

Matti Joensuu

Job control as a predictor of mental and cardiovascular health: a prospective multicohort study



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Editor Virve Mertanen
Address Finnish Institute of Occupational Health
Arinatie 3
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Tel. +358-30 4741
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Job control as a predictor of mental and cardiovascular health: a prospective multicohort study

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Institute of Behavioural Sciences
Faculty of Behavioural Sciences
University of Helsinki, Finland

Supervisors: Adjunct professor Ari Väänänen, PhD
Finnish Institute of Occupational Health
Helsinki, Finland

Professor Mika Kivimäki, PhD
University of Helsinki and
Finnish Institute of Occupational Health
Helsinki, Finland

Reviewers: Professor Emeritus Antti Uutela, PhD
National Institute for Health and Welfare
Helsinki, Finland

Adjunct professor, Tarja Heponiemi, PhD
National Institute for Health and Welfare
Helsinki, Finland

Opponent: Professor Taru Feldt, PhD
University of Jyväskylä
Jyväskylä, Finland

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ABSTRACT

Job control has been a key concept in research on the psychosocial work environment and employee health for decades. A general hypothesis is that the more job control employees have, the lower their risk of stress-related diseases. However, the evidence to date has been inconclusive. The two components of job control, skill discretion and decision authority, may be differentially associated with health, which is a possible explanation for previous mixed findings. Therefore, this study examined the longitudinal associations of job control and its components separately, along with mental health and incident cardiovascular disease.

The samples used were the Still Working study (N=13 868), the Finnish Public Sector Study (N=60 202) and the Individual-Participant Data Meta-analysis in the Working Populations consortium (N=197 473). Survey responses to job control scales were linked to information on sickness absences and hospitalizations due to psychiatric disorders and hospitalizations and mortality from cardiovascular diseases derived from national registers for initially healthy employees. The follow-up period ranged from one year for sickness absence to 20 years for mortality. The data were analyzed using Cox proportional hazard models, probit regression and random-effects meta-analysis. Employees from hospital wards were linked to information on hospital ward overcrowding in an instrumental variable regression analysis of an external measure for job control.

Skill discretion and decision authority showed different, to some extent opposite and subgroup specific associations with mental and cardiovascular health. In several analyses a high decision authority was associated with an increased risk of future mental or cardiovascular ill health. In the Still Working cohort study, the adjusted hazard ratio for cardiovascular mortality was 1.47 (95% confidence interval, CI, 1.12, 1.93) for high decision authority and 1.01 (95% CI 0.76, 1.34) for high

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skill discretion. Job control as a combined construct was not associated with incident cardiovascular disease in the meta-analysis of prospective studies when adjusted for age, sex and socio-economic status (hazard ratio 0.95, 95% CI 0.75–1.19 for highest quartile vs. lowest quartile). In the instrumental variable regression hospital ward overcrowding did not function as an external indicator for job control.

Job control appears to be an equivocal concept in terms of health risk as its components were differently associated with health outcomes. These findings suggest that decision authority and skill discretion need to be separated and different work contexts should be differentiated in studies on job control, mental health and cardiovascular diseases.

TIIVISTELMÄ

Työn hallinta on ollut olennainen käsite psykososiaalisen työympäristön ja terveyden välisten yhteyksien tutkimuksessa vuosikymmenien ajan. Yleinen hypoteesi on, mitä suuremmat työn hallinnan mahdollisuudet, sitä pienempi on työntekijän riski sairastua stressiperäisiin sairauksiin. Tutkimustulokset yhteydestä eivät kuitenkaan yksiselitteisesti tue tätä hypoteesia. Työn hallinnan kaksi ulottuvuutta, työn monipuolisuus ja päättäntävalta työssä, voivat olla eri tavalla yhteydessä terveyteen, mikä selittäisi aiempia, osin ristiriitaisia tuloksia. Näin ollen tämä pitkittäistutkimus tarkasteli työn hallinnan, ja erikseen sen osatekijöiden, yhteyksiä tuleviin mielenterveysongelmiin ja sydäntauteihin.

Aineistoina käytettiin Yhä töissä -seurantatutkimusta (N = 13 868), kuntasektorin henkilöstön seurantatutkimusta (N = 60 202) ja Individual-Participant Data Meta-analysis in Working Populations -tutkimuskonsortiota (N = 197 473). Seurannan alussa terveiden työntekijöiden kyselyvastaukset työn hallinnasta yhdistettiin kansallisiin rekisteritietoihin, jotka koskevat mielenterveyden häiriöistä aiheutuvia sairauspoissaoloja ja sairaalajaksoja sekä sydäntautien aiheuttamia sairaalajaksoja ja kuolemia. Seuranta-ajat vaihtelivat sairauspoissaolojen vuoden seurannasta 20 vuotta kestäneeseen kuolleisuuden seurantaan. Analyyseina käytettiin Coxin verrannollisten riskitiheyksien mallia, probit regressiota sekä satunnaisvaikutusten meta-analyysiä. Tiedot sairaalaoastojen työntekijöistä yhdistettiin tietoihin osastojen täyttöasteista, jota käytettiin instrumentaalisessa regressioanalyysissä todentamaan työn hallinta ulkoisella tietolähteellä.

