factor that impacts the higher number of unspecified stroke-related reports (Cheng et al., 2012).

4.4.2 Inclusion criteria
The individuals were included as cases if they suffered their first stroke in either 2014 or 2015. Since the aim of this study is to examine the association between exposure to occupational psychosocial stress and stroke, individuals who had previously been diagnosed with stroke were excluded.

4.5 Covariates
The highest obtained education was acquired from the LISA register. From seven categories, we categorized education into three categories: (1) primary and lower secondary school or less (⩽9 years); (2) secondary (10-11 years) and upper-secondary (12 years); (3) post-secondary/university, 2 years or less (13-15 years), more than 3 years of post-secondary/university and postgraduate degree (>15 years).

Information on gender data and civil status was obtained from the Swedish Total Population Register. Civil status is categorized as married/registered partner and unmarried. The unmarried category included unmarried, divorced, and widowed individuals.

4.6 Data analysis

Analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC, USA). Odds ratios were estimated using logistic regression analysis. Crude and adjusted models were created for three psychosocial stress exposures (decision authority, psychosocial demands, and job strain), in association with the outcome (stroke). We stratified the analysis by gender (men, women) and by region. Regions were stratified by population above 1 million people (Stockholm County, Västra Götaland County, Skåne County) and below 1 million people (all other counties in Sweden). We used active jobs (high demands, high control) as the reference group for job strain as it is the most positive combination according to the JDC model. Compared to low-strain jobs, active jobs are hypothesized to increase motivation, learning, and skill development (Van der Doef & Maes, 1999).

4.7 Ethical considerations

Register data was originally collected for statistical purposes, not for research. However, ethical approval for using the data for research purposes has been received (2018/1298-31/2). The authors have not had access to any data that makes it possible to link sensitive information, such as medical conditions, to specific individuals. The individual's Swedish personal identification number is not available at the institution, it is only available at Statistics Sweden (SCB). In this study, it is not likely to identify an individual through stroke diagnosis, as stroke is a common diagnosis. The authors only had access to information about the individuals that was necessary for this study's purpose. The data is stored in a secure server at Karolinska Institute. Permission to access the server must be individually requested and access is limited to the pertinent folders. The server has no internet access and data can only be added and removed by a limited number of individuals within each institution.

5 RESULTS

5.1 Population

Table 3. Comparison of baseline characteristics between the highest and lowest quantiles (Q) of occupational exposure to psychosocial stress and job strain categories.

	Totalt (%)	Decision authority (%)		Psychosocial demands (%)	
Gender		Q1 (low)	Q5 (high)	Q1 (low)	Q5 (high)
Male	1 742 739 (51.2)	342 745 (56.6)	341 432 (49.2)	341 720 (51.1)	364 368 (60.6)
Female	1 659 573 (48.8)	262 303 (43.4)	352 264 (50.8)	333 258 (48.9)	348 988 (49.4)
Civil status					
Married	1 583 327 (46.5)	259 144 (42.8)	381 232 (55.0)	273 916 (55.4)	394 868 (40.6)
Unmarried	1 818 985 (53.5)	345 904 (57.2)	312 464 (45.0)	401 062 (44.6)	318 488 (59.4)
Education					
1	318 551 (9.4)	76 715 (12.7)	22 747 (3.3)	119 926 (17.8)	35 074 (4.9)
2	1 608 113 (47.3)	289 937 (47.9)	186 576 (26.9)	429 901 (24.7)	176 354 (24.7)
3	1 475 648 (43.4)	238 396 (39.4)	484 373 (69.8)	125 151 (70.4)	501 928 (70.4)
Age		md=43.1	md=45.3	md=44.1	md=44.3
	Totalt (%)	Job strain			
Gender		Active	Low strain	Passive	High strain
Male	1 742 739 (51.2)	548 035 (51.9)	328 196 (49.9)	563 762 (53.6)	302 746 (47.5)
Female	1 659 573 (48.8)	508432 (48.1)	329 278 (50.1)	487 161 (46.4)	334 702 (52.5)
Civil status					
Married	1 583 327 (46.5)	570 162 (54.0)	291 878 (44.4)	415 607 (39.5)	305 680 (48.0)
Unmarried	1 818 985 (53.5)	486 305 (46.)	365 596 (55.6)	635 316 (60.5)	331 768 (52.0)
Education					
1	318 551 (9.4)	42 084 (4.0)	74 908 (11.4)	152 724 (14.5)	48 835 (7.7)
2	1 608 113 (47.3)	332 533 (31.5)	350 339 (53.3)	726 145 (69.1)	199 096 (31.2)
3	1 475 648 (43.4)	681 850 (64.5)	232 227 (35.3)	172 054 (16.4)	389 517 (61.1)
Age		md=45.4	md=44.2	md=43.0	md=44.4