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Työn monipuolisuus ja päätäntävalta työssä olivat eri tavoin yhteydessä mielenterveyden häiriöihin ja sydäntauteihin. Joissain analyysissä yhteydet olivat erisuuntaisia tai tulivat esiin vain joissain alaryhmissä. Suuri päätäntävalta työssä oli useassa eri analyysissä yhteydessä kohonneeseen tulevan mielenterveyden häiriön tai sydäntaudin riskiin. Yhä töissä -aineistossa suuren päätäntävallan vakioitu riskisuhde sydänkuolemille oli 1,47 (95 % luottamusväli, 1,12; 1,93) ja suuren työn monipuolisuuden 1,01 (95 % luottamusväli 0,76; 1,34). Työn hallinta ei ollut yhteydessä sydäntautien riskiin prospektiivisten tutkimusten meta-analyysissä; ikä, sukupuoli ja sosioekonominen asema vakioitu riskisuhde 0,95 (95 % luottamusväli 0,75; 1,19). Sairaalaosastojen täyttöaste ei toiminut työn hallinnan ulkoisena mittarina. Työn hallinta ei vaikuta olevan yksiselitteinen terveysriski, sillä sen osatekijät olivat eri tavoin yhteydessä tulevaan terveyteen. Tulokset viittaavat siihen, että työn monipuolisuutta ja päätäntävaltaa työssä tulisi tarkastella itsenäisesti ja eri työkontekstit tulisi erottaa toisistaan tulevissa työn hallinnan, mielenterveyden ja sydäntautien tutkimuksissa.

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LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the five original publications listed below. The original articles are referred to in the text with Roman numerals (I–V). The original articles have been republished in this thesis with the permission of Elsevier B.V (I, IV), Oxford University Press (II, V), and BMJ publishing group ltd (III).

- I Joensuu M, Väänänen A, Koskinen A, Kivimäki M, Virtanen M, Vahtera J. Psychosocial work environment and hospital admissions due to mental disorders: a 15-year prospective study of industrial employees. *J Affect Disord.* 2010; 124:118–25.
- II Joensuu M, Kivimäki M, Koskinen A, Kouvonen A, Pulkki-Råback L, Vahtera J, Virtanen M, Väänänen A. Differential associations of job control components with mortality: a cohort study, 1986–2005. *Am J Epidemiol.* 2012;175:609–19.
- III Joensuu M, Kivimäki M, Pentti J, Virtanen M, Väänänen A, Vahtera J. Components of job control and mortality: the Finnish Public Sector Study. *Occup Environ Med.* 2014;71:536–42.
- IV Kivimäki M, Nyberg ST, Batty GD, Fransson EI, Heikkilä K, Alfredsson L, Bjorner JB, Borritz M, Burr H, Casini A, Clays E, De Bacquer D, Dragano N, Ferrie JE, Geuskens GA, Goldberg M, Hamer M, Hoofman WE, Houtman IL, Joensuu M, Jokela M, Kittel F, Knutsson A, Koskenvuo M, Koskinen A, Kouvonen A, Kumari M, Madsen IE, Marmot MG, Nielsen ML, Nordin M, Oksanen T, Pentti J, Rugulies R, Salo P, Siegrist J, Singh-Manoux

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- A, Suominen SB, Väänänen A, Vahtera J, Virtanen M, Westerholm PJ, Westerlund H, Zins M, Steptoe A, Theorell T; IPD-Work Consortium. Job strain as a risk factor for coronary heart disease: a collaborative meta-analysis of individual participant data. *Lancet*. 2012;380:1491–7.
- V Kivimäki M, Vahtera J, Kawachi I, Ferrie JE, Oksanen T, Joensuu M, Pentti J, Salo P, Elovainio M, Virtanen M. Psychosocial work environment as a risk factor for absence with a psychiatric diagnosis: an instrumental-variables analysis. *Am J Epidemiol*. 2010;172:167–72.

ABBREVIATIONS

CES-D	Center for Epidemiologic Studies Depression scale
CI	Confidence interval
CIDI	Composite International Diagnostic Interview
COPSOC	Copenhagen Psychosocial Questionnaire
FPSS	Finnish Public Sector Study
GHQ	General Health Questionnaire
HR	Hazard Ratio;
HSCL-10	Hopkins symptom check list -10
ICD-8, 9, 10	International Classification of Diseases, 8 th , 9 th , 10 th revisions
JCQ	Job Content Questionnaire
NIOSH-GJSQ	National institute of Occupational Safety and Health Generic Job Stress Questionnaire
OR	Odds ratio
QPSnordic	General Nordic Questionnaire
RR	Relative risk
SCAN	Schedules for Clinical Assessment in Neuropsychiatry
SCL-CD	Symptom Checklist-Core depression
SD	Standard deviation

1 INTRODUCTION

Different areas of life, such as social circumstances, personal relationships and traumatic events, contribute to the stress and health of individuals. A poor psychosocial work environment is believed to be one important source of stress and a risk factor for employee health (1). Increased risk has been observed in particular in relation to mental disorders (2, 3, 4) and cardiovascular disease (5, 6), that is, diseases in which stress is assumed to be a contributing factor. Mental disorders are the leading cause for disability pensions in Finland, accounting for 40% of all disability pensions in 2013 (7). Cardiovascular disease is the leading cause of death, accounting for 39% of deaths in Finland in 2012 (7). Of specific disorders, ischemic heart disease was the leading cause of Global Burden of Disease in 2010 measured as disability adjusted life-years, and major depressive disorder was ranked 11th (8). The association of job control and health outcomes has been extensively studied during recent decades (9). However, the findings have been inconsistent (e.g. 10, 11) and the methodologies used in the majority of studies have had limitations that have prevented definite conclusions (3, 12).

1.1 The concept of job control

The concept of job control (also known as decision latitude, job autonomy) has been an essential element in the study of work-related psychosocial factors (9, 13). The concept defines a condition where the employee can make decisions about their job on their own and the work is not restricted to a single, repetitive task. The idea of an employee's personal influence and power over their job was presented as early as in the 1960s (14). However, the first wide-spread definition and operation-

alization of the job control construct, as it is used today, was formulated by Hackman & Oldham in the concepts of skill variety and autonomy in the Job Diagnostic Survey in 1975 (15). In 1979, Karasek introduced the Demand-Control model (16) which was influenced by the work of Hackman & Oldham and the Scandinavian tradition of democracy in the workplace (17, p. 4). This model was then applied to study the effects of job content on the health of employees (18). In the Demand-Control model, job control, at first labelled as decision latitude, was comprised of two components: decision authority and skill discretion. Decision authority was described as the degree to which an employee can decide on the amount, tempo/pace and methods of his/her work. Skill discretion referred to opportunities for variable work in which the employee can use his/her competencies and learn new things. Other factors that since then have been seen to be related to the job control concept include work-time control, the employees influence on working times (19).

1.1.1 Theories incorporating the job control concept

Hackman & Oldham constructed the first theory which included job control or an equivalent and operationalized as the calculation of the Motivating Potential Score (15). It was constructed to reflect three Critical Psychological States: Experienced Meaningfulness (task-related factors), Experienced Responsibility (job autonomy) and Knowledge of Results (received feedback). The Motivating Potential Score could be calculated as the product of these three factors. However, this theory has been primarily viewed in relation to job satisfaction, motivation at work and organizational performance (13).

With regard to work-related stress and the associations between psychosocial factors and health, the most influential theory has been the aforementioned Demand-Control model (16, 17) where job demand and job control are plotted as dimensions creating four separate classes: low control-low demands (passive job), high control-high demands (active job), high control-low demands (low strain job), and low control-high demands (high strain job). In this model, often referred to also as the Job strain model, high job demands, such as heavy workload with tight deadlines, and low job control, separately and in combination, are seen as unhealthy aspects of the job. The most stressful work situation, high job

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strain, is depicted when high demands and low job control co-occur and have additive or even multiplicative negative effects. A buffer-hypothesis of the model implies that higher job control could buffer against the stressful effects of high job demands experienced by the employee. Later, social support has been incorporated into the model suggesting that a high strain situation is more stressful if the employee additionally does not receive social support from colleagues or supervisors (20). This model is referred to as the iso-strain model due to the isolation effect of low social support.

A further development of the Demand-Control model is the Job Demands-Resources model (21), which expands the original Demand-Control model to include a variety of physical, psychological, social, or organizational demands and resources, including job control. The accumulation and interactions of these factors are seen to influence the psychological well-being of employees.

Even the earlier models acknowledge the ambiguity in the job control concept. The Motivating Potential Score model (15), for example, states that higher levels of job control may not always be beneficial to the employee, depending on personal or situational characteristics. Also, the Demand-Control model, in turn, discusses the possibility that higher job control could be a stressor (17, p. 44) or could be confused with job demands (17, p. 62). However, these notions have not been, in general, emphasized in the studies and recommendations made using these models. Moreover, the Vitamin model (22, 23) explicitly states that psychosocial factors do not have a linear beneficial effect and that high job control could be detrimental to employee health. The model states that job characteristics function like vitamins, where an optimal level of a certain job characteristic exists and a further increase may be harmful. However, research based on the Vitamin model has been scarce, though some studies have found support for these non-linear effects (24, 25).

It could be hypothesized that the dimensions of job control, skill discretion and decision authority, are linked to different psychological mechanisms (17, p. 60). Higher skill discretion may have more to do with the motivation of the employee by enriching an otherwise mechanical job. Therefore it may have more influence on outcomes like job satisfaction and boredom at work and the direct stress effects of skill discretion may be smaller. Decision authority, both high and low, could have a more

direct stress mechanism. Low decision authority can be linked to an experience of an employee of being in a demanding situation to which he cannot adjust. High decision authority, on the other hand, may increase the employee's responsibilities and expectations towards him.

Furthermore, it has been noted that the boundaries the job control construct and the possible differential effects of its components have not been explicitly formulated in any theory (26). For example, Ganster (27) identified seven different domains (tasks, pacing, scheduling, physical environment, decision making, other people, and mobility) of work where individuals might have control. He hypothesized whether these are equally important, the same in different occupations or individuals, do they accumulate, and can one compensate for another? Also Kasl (28, p. 50) has pointed out the need to distinguish between questions regarding decision authority and skill discretion in the concept of job control because, though they might both be beneficial and associated with each other, they clearly do not represent the same construct.

1.1.2 The measurement and different operationalizations of job control

The primary method for studying job control has been the use of self-report questionnaire surveys, where a scale intended to measure the construct is made by combining the answers to a set of questions. In the Job diagnostic survey questionnaire skill variety was measured with question such as "How much variety is there in your job? That is, to what extent does your job require you to do many different things at work?" Autonomy was measured with questions such as "How much autonomy is there in your job? That is, to what extent does your job permit you to decide on your own how to go about doing the work?"

The Job Content Questionnaire (JCQ) (29) was designed for the purpose of testing the Demand-Control model, and has been the most common measure in the research on job control. Skill discretion is measured in the JCQ by 6 items (e.g. "My job requires that I learn new things", "I get to do a variety of things in my job") and decision authority (by 3 items ("My job allows me to make a lot of decisions on my own", "I have a lot to say about what happens in my job", "In my job, I am given little freedom to decide how I do my work"). All the questions for job control dimensions in the JCQ can be found in Study III.

The skill discretion, decision authority and overall job control scales in the JCQ have shown moderate to high internal consistency (29) and factorial validity (29, 30).

Job titles and occupations have been used as external indices of the levels of job control employees have. Job exposure matrices (31) or other work content analyses (32) have been conducted and different occupations are assigned a specific score of job control based on these evaluations. This occupation-specific score is then applied to all employees in this occupation as a proxy measure for their level of job control.

1.2 Previous research on job control and mental health

Much of the research on the associations between job control and mental health has been cross-sectional (33). However, a number of longitudinal studies have also been conducted in which self-reported job control was studied in relation to, for example, general distress scales (34), depression scales (35), doctor-diagnosed depression (36), structured clinical interviews (37) and prescribed antidepressant medications (38). Meta-analyses on these longitudinal studies have found an approximate risk of 1.2 for new-onset mental disorder in employees with low job control at study baseline (2, 3, 4). However, these estimates have been based on only two to eight studies in each meta-analysis. An updated list of 14 prospective studies on job control and mental health is presented in Table 1. As can be seen from the table, only one study (39) analyzed the effects of skill discretion and decision authority separately. In the majority of studies, the composite measure of job control, decision latitude, which combines skill discretion and decision authority, was used. Therefore it is difficult to evaluate the individual effects of these two components.