Education 1: primary and lower secondary school or less (⩽9 years)
Education 2: secondary (10-11 years) and upper-secondary (12 years)
Education 3: post-secondary/university, 2 years or less (13-15 years), more than 3 years of post-secondary/university and postgraduate degree (>15 years)

5.1.1 Decision authority

Higher education is more prevalent at the highest level of decision authority than at the lowest level. When compared to the lowest level of decision authority, the highest level of decision authority has more married people and a lower median age. At the lowest level of decision authority, men outnumber women. Gender distribution is more equal at the highest level.

5.1.2 Psychosocial demands

Higher education is more prevalent at the highest level of psychological demands. The median age does not differ significantly between the lower and upper levels. At the lower level, most people are unmarried, but at the higher level, most people are married.

5.1.3 Job strain

Men tend to work in both active and passive jobs more frequently than women. While women are more likely than men to work in jobs with low and high levels of stress. Compared to those who are unmarried, married people make up the majority of those with active jobs. Most individuals are unmarried and work in low-strain, passive, and high-strain jobs. Individuals with active jobs typically have higher education than those in the other groups. Individuals with lower and medium levels of education are more likely to work in passive employment than individuals with higher levels of education. Individuals with higher education than lesser education work in high-strain occupations. In low-strain employment, most individuals have medium to high education levels. The lowest median age is in passive jobs and the highest is in active jobs.

Table 4. Subtypes of stroke

Subtype	Cases (%)
Hemorragic:	1004 (21.4)
Ischemic:	3638 (77.5)
Unspecified:	52 (1.1)

5.2 General results

The results of the crude and adjusted analysis are shown in Table 5.

Table 5. Odds Ratio (Hazards ratios and 95% confidence intervals for the risk of stroke), according to job control, job demand, and job strain.

JEM	Quintiles	N cases	Crude	Adjusted 1	Adjusted 2
Decision authority	Low	875	1.27 (1.15-1.40)	1.30 (1.18-1.43)	1.21 (1.10-1.34)
	Medium low	1084	1.36 (1.24-1.49)	1.38 (1.26-1.51)	1.24 (1.13-1.37)
	Medium	1016	1.26 (1.15-1.28)	1.30 (1.18-1.43)	1.19 (1.08-1.31)
	Medium high	927	1.16 (1.06-1.28)	1.12 (1.02-1.24)	1.06 (0.96-1.17)
	High	792	1	1	1
Psychosocial demands	Low	1097	1.18 (1.08-1-29)	1.26 (1.16-1.38)	1.11 (1.01-1.22)
	Medium low	962	1.12 (1.02-1.22)	1.31 (1.20-1.43)	1.17 (1.06-1.28)
	Medium	855	0.86 (0.79-0.94)	1.00 (0.91-1.10)	0.93 (0.84-1.02)
	Medium high	796	0.86 (0.78-0.94)	0.96 (0.87-1.05)	0.93 (0.85-1.02)
	High	984	1	1	1
Job strain	Active	1260	1	1	1
	Low strain	900	1.15 (1.05-1.25)	1.23 (1.13-1.34)	1.15 (1.05-1.25)
	Passive	1648	1.32 (1.22-1.42)	1.44 (1.34-1.55)	1.30 (1.12-1.41)
	High strain	886	1.17 (1.07-1.27)	1.21 (1.11-1.32)	1.12 (1.10-1.31)

Crude: not adjusted.
Adjusted 1: adjusted for age, gender, and civil status.
Adjusted 2: adjusted for age, gender, civil status, and education.

5.2.1 Decision authority

The results show an association between lower levels of decision authority and an increased risk of stroke compared to the highest level of decision authority. The first quintile of decision authority was associated with an increased risk of 1.21 (95% CI 1.10-1.34). The second quintile was associated with an increased risk of 1.24 (95% CI 1.13-1.37). The third quintile was associated with a 1.19 (95% CI 1.08-1.31) increased risk of stroke compared to the highest level of decision authority.