Studies using an external indicator for levels of job control have not shown large or consistent associations with mental health (39, 40, 41). A study that analysed the differences between aggregated work unit evaluations and self-evaluations of job control of depressed employees found that depressed employees perceived their job control to be lower than non-depressed employees in the same unit suggesting that reporting bias could potentially confound the association between job control and mental health (42).

Table 1. Prospective studies on job control and mental health

Study	Year of baseline	N	Follow-up	Baseline health adjustment/exclusion	Exposure of job control analysed	Outcome	Main findings for low job control
Kawakami (43)	1984	431	1,2, and 3 years	Adjustment for Zung-depression scale	1 item: Lack of control over work pace	Zung-scale depressed cases	RR 1.71* after one year, ns. in 2 nd and 3 rd year.
Griffin (31)	1991–1993	7270	5 years	GHQ cases for depression and anxiety	JCQ, Decision latitude	GHQ cases for depression and anxiety	OR 1.15 ns. (both sexes) for depression; 1.43* (men), 1.20 ns. (women) for anxiety
Clays (44)	1995–1998	2139	6.6 years	Exclusion of depression cases according to CES-D	JCQ, Decision latitude	Depression cases according to CES-D	OR 1.07 ns. (men), 1.90* (women)
Niedhammer (35)	1995	11552	12 months	Adjustment for sickness absence due to depression or anxiety	JCQ, Decision latitude	Depressive symptoms, CES-D scale	OR's 1.38* (men), 1.41* (women)
Inoue (45)	1996–1998	15256	5.1 years	Exclusion of depression cases according to CES-D	NIOSH-GJSQ, Job control	Sickness absence > 30 days due to depression	HR 3.57*
Plaisier (37)	1997	2646	2 years	Exclusion of all mental disorder cases according to CID-I	JCQ, Decision latitude	Depression or anxiety diagnosis in CIDI-interview	RR 0.81 ns.

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Ylipaavalniemi (36)	1998	10969	2 years	Exclusion of doctor diagnosed depression (self-report) cases, adjustment for GHQ cases	JCQ, Decision latitude	Doctor diagnosed depression (self-report)	OR 1.0 ns. (0.87 ns. adjusted for baseline GHQ)
Virtanen (38)	2000–2001	3366	12 months	Adjusted for self-reported lifetime mental disorders and depression and anxiety cases according to CIDI	JCQ, Decision latitude	Antidepressant medication from drug imbursement registry	OR 0.95 ns. (men), 0.96 ns. (women)
Laaksonen (46)	2000–2002	4488	5 years	Excluded employees with antidepressant medication from drug imbursement registry	JCQ, Decision latitude	Antidepressant medication from drug imbursement registry	HR 1.06 ns. (women), 0.96 ns. (men)
Bonde (39) Municipal	2002–2005	4815	2.3 years	Excluded employees with antidepressant medication from drug imbursement registry	COPSOQ, Decision latitude	Antidepressant medication from drug imbursement registry	HR 1.24 ns.

Table 1. continues on next page...

Table 1. continues...

Study	Year of baseline	N	Follow-up	Baseline health adjustment/exclusion	Exposure of job control analysed	Outcome	Main findings for low job control
Bonde (39) County	2002–2005	13335	2.3 years	Excluded employees with antidepressant medication from drug imbursement registry	Ad hoc scale, Skill discretion, Decision authority	Antidepressant medication from drug imbursement registry	HR 1.07 ns. low skill discretion: 1.1 ns. low decision authority
Grynderup (47)	2007	3046	2 years	Exclusion of depression cases according to SCAN	COPSOQ, Decision latitude	Depression cases according to SCAN	OR 1.65 ns.
Finne (48)	2004–2009	3212	2 years	Exclusion of mental distress cases according to HSCL-10	QPSnordic, Decision control; Control over work intensity	Mental distress cases according to HSCL-10	OR 1.33 ns. for Decision control; 0.90 ns. for Control over work intensity.
Theorell (49)	2008	6177	2 years	Adjustment for SCL-CD depression scale	JCQ, Decision authority	SCL-CD depression scale	β -0.039* (men), -0.019 ns. (women)

* Statistically significant $p \leq 0.05$. Ns. statistically non-significant. RR, Relative risk; OR, Odds ratio; HR, Hazard Ratio; GHQ, General Health Questionnaire; JCQ, Job Content Questionnaire; CES-D, Center for Epidemiologic Studies Depression scale; NIOSH-GJSQ, National Institute of Occupational Safety and Health Generic Job Stress Questionnaire; CIDI, Composite International Diagnostic Interview; COPSOC, Copenhagen Psychosocial Questionnaire; SCAN, Schedules for Clinical Assessment in Neuropsychiatry; HSCL-10, Hopkins symptom check list -10; QPSnordic, General Nordic Questionnaire; SCL-CD, Symptom Checklist-Core depression.

1.3 Previous research on job control and cardiovascular health

Studies of job control and cardiovascular health have primarily focused on job strain, job control being viewed only as a part of the Demand-Control model (5, 6). Although low job control on its own has previously been linked with increased, though moderate, risk of different objective cardiovascular outcomes (6), there are some studies that have found no (10, 50, 51) or even some opposite associations, that is, high job control or its subcomponents being related to increased health risk. For example, in a 10-year follow-up of the Framingham Offspring -cohort, high decision authority was associated with increased incident coronary heart disease in women (10). In some studies, the level of job control has also been found to be slightly lower (rather than higher) among persons with normal arteries (52) as compared with patients with prevalent coronary disease. Furthermore, job control has not been an important prognostic factor in patients with acute myocardial infarction (53), though job strain has (53, 54). In a 20-year follow up of employees in Israel, high job control was found to be a protective factor for all-cause mortality in men but a risk factor in women. (11). A meta-analysis of prospective studies on job control and incident cardiovascular disease was performed in this thesis (study IV). Two prospective studies that have been reported after the meta-analysis showed no associations of low job control to incident cardiovascular disease (55, 56). In general, skill discretion and decision authority have not been differentiated in prospective studies on job control and cardiovascular health, with the exception of the Framingham-study (10).

1.4 Hypothesised pathways from job control to mental disorders and cardiovascular disease

The way in which environmental factors, such as the psychosocial situation at work, could affect health has been proposed to involve stress response where external stimuli increases the activation of the hypothalamus-pituitary adrenal gland axis and the release of corticotropic

1 INTRODUCTION

hormone (57). Harmful effects to health occur when this activation is prolonged without a break in the stress response and the body does not get a chance to relax and recuperate. However, it has been noted that external factors, i.e. stressors, do not elicit a similar physiological response in all individuals, but personal resources and learned behaviours and strategies influence the magnitude of the stress response (58). Perceived control, defined as “the belief that one has one’s disposal a response that can influence the averseness of an event” (59), has been seen as an important factor moderating the link between external factors and a stress response (59, 60, 61). Exposure to uncontrollable stress has been linked to higher physiological and neural imaging stress markers both in humans (62) and in animal studies (63) compared with a situation of controllable stress. Repeated exposure to stressful stimuli without means to escape the situation has been found to elicit a withdrawal effect termed “learned helplessness” in animals (64). A similar mechanism, though much more complicated due the different attributions a human can make, has been proposed to be a contributing factor in depression (65). Higher levels of perceived control have also been associated with better health behaviors (66). However, it has been noted that opportunities for control might not be adaptive for all individuals or in all contexts (67) and a recent experimental study found that increasing autonomy over break times in a word processing task elevated the physiological stress levels of female participants (68).

In turn, the mechanisms from stress to illness could be etiological, indirect, triggering or prognostic (5). The etiological effects of prolonged stress can be mental exhaustion which directly leads to depression (69) or physiological changes in metabolism (70), blood pressure (71), platelet function (72) and other mechanisms increasing the risk of cardiovascular disease. Prolonged stress can also have indirect effects, through lifestyle change, where stressed individuals increasingly eat unhealthy foods, exercise less, smoke and use too much alcohol and therefore their risk to cardiovascular disease (73) and/or depression is increased (74). Stress response could also act as a trigger of cardiac or cerebrovascular event in vulnerable persons with already increased risk of manifest disease (75, 76). Finally, stress could act as a prognostic factor where high stress effects the prognosis among individuals who already have the disease (77).

1.5 Gaps in knowledge

Several earlier studies where job control and health have been examined have tested the Demand-Control model (9). In these studies the two components of job control, skill discretion and decision authority, have typically been combined under the general job control construct and their independent associations to health have seldom been tested. Further limitations include low methodological quality in terms of study designs. Only a few longitudinal studies have been reported and of these many are not true prospective studies since they have not controlled for baseline health properly by adjusting or excluding employees with health conditions or preclinical symptoms (3). Therefore reversed causality, i.e. deteriorated health affecting reports of job control, cannot be ruled out as an alternative explanation for the observed associations (78). Also, the follow-up times in longitudinal studies have been quite short, typically one to two years, which makes the observation of significant effects on health conditions which take years to develop unlikely. Reporting (42) and common method (79) biases are further sources of error as typically both job control and health, particularly mental health, have been assessed using self-report questionnaires, which can be influenced by, for example, the personal characteristics of the respondents. The use of symptom scales, such as the General Health Questionnaire, (34) also makes the interpretation of the clinical significance of the results problematic (2). Further, residual confounding by unmeasured factors, such as childhood circumstances (80), may have caused bias in the result. Finally, as socioeconomic status is strongly linked to job control, simple adjustments for socioeconomic status may not be able to properly control for its effects. Socio-economic position and the place in the organizational hierarchy are difficult to separate from the job control concept as socioeconomic position is defined on the basis of power relations; job control, by definition, reflects such relations. This overlap is particularly evident when occupation is used as a measure of socioeconomic position as well as an indicator of job control (81). However, higher education, income, occupational position and high social status stemming from these are strongly associated with better health and therefore can easily confound any analyses of the job control-health associations (82). Ideally, analyses should be run separately for different socioeconomic groups and sectors of employment (83).

2 THE PRESENT STUDY

The overarching aim of this study is to determine the association of job control and with employee health. The limitations of earlier knowledge were taken into account by separating the subcomponents of job control and using prospective data from multiple samples, long follow-up times, clinically relevant objective outcomes and stratified analyses in different socio-economic groups. The outset for the studies was the construction of large employee cohort datasets, the Still Working study, the Finnish Public Sector study and the Individual Participant Meta-analysis consortium, where questionnaire data on working conditions were linked to national health registers for each employee. These datasets were set up in order to get a more reliable and accurate estimation of the associations seen in many earlier studies of the psychosocial working environment and employee health.

Originally, Study I was designed to look at the associations of job control subcomponents with clinical mental health outcomes in a long follow-up. The results turned out to be very surprising and, in part, contrary to the then common understanding of the associations of job control and health. For this reason, Studies II and III were designed to expand and test the generalizability of the discoveries in Study I. Study IV was performed to understand the association between job control (as part of job strain) in a broader European context and Study V was designed to apply an alternative methodology of studying psychosocial factors at work with the aim of reducing reporting bias by using instrumental analysis.