5.2.2 Psychosocial demands

The results show an association between low and medium-low levels of psychosocial demands. The results show an increased risk of stroke compared to the highest level. The first quintile of psychosocial demands was associated with an increased risk of 1.11 (95% CI 1.01-1.22). The second quintile was associated with a 1.17 (92% CI 1.06-1.28) increased risk of stroke compared to the highest level of psychosocial demands.

5.2.3 Job strain

The results show an association between low-strain jobs, passive jobs, high-strain jobs, and an increased risk of stroke compared to active jobs. Having a low-strain job was associated with an increased risk of 1.15 (95% CI 1.05-1.25) compared to having an active job. Having a

passive job was associated with an increased risk of 1.30 (95% CI 1.12-1.41). Having a high-strain job was associated with an increased risk of 1.12 (1.10-1.31) compared to an active job.

5.3 Gender differences

Results of the crude and adjusted analysis for men are shown in Table 6. The results for women are shown in Table 7.

Table 6. Odds Ratio (Hazards ratios and 95% confidence intervals for the risk of stroke), according to job control, job demand, and job strain, men.

JEM	Quintiles	N cases	Crude	Adjusted 1	Adjusted 2
Decision authority	Low	612	1.20 (1.07-1.35)	1.30 (1.16-1.47)	1.21 (1.07-1.36)
	Medium low	621	1.27 (1.13-1.43)	1.33 (1.18-1.50)	1.22 (1.08-1.38)
	Medium	665	1.25 (1.12-1.41)	1.36 (1.21-1.53)	1.23 (1.09-1.39)
	Medium high	619	1.12 (0.99-1.26)	1.11 (0.98-1.25)	1.04 (0.92-1.17)
	High	508	1	1	1
Psychosocial demands	Low	720	1.16 (1.04-1.29)	1.23 (1.11-1.37)	1.13 (1.01-1.26)
	Medium low	611	0.97 (0.87-1.08)	1.19 (1.06-1.33)	1.10 (0.98-1.23)
	Medium	497	0.77 (0.69-0.87)	0.96 (0.86-1.08)	0.94 (0.84-1.06)
	Medium high	533	0.87 (0.77-0.97)	0.94 (0.84-1.06)	0.93 (0.83-1.04)
	High	664	1	1	1
Job strain	Active	845	1	1	1
	Low strain	526	1.04 (0.93-1.16)	1.20 (1.08-1.34)	1.15 (1.02-1.28)
	Passive	1063	1.22 (1.12-1.34)	1.41 (1.29-1.54)	1.31 (1.19-1.44)
	High strain	591	1.27 (1.14-1.41)	1.31 (1.18-1.46)	1.28 (1.15-1.42)

Crude: not adjusted.
Adjusted 1: adjusted for age and civil status.
Adjusted 2: adjusted for age, civil status, and education.

Table 7. Odds Ratio (Hazards ratios and 95% confidence intervals for the risk of stroke), according to job control, job demand, and job strain, women.

JEM	Quintiles	N cases	Crude	Adjusted 1	Adjusted 2
Decision authority	Low	263	1.24 (1.05-1.47)	1.28 (1.08-1.51)	1.24 (1.05-1.47)
	Medium low	463	1.55 (1.34-1.80)	1.44 (1.25-1.67)	1.29 (1.11-1.51)
	Medium	351	1.25 (1.07-1.46)	1.19 (1.02-1.39)	1.15 (0.99-1.35)
	Medium high	308	1.17 (1.00-1.38)	1.16 (0.99-1.36)	1.12 (0.95-1.32)
	High	284	1	1	1
Psychosocial demands	Low	377	1.23 (1.06-1.43)	1.31 (1.13-1.52)	1.06 (0.89-1.25)
	Medium low	351	1.38 (1.19-1.61)	1.59 (1.36-1.85)	1.29 (1.09-1.53)
	Medium	358	1.07 (0.92-1.24)	1.08 (0.93-1.26)	0.89 (0.75-1.05)
	Medium high	263	0.86 (0.73-1.01)	0.98 (0.83-1.16)	0.93 (0.78-1.09)
	High	320	1	1	1
Job strain	Active	415	1	1	1
	Low strain	374	1.39 (1.21-1.60)	1.29 (1.12-1.48)	1.16 (1.00-1.34)
	Passive	585	1.47 (1.30-1.67)	1.50 (1.32-1.70)	1.30 (1.13-1.50)
	High strain	295	1.08 (0.93-1.25)	1.03 (0.89-1.20)	1.08 (0.92-1.25)

Crude: not adjusted.
Adjusted 1: adjusted for age and civil status.
Adjusted 2: adjusted for age, civil status, and education.