The specific objectives were as follows (original articles are referred to with Roman numerals):

2 THE PRESENT STUDY

1. To determine the associations of job control and its subcomponents, decision authority and skill discretion, with mental ill health (Study I)
2. To examine the extent to which the components of job control, decision authority and skill discretion, are associated with cardiovascular disease and total mortality (a replication of Study I with a different set of health outcomes) (Study II)
3. To test whether the results on job control and cardiovascular disease and total mortality (study II) are replicable in another research setting (Study III)
4. To determine the magnitude of cardiovascular disease risk associated with job control in European working populations based on a large-scale individual-level meta-analysis of multiple cohort studies (Study IV)
5. To explore whether the instrumental variable method can be used to strengthen causal inference in the study of the association between job control and health (Study V)

3 MATERIALS AND METHODS

3.1 Materials and procedures

The data in Studies I and II were from the Still Working study, a prospective cohort study of private sector industrial employees in a Finnish multinational forest industry corporation (84, 85). A questionnaire on behavioural risk factors, psychosocial factors at work and health was sent to all 12 173 employees of the company in Finland in the spring of 1986, and to all 13 411 employees in the spring of 1996. A total of 9 282 employees (response rate 76%) responded to the questionnaire in 1986 and 8 371 (response rate 62%) in 1996. Those who had already responded in 1986 were excluded from the 1996 cohort. All employees who had been admitted to hospital due to mental disorders between 1972 until the time of the survey (n=377) were excluded from the study in Study I. In Study II employees who had been admitted to hospital for cardiovascular-, cancer-, alcohol-related or mental health reasons according to the Finnish Hospital Discharge Register (86) from 1969 until the time of the survey (n=945) were excluded. Thus, the final analytic cohort included 13 868 employees in Study I and 13 510 employees in Study II. The mean age for the analytic cohort was 41.7 years (range 16–65) in Study I and 40.6 years (range 16–65) in Study II.

The data in Study III were derived from the Finnish Public Sector Study (FPSS), an on-going prospective cohort study of employees in the municipal services of 10 Finnish towns and 21 public hospitals (87). The eligible population from the register cohort of FPSS (n=151 618) included those who had been employed for a minimum of six months at the participating organizations between 1991 and 2005. Employers' records have been used to identify the eligible employees for a nested survey cohort to whom questionnaire surveys have been repeated every

3 MATERIAL AND METHODS

four years, since 2000. In total, 66 418 participants responded at least once to surveys in 2000 (response rate 67%) and 2004 (response rate 65%). In this study, the data from the first year when the survey response of an employee were available was used. The employees who had been admitted to hospital for cardiovascular-, cancer-, alcohol-related or mental health reasons according to the Finnish Hospital Discharge Register (86) at any time during the 10 years prior to the survey were excluded (n=6 216). Thus, the final analytic cohort included 60 202 employees. The mean age in the cohort was 43.3 years (range 17–69).

Study IV used the individual-participant-data meta-analysis in working populations (IPD-Work) consortium data from 13 independent cohort studies started between 1985 and 2006, in Finland, Sweden, Denmark, the Netherlands, Belgium, France, and the UK. The characteristics of the different cohorts presented in the appendix of Study IV and the measures used in them are analysed in Fransson et al (88). After exclusions for baseline health, the analytic cohort consisted of 197 473 employees. The mean age in the cohort was 42.3 years. The analysis of job control was limited to 8 cohorts to which the authors had full access to the data. Both the Still Working cohort and the FPSS cohort were included in this meta-analysis.

In Study V, female nurses who worked in the 203 hospital wards were identified from the employers' registers from the FPSS cohort. Beginning and end dates for all employment contracts were also retrieved. A total of 3 103 (78%) of the nurses had responded to the questionnaire. To ensure the study participants had been exposed to conditions on the wards for a reasonable length of time, those employees who had at least a contract of 3 months on the wards before the survey were selected (N=2 965). In order to assess sickness absence which started after the measurement of overcrowding and job demands, those employees who had one or more periods of sickness absence with a psychiatric diagnosis during the six months prior the survey (N=39) were excluded. In addition, those participants who had missing data for any of the study variables (N=142) were excluded. The final cohort in Study V consisted of 2 784 female nurses. The mean age in the cohort was 42.2 years (range 20–64).

Using the unique national identification number that each permanent inhabitant in Finland receives, the participants in the Still Working cohort and the Finnish Public Sector cohort were linked to the Finnish

Hospital Discharge Register (86), the Statistics Finland National Death Registry (89), which provided comprehensive data on dates and causes of mortality and the drug reimbursement register of the Social Security Institution. In Study V the participants were followed up through record linkages for sickness absence with a psychiatric diagnosis in the Social Security Institutions sickness absence allowance register for a 12-month period after the questionnaire survey.

The Ethics Committee of the Finnish Institute of Occupational Health approved studies I, II and V. The Ethics Committee of the Hospital District of Helsinki and Uusimaa approved Study III. Each constituent study in Study IV was approved by the relevant local or national ethics committees.

3.2 Measures

3.2.1 Predictors

In studies I and II dimension of job control were assessed using questions which later formed the core of the Occupational Stress Questionnaire (90). The items of the scales used in studies I and II used are presented in a Web Appendix of Study II. Skill discretion (Cronbach's alpha 0.82) was measured by 5 items (e.g., "Is your work monotonous or variable?" or "Can you use your knowledge and skills in your work?"). Decision authority (alpha 0.79) was measured by five items (e.g., "Can you plan your work yourself?" or "How much influence do you have on the objectives of your work, i.e. on what you are expected to achieve?"). The Pearson correlation between skill discretion and decision authority was 0.46. Correlations between the 2 time points 1986 and 1996 in studies I and II, skill discretion $r = 0.67$, decision authority $r = 0.59$ show that the job control dimensions were relatively stable over time. Previous studies have found the validity of the scales to be satisfactory (84, 91).