5.3.1 Decision authority

The results show an association between lower levels of decision authority and an increased risk of stroke, compared to the highest level of decision authority, for both men and women. However, for women, the result for a medium level of decision authority was not significant when adjusted for age, marital status, and education. The first quintile of decision authority was associated with an increased risk of 1.21 (95% CI 1.07-1.36) for men and 1.24 (95% CI 1.05-1.47) increased risk for women. The second quintile was associated with an increased risk of 1.22 (95% CI 1.08-1.39) for men and an increased risk of 1.29 (95% CI 1.11-1.51) for women. The third quintile was associated with an increased risk of 1.23 (95% CI 1.09-1.39) for stroke in men compared to the highest level.

5.3.2 Psychosocial demands

The results show an association between the lowest level of psychosocial demands and an increased risk of stroke compared to the highest level for men. For women, the lowest level of psychosocial demands is not significant. However, the medium-low level shows an association with an increased risk of stroke compared to the highest level. The first quintile on psychosocial demands was associated with an increased risk of 1.13 (95% CI 1.01-1.26) stroke for men. The second quintile was associated with an increased risk of 1.29 (95% CI 1.09-1.53) for stroke in women.

5.3.3 Job strain

The results show an association between low-strain, passive jobs, high-strain, and an increased risk of stroke compared to active jobs for men. Having a low-strain job was associated with an increased risk of 1.15 (95% CI 1.02-1.28) compared to having an active job. Passive jobs were associated with an increased risk of 1.31 (95% CI 1.19-1.44). High-strain jobs were associated with an increased risk of 1.28 (1.15-1.42) compared with active jobs. For women, having a passive job was associated with an increased risk of 1.30 (95% CI 1.13-1.50) compared with having an active job. The results for having a low-strain job were borderline significant.

5.4 Regional differences

Results of the crude and adjusted analysis for people living in a region with a population below 1 million are shown in Table 8. Results for people living in a region with a population above 1 million are shown in Table 9.

Table 8. Odds Ratio (Hazards ratios and 95% confidence intervals for the risk of stroke), according to job control, job demand, and job strain, a region with a population under 1 million.

JEM	Quintiles	N cases	Crude	Adjusted 1	Adjusted 2
Decision authority	Low	485	1.27 (1.10-1.50)	1.40 (1.22-1.61)	1.30 (1.13-1.50)
	Medium low	637	1.34 (1.17-1.53)	1.38 (1.21-1.58)	1.35 (1.18-1.55)
	Medium	566	1.22 (1.07-1.40)	1.31 (1.14-1.50)	1.25 (1.09-1.44)
	Medium high	456	1.12 (0.97-1.29)	1.14 (0.99-1.31)	1.07 (0.93-1.24)
	High	339	1	1	1
Psychosocial demands	Low	617	1.13 (1.00-1.27)	1.18 (1.05-1.33)	1.09 (0.95-1.23)
	Medium low	539	1.12 (0.99-1.27)	1.28 (1.13-1.44)	1.18 (1.04-1.35)
	Medium	420	0.85 (0.75-0.97)	0.96 (0.84-1.09)	0.91 (0.79-1.04)
	Medium high	416	0.94 (0.83-1.07)	1.02 (0.89-1.16)	0.96 (0.87-1.14)
	High	491	1	1	1
Job strain	Active	584	1	1	1
	Low strain	441	1.06 (0.94-1.20)	1.16 (1.03-1.31)	1.11 (0.97-1.30)
	Passive	952	1.29 (1.16-1.43)	1.44 (1.29-1.59)	1.35 (1.20-1.51)
	High strain	506	1.22 (1.08-1.37)	1.33 (1.18-1.50)	1.32 (1.17-1.49)

Crude: not adjusted.
Adjusted 1: adjusted for age, gender, and civil status.
Adjusted 2: adjusted for age, gender, civil status, and education.

Table 9. Odds Ratio (Hazards ratios and 95% confidence intervals for the risk of stroke), according to job control, job demand, and job strain, a region with a population over 1 million.

JEM	Quintiles	N cases	Crude	Adjusted 1	Adjusted 2
Decision authority	Low	390	1.20 (1.05-1.38)	1.26 (1.10-1.44)	1.11 (0.97-1.23)
	Medium low	447	1.30 (1.13-1.50)	1.25(1.10-1.42)	1.12 (0.97-1.28)
	Medium	450	1.24 (1.09-1.41)	1.23 (1.08-1.41)	1.11 (0.97-1.27)
	Medium high	471	1.17 (1.03-1.33)	1.12 (1.02-1.31)	1.04 (0.91-1.18)
	High	453	1	1	1
Psychosocial demands	Low	480	1.21 (1.06-1.37)	1.34 (1.18-1.52)	1.14 (0.99-1.30)
	Medium low	423	1.09 (0.96-1.24)	1.32 (1.16-1.50)	1.15 (1.00-1.32)
	Medium	435	0.87 (0.77-0.96)	1.04 (0.91-1.18)	0.95 (0.83-1.09)
	Medium high	380	0.79 (0.69-0.90)	0.90 (0.79-1.03)	0.87 (0.76-1.00)
	High	493	1	1	1
Job strain	Active	676	1	1	1
	Low strain	459	1.21 (1.08-1.37)	1.30 (1.15-1.46)	1.19 (1.05-1.34)
	Passive	696	1.28 (1.15-1.43)	1.42 (1.27-1.57)	1.24 (1.10-1.39)
	High strain	380	1.07 (0.94-1.21)	1.07 (0.94-1.21)	1.06 (0.93-1.20)

Crude: not adjusted.
Adjusted 1: adjusted for age, gender, and civil status.
Adjusted 2: adjusted for age, gender, civil status, and education.

5.4.1 Decision authority

The results show an association between lower levels of decision authority and an increased risk of stroke, compared to the highest level, for people living in a region under 1 million people. The first quintile of decision authority was associated with an increased risk of 1.30 (95% CI 1.13-1.50). The second quintile was associated with an increased risk of 1.35 (95% CI

1.18-1.55). The third quintile was associated with an increased risk of 1.25 (95% CI 1.09-1.44) for stroke compared to the highest level. For people living in a region with a population over 1 million, the crude results show an increased risk on lower levels of decision authority. However, the results were not significant for any level of decision authority when adjusted for age, marital status, and education.

5.4.2 Psychosocial demands

The results show an association between medium-low levels of psychosocial demands and an increased risk of stroke compared to the highest level, for people living in a region under 1 million people. The second quintile was associated with an increased risk of 1.18 (95% CI 1.04-1.35). The results are similar for people living in a region with a population over 1 million; however, the results are borderline significant. The second quintile was associated with an increased risk of 1.15 (95% CI 1.00-1.32) compared to the highest level.

5.4.3 Job strain

The results show that having a high-strain job or a passive job, compared to having an active job, was associated with an increased risk of stroke for people living in a region with a population under 1 million. Passive jobs were associated with an increased risk of 1.35 (95% CI 1.20-1.51) and high-strain was associated with an increased risk of 1.32 (95% CI 1.17-1.49) for stroke compared to active jobs. For people living in a region with a population over 1 million, having a passive job was associated with an increased risk of 1.24 (1.10-1.39). Having a low-strain job was associated with an increased risk of 1.19 (95% CI 1.05-1.34) for stroke compared to having an active job.

6 DISCUSSION

6.1 Purpose and Results

6.1.1 The purpose of the study

The purpose of this study is to examine the relationship between occupational exposure to psychosocial stress and stroke risk in Sweden. Furthermore, the study looks at variations by gender and region to better understand how exposures might affect different population groups.

Based on previous research, it has been shown that gender and geographic location can impact the prevalence and incidence of stroke, and stress-related disorders (Booth et al., 2015). Therefore, it is imperative to understand whether occupational psychosocial stress can provide insights into this relationship. The demand-control model by Karasek was used to assess psychosocial strain in the workplace, due to its applicability in researching job strain and its relationship to cardiovascular diseases (Alves et al.,2015).

This study has the potential to contribute significant new knowledge to the field of psychosocial stress and stroke risk. In addition, this provides information on the factors that can potentially influence stroke risk and provides valuable insights for occupational health treatments aimed at lowering the impact of psychosocial stress.

6.1.2 Summary of the results

The results of this study indicate a relationship between psychosocial stress and stroke risk. Lower levels of decision authority and psychosocial demands are associated with increased stroke risk. The results are similar when stratified for gender and region. However, for decision authority, the results are not significant for people living in a larger region.