In studies III and V job control dimensions were measured with the JCQ (29). Skill discretion (Cronbach's alpha 0.81, in study III) was measured by 6 items (e.g. "My job involves a lot of repetitive work") and decision authority (alpha 0.77, in study III) was measured by 3 items (e.g. "I have a lot to say about what happens in my job"). All items had

a 5-point scale (1 very little – 5 very much). As there are no validated clinical cut-off points for these scales, both summary scales were divided into tertiles for the analyses.

In Study IV job control and job demands were measured with questions from job-content questionnaire or similar scales in all included studies and the scales were validated and harmonized (88). The Pearson correlation coefficient between the harmonized scales used in Study IV and the complete versions was greater than 0.9 except for one study in which it was 0.8. To minimize investigator bias, the measures derived from the scales were validated before extracting data for coronary heart disease, with investigators masked to outcome information (88).

Ward overcrowding was used as an external predictor in the instrumental analysis in Study V. The participating hospitals collected monthly figures on bed occupancy in each ward according to the procedure set by the National Institute for Health and Welfare in Finland. Monthly bed occupancy was calculated by dividing the sum of inpatient days with the number of beds available (i.e., the number of beds * the number of days the ward was in use). Ward closure days were excluded from the denominator. The day of admission but not the day of discharge for each patient was included in the sum of inpatient days. The rate above which a hospital ward is overcrowded is less than 100% and is defined as >85%. (10–12). To assess the excess rate of bed occupancy, the optimal bed occupancy rate (<85%) was first coded as 0% and all rates above 85%, i.e. overcrowding, were calculated by subtracting 85 from the rate. Then a 4-level overcrowding score was created based on the mean of the monthly excess bed occupancy rates over the preceding 3 months before the survey (1= 0%; 2= >0% to <5%; 3= >5% to <10%, and 4= >10% excess occupancy). In previous studies, the measure of hospital ward overcrowding has been associated with sub-optimal employee (92) and patient outcomes (93).

3.2.2 Outcomes

Hospital admissions for mental disorders

For studies I and II data on hospital admissions due to mental disorders were collected from the Finnish Hospital Discharge Register maintained by the National Institute for Health and Welfare in Finland (86). The

3 MATERIAL AND METHODS

centre gathers discharge records annually from all hospitals in Finland. The register contains dates of admission and discharge, and primary and subsidiary diagnoses according to the International Classification of Diseases (ICD) versions 8, 9, or 10 (94, 95). For uniformity, the diagnoses were converted to match the ICD-9 classification. The diagnosis used as the outcome variable was the main or one of the subsidiary diagnoses, whichever was the first mental disorder diagnosis. For disorder-specific analyses the diagnoses were classified into three groups: alcohol-related disorders (ICD-9: 291-292,303-305), unipolar depressive disorders (ICD-9: 296.2, 296.3, 298.0, 300.4, 309.0, 311.0) and other mental disorders, covering all mental disorder diagnoses other than the aforementioned. These diagnoses included mainly bipolar disorders, psychoses, and anxiety disorders, and were grouped together due to a small number of cases in any specific category. The largest diagnostic groups represented in the study group were affective disorders ICD-9 code 296 (169 cases as first admissions with a mental disorder diagnosis) and mental and behavioural disorders due to over-consumption of alcohol ICD-9 code 291 (120 cases) and ICD-9 code 303 (111 cases).

All-Cause mortality and cardiovascular mortality and morbidity

Mortality data from 1 March 1986 to 31 December 2005 in Study II and from 2000 to 2010 in Study III were obtained from the National Death Registry maintained by Statistics Finland. The database provides virtually complete population mortality data (89). The dates and causes of death (from death certificates) were obtained for all the participants. Diagnoses were according to the International Classification of Diseases (ICD) versions 8, 9, or 10. For uniformity, they were converted to match the ICD-9 classification. Separate analyses were made for deaths due to cardiovascular diseases (ICD-9 codes 390—459, ICD-10 I00—I99) cancer (ICD-9 codes 140—208, ICD-10 C00—C97), alcohol-related causes (ICD-9 codes 291, 3050, 303, 3575, 4255, 5353, 5710-5713, 5770D-5770F, 7607A, 7795A, E851, E860, ICD-10 F10, G312, G4051, G621, G721, K929 I426, K70, K860, O354, P043, X45) and external causes (ICD-9 codes E800—E858 or E860—E990, ICD-10 V01—X44 or X46—Y89).

Information about incident coronary heart disease during follow-up in Study IV was derived from national hospital admission and death registries in the included studies except the Belstress study (50) in which disease events were registered by the human resources department and occupational health service, and the GAZEL cohort study (96), in which registry data for admission were not available and non-fatal events were based on self-report questionnaires distributed yearly. Individuals were defined as having incident coronary heart disease according to the type and time of diagnosis of their first disease event. Date of diagnosis, hospital admission due to myocardial infarction, or date of death from coronary heart disease was used to define disease incidence, which were recorded with MONICA categories, or codes ICD-9 or ICD-10 revision (94, 95, 97). Only the main diagnosis from mortality and hospital records was used. All non-fatal myocardial infarctions that were recorded as I21–I22 (ICD-10) or 410 (ICD-9) and coronary deaths recorded as I20–I25 (ICD-10) and 410–414 (ICD-9) were included.

Sickness absence for mental disorders

In Study V data on diagnosis-specific sickness absences were retrieved from the national sickness absence register of the Social Insurance Institution of Finland. All permanent residents aged 16–67 years in Finland are entitled to daily allowances due to sickness absence based on a medical certificate. Absences are covered up to one year after a waiting period of nine days, in addition to the first day of illness. If the absentee is paid a wage or salary while on sickness absence (this is the case for all the participants in the present study), sickness allowance is paid directly to the employer. The data cover virtually all sickness absence episodes of 10 days or more. The data also include diagnosis for each sickness absence spell. An ICD-10 diagnosis with 3-digits is assigned to each sickness absence episode by the treating physician. Sickness absence cases were defined as those with sickness absence due to any mental or behavioural disorder (F00–F99) during the one-year follow-up period after the survey. In addition, those with sickness absence due to depressive disorders (F32–F34) were identified.