Regarding job strain, the results show an increased stroke risk for men working in passive jobs, low-strain jobs, and high-strain jobs, compared to an active job. For women, passive jobs increased stroke risk. For individuals living in different regions, passive jobs showed an increased stroke risk for both groups. In larger regions, low-strain jobs were associated with increased stroke risk. In smaller regions, high-strain jobs showed an association with increased stroke risk.

6.2 Decision authority

The results for decision authority are in accordance with previous studies that have shown low job control is associated with an increased stroke risk in men and women (Toivanen, 2012). These studies also used Swedish register data; however, the exposure data was collected in 1990. An earlier version of the JEM was used in these studies. In our study, the exposure data is from 2013, with a follow-up period of one and two years. The study by Toivanen (2008) had a 13-year follow-up for the incidence of stroke. The other study had a five-year follow-up with stroke mortality as an outcome (Toivanen & Hemström, 2008). The results seem to be similar

even with a longer follow-up period. This could indicate that decision authority and its relationship with stroke is quite stable. By using a longer follow-up period influencing factors that could increase the risk of stroke might be more likely to occur between the exposure and the outcome period. That could potentially affect the association between psychosocial stress and stroke.

6.3 Psychosocial demands

When using the same JEM, other studies have shown similar results regarding psychosocial demands. According to Almroth et al. (2021), higher psychosocial demands were associated with a decreased risk of depression. Whereas lower levels of psychosocial demands were associated with a higher risk of hypertensive disorders in pregnant women (Lissåker, Hemmingsson, Kjellberg, Lindfors, and Selander, 2022). This could indicate that lower demands are more harmful to health than high demands, contrary to the JDC-model hypothesis.

All demands might not be equal. Previous studies have shown that job demands can be categorized into two subcategories: job hindrances and challenges (Van den Broeck, De Cuyper, De Witte & Vansteenkiste, 2010). Job hindrances are health-impairing demands that hinder optimal functioning. Job challenges are demands that require some energy and can be challenging. These kinds of demands are assumed to have different relationships with health and well-being. However, these studies are based on the Job Demands-Resources model. The model aims to account for both ill health and the well-being of employees; by categorizing job aspects as demands and resources (Van den Broeck et al., 2010). Even though our study is intended to measure demands as described in the JDC-model, the result could indicate the JEM is not measuring demands as intended. The JEM might be able to measure an aspect of demands that is not as harmful as theorized in the JDC-model.

When compared to decision latitude, the association between assessment methods is weaker for demands (Theorell, 2020). One explanation could be that JEM-based assessments for demands do not have enough questions. In this JEM, demands are based on three questions, and the decision latitude is based on seven questions. However, in this study we are only using decision authority for the decision latitude, which consists of four questions. Even though psychosocial demands and decision authority have a similar number of questions, the results vary when comparing them to the hypothesis of the JDC-model. According to Theorell (2020), studies have shown that the individual´s occupation can explain 45% of the reliable variance in decision latitude and just 7% of the reliable variance in demands. This could indicate that demands are more influenced by individual factors than decision latitude.

6.4 Job strain

The JDC-model, suggests that jobs in the high-strain category are more likely to cause negative effects including physical and psychological stress and disease. However, jobs within the active category are believed to lead to increased motivation, learning, and skill development (Toivanen, 2012). According to our study, high-strain jobs were in most cases associated with a greater stroke risk compared to active jobs. Which correlates with the JDC models hypothesis. According to Bonsaksen et al. (2019), high-strain jobs were shown to be more common among younger people, women, people with lower education levels, those who worked odd hours, and part-time. Some groups of individuals may be more susceptible to the adverse health effects, in jobs with high levels of stress. Jobs with high expectations and low job control have been linked to a variety of physical and mental health issues, including cardiovascular disease and stress. Providing support and resources to employees to help them cope with the demands of their jobs might reduce the negative impacts of high strain.

One hypothesis of the JDC-model is that high levels of control can potentially buffer the negative effects of high demands on health and well-being (Van der Doef & Maes, 1999). The results of our study indicate that the buffer hypothesis may not be relevant, and high demands might even be a protective factor. This could indicate that the demands we are measuring are not the same that the JDC-model uses. According to Häusser et al. (2010), other studies using different measurements have also found a lack of evidence for the buffer hypothesis, which correlates with our study's findings.

Another dimension of job strain is passive jobs. Our study found that passive jobs increase the stroke risk for all groups. This indicates that individuals with jobs that do not require a lot of physical activity or mental stimulation may be more susceptible to stroke. Passive jobs lack challenge and substantial content, which can lead to boredom and lack of motivation. This highlights the importance of considering not only the physical demands of a job but also its mental and social aspects when assessing the risk of chronic diseases such as stroke. In the study by Gimeno (2009), passive jobs were likely to contribute to an inactive lifestyle, with a lack of physical activity which is a risk factor for diseases, such as stroke. As our study did not include aspects of physical activities for the individuals included in the study, it's unclear how it would have affected the outcome.

According to Kapral (2019), previous studies have shown that specific types of occupations may raise the risk of stroke in various population groups. However, gender and regional differences were observed, indicating that it might be important to examine demographic factors when looking at associations between types of jobs and health outcomes (Kapral et al., 2019).

In a study by Torén et al. (2014) the association between psychosocial stress based on the JDC model and stroke was assessed among Swedish men. The study did not find an increased stroke risk in any of the job demand-control (JDC) categories, but an increased stroke risk was

observed among participants reporting stress and belonging to either the passive, active, or high-strain categories. The results of passive and high-strain jobs correlate with the results found in our study. This might indicate that individuals in these groups might be more susceptible to the negative health effects of job strain. This suggests that the subjective experience of stress may play a more significant role in health outcomes than the objective measures of job demand and control.

6.5 Regional differences

The results show regional differences in decision authority and job strain. This may indicate regional differences in the labor market between urban and rural areas. Additionally, psychosocial factors could impact the individual's level of stress, for example, work-life balance or proximity to nature and activities outside of work.

The demands of occupations available in urban areas may differ from those offered in rural areas. Urban jobs, for example, may involve more interpersonal engagement, such as pressure to perform in social settings which can contribute to psychosocial stress. Furthermore, the job market in urban areas may be more competitive, contributing to feelings of job instability and stress. Recruitment and retention of workers in some professions could be a potential problem in rural communities (Kim & Hopkins, 2016).

Areas with smaller populations may have different industries with social and cultural norms around work that differ from jobs in larger areas, which can affect job strain. For example, there may be an expectation of long work hours and a strong work ethic, which can contribute to higher levels of job strain. Additionally, rural areas may have fewer employment opportunities, which can contribute to concerns of job insecurity and stress. This correlates with the study by Tham (2022), there is a difference in stress factors in rural areas due to limited resources. Employees tend to work longer in their profession than individuals in urban areas. Additionally reported higher levels of burnout, and lower reported help-seeking behaviors.

Access to healthcare resources and other occupational support systems may differ between rural and urban areas. That can contribute to it being more difficult for individuals to manage health conditions that can contribute to job strain, such as chronic stress or mental health issues. In the study by Kapral et al. (2019) rural areas limited access to healthcare services and acute stroke care interventions, which resulted in lower rates of attendance at healthcare appointments and higher rates of stroke and mortality. Overall, the reasons for differences in the effects of psychosocial stress in urban and rural areas are complex and may be related to several factors such as social and cultural norms, job type, and access to healthcare and support systems.

6.6 Methods

6.6.1 Skill discretion

In this study, for job control, we included decision authority and did not include skill discretion as a component of the decision latitude. It is unclear if skill discretion measures control. Some studies have indicated that high-skill discretion can be perceived as a psychological demand instead of an aspect of job control (Theorell, 2014). According to Theorell (2020), the level of skill discretion has increased in later years due to increased education levels in the working population. Therefore, in some studies the decision latitude is represented by the decision authority component.

6.6.2 Limitations of the study

A limitation of this study is that it is not generalizable to other countries since it is based on Swedish data. Another limitation is that the register data that was used initially was collected for statistical purposes and not for research purposes. We are limited to the data that have been collected in the registers and therefore we cannot adjust for genetic predispositions or lifestyle variables that potentially could affect the risk of stroke, for example, smoking and BMI.

For civil status, we focused on married and unmarried. Some people in the unmarried category might not be single and could be living with someone. We are not able to adjust to their living situation in this study. However, civil status does not seem to be an important confounder. This limitation probably does not affect the results.

Another limitation is that the JEM used in this study is based on survey responses and aggregated on an occupational group level. The JEM may not reflect variations that may occur between individuals in the same occupation. As we do not know what task the individual has in their job, we only have information about their job code. However, by using the JEM we can include a large number of people in the study. It is unlikely that differential misclassification would occur here as the exposure is collected independently from the outcome.

6.6.3 Strengths of the study

A strength of this study is that the registers include a large population, compared to if we had collected new data. The registers include over 3,4 million people in Sweden and for the years 2014 and 2015 we have access to 4,694 cases of stroke. Due to the large population in this study, we can look at the results for men and women separately and look at differences between regions with larger and smaller populations. We would not be able to do this with a smaller sample.

Another strength of this study is that we reduce the risk of differential misclassification due to recall bias. This means that the association between exposure and outcome can be over- or underestimated. For example, an individual could overestimate the psychosocial stress if they suffered a stroke and believe there is a connection between stress and stroke. We are using prospective data and are looking at the outcome in 2014/2015 and comparing it to reported

psychosocial stress in 2013. The outcome is reported by hospitals and not by the individuals included in the study.

Collecting diagnosis data directly from hospitals has the potential to be more effective than collecting information through surveys or self-reporting, both can be time-consuming and result in biased data collection. Medical professionals are qualified to treat and diagnose patients, therefore ensuring that the information is accurate and dependable. When collecting diagnosis information from the National Patient Registers, the data represent a larger population.

6.6.4 Ethics

The data is secondary so there is no direct harm to the participants. Even though the data was originally collected for statistical purposes, we consider the study to be ethically justified. Understanding how occupational psychosocial stress impacts health, could potentially lead to a greater focus on the psychosocial work environment and the importance of preventive work to reduce the risk of illness.

6.7 Future research

The results for demands in this study and previous ones do not match the JDC-model. Future research could look at what types of demands in the work environment are harmful and what types are more beneficial or protective. Research on the psychosocial work environment and its effects on various diseases may contribute to new knowledge in the field.

It would also be interesting to study the relationship between occupational psychosocial stress and stroke in a study with a similar sample size and include confounding lifestyle factors such as smoking, physical activity, and BMI. To better understand the impact of lifestyle factors and the significance of the relationship to stroke risk, the information can contribute towards guiding more targeted interventions.

Future research could be used to develop interventions to reduce psychosocial stress in the workplace and improve their effectiveness in reducing stroke risk. To create successful interventions to lower stroke risk in those who experience high levels of stress. Strategies such as stress reduction and stress management training could be applied to improve the workplace. More research is needed to better understand the relationship between psychosocial stress and stroke.

6.8 Conclusions

Lower levels of psychosocial demands appear to increase the stroke risk. The results could indicate that the type of demand that is measured with the JEM used in this study does not capture a negative aspect of demand, but rather a positive or protective aspect. For job strain, in this study, passive jobs have a stronger association with increased stroke risk than high-strain jobs. One reason could be that the demands that we are measuring are not as negative as the

type of demands in the JDC-model. The combination of low demands and low control could therefore provide a more negative psychosocial work environment than the combination of high demands and low control.

The results suggest that occupational psychosocial stress may influence health outcomes. It is important for employers to consider not only the demands and control of a job but also the stress levels experienced by their employees. Providing resources and support to help employees manage stress could reduce the negative impact of job strain on health outcomes.

Overall, occupational psychosocial stress appears to potentially be an important factor in the individual's stroke risk regardless of gender and regional differences. Improving the psychosocial work environment could contribute to reducing stroke risk for employees.

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Appendix 1

Psykosocial JEM 1997 – 2013 (Fredlund, Hallqvist & Diderichsen, 2000)

JEM	Fråga
Påverkansmöjligheter	
	Bestämma när arbetsuppgifter ska göras (Kan du delvis själv bestämma när olika arbetsuppgifter skall göras?)
	Bestämma arbetstakten (Har du möjlighet att själv bestämma din arbetstakt?)
	Korta pauser för att prata (Kan du ta korta pauser i stort sett när som helst för att prata?
	Beslutar om uppläggning av arbete (Händer det att du är med och beslutar om uppläggningen av ditt arbete?)
Psykosociala krav	
	Så stressigt inte hinner prata eller tänka om annat än arbetet (Har du vissa tider så stressigt att du inte hinner prata om eller ens tänka på något annat än arbetet?)
	Övertid (Har du ibland så mycket att göra att du blir tvungen att dra in på luncher, arbeta över eller ta med jobb hem?)
	Kräver arbetet hela din uppmärksamhet och koncentration?