3.2.3 Covariates

The covariates used in each study are presented in Table 2. Age and sex (Study V included only women) were adjusted for in all studies. Occupational status was adjusted for analyses with job control in studies I, II, III and V. Co-worker support and supervisor support were adjusted for in studies I, II and III and time pressure at work in Study III and in a subsample of I and II. Supervisor status was adjusted for in studies I and II, and sensitivity analyses by excluding all supervisors were made in studies I and II, and in a subsample of Study III. Additional covariates that were included in the samples where available were: smoking status (studies III, IV and subsample of I, II), physical inactivity (III, IV, V subsample I, II), obesity (III, IV, IV), heavy alcohol consumption (III, IV, V subsample I, II), physical work environment (I), and entitlement to imbursement due to chronic diabetes or hypertension in the Drug Imbursement Register held by the Social Insurance Institution (98) in studies I, II and III. In study V adjustments were also made for the length of employment contract (<1, 1–4, >4 years), type of contract (temporary vs. permanent), hospital district, and specialty (internal medicine, surgery, pediatrics, other).

3.3 Statistical analyses

Cox proportional-hazards models were used to analyze the associations between work characteristics and outcomes in studies I, II, III and IV. For each participant, person-days of the follow-up were calculated from the baseline measurement (1986 or 1996 in studies I and II, 2000 or 2004 in Study III and from 1985–2006 depending on the sample in Study IV) until the first outcome event or the end of follow up, whichever came first. In Study I, follow up was stopped for employees who reached the age of 65 (the official retirement age at the time of the study). The average follow-up times are reported in Table 2. The time-dependent interaction terms between each predictor and logarithm of the follow-up period were non-significant in all studies, confirming that the proportional hazards assumption was justified (all p values >0.70). Hazard ratios (HR) and 95% confidence intervals (95% CI) for categorical independent vari-

3 MATERIAL AND METHODS

ables and continuous linear variables provided risk estimates. For the continuous linear variables, the results show the effect associated with one standard deviation increase in standardized work-related psychosocial risk measures at the baseline (mean = 0, standard deviation = 1) or in the item-specific analyses one scale point increase. The analyses were done in a stepwise manner, first examining the unadjusted associations of the predictor to the outcomes. Then adjustments were made by first adjusting for age, sex and occupational status. Then additional adjustments were made for physical health (hypertension, diabetes), physical work environment, supervisor position, supervisor support, co-worker support, time pressure, smoking, alcohol consumption, physical activity, and obesity/ BMI depending which of these were available in each study and are presented in Table 2.

The analyses were carried out also in subgroups (men and women in studies I, II, III, IV, white collar and blue collar employees in studies II, III, IV and a combination of sex and occupational status in Study III). In Study II, the mediating effect of the new-onset mental disorders on mortality was analyzed, where hospitalization for mental disorders was additionally adjusted for as a time dependent variable, in which the first hospitalization of each individual was included. In Study IV, the study-specific effect estimates were pooled and their standard errors in fixed-effects and random-effects meta-analyses were calculated (only random effects results are presented). In Study IV between study heterogeneity was assessed with the I^2 statistic.

An instrumental variable regression approach was used in Study V (99). The strength of ward overcrowding as an instrument for psychosocial factors was examined by using F statistics (values 10 or more are taken to indicate sufficient strength to ensure the validity of instrumental variable methods) (100, 101) and exogeneity of the instrument by using the Wald test. Associations between sickness absence with a psychiatric diagnosis and those psychosocial factors for which overcrowding provided a sufficiently strong instrument were examined using conventional and instrumental probit regression analysis. The probit model is based on the standard cumulative normal probability distribution and the coefficient of probit model is called the probit index (102). Analyses were adjusted for baseline covariates. To illustrate differences between standard and instrumented analyses, probabilities of sickness absence with a psychiatric

3 MATERIAL AND METHODS

diagnosis were calculated for those at the bottom and top quartile of the psychosocial work factors. All these analyses were repeated using sickness absence with diagnoses of depressive disorders as the outcome variable.

All the analyses in the different studies were performed with maximum data, which resulted in some variation in the number of participants in different comparisons. The only exception was the multivariate models, which involved only the participants with no data missing for any of the predictors. The Cox proportional-hazards model analyses were conducted using the PHREG procedure in the SAS 9.1 or 9.2 statistical software package (103). The pooled effects in Study IV were calculated with STATA-MP version 11.1. The instrument variable regression analyses in Study V were made with STATA 10.0 software. The forest plot figure in Study III was produced with Meta Data Viewer software (104).

Table 2. Description of the characteristics of the cohorts used in each study.

Study characteristics	I	II	III	IV	V
Study sample	The Still working cohort	The Still working cohort	The FPSS cohort	The IPD-cohort	Female nurses from the FPSS cohort
Analytic cohort <i>n</i>	13 868	13 510	60 202	197 473	2784
Men %	77	77	20	51	0
Age, mean,range	41.7, 16–65 years	40.6, 16–65 years	43.3, 17–69 years	42.3 years, *	42.2, 20–64 years
Blue collar %	67	67	18	32	0
Response rate	76 % in 1986, 62 % in 1996	76 % in 1986, 62 % in 1996	67 % in 2000, 65 % in 2004	*	78 %
Study design	Prospective	Prospective	Prospective	Prospective	Prospective
Follow up	15 years 1 month	15 years 5 months	8 years 10 months	7 years 6 months	1 year
Predictors	Skill discretion Decision authority	Skill discretion Decision authority	Skill discretion Decision authority	Job control	Ward overcrowding, Job demands, Job control

Table 2. continues on next page...

Table 2. continues...

Study characteristics	I	II	III	IV	V
Outcomes	Hospitalisation for all-cause and cause-specific mental disorder	All-cause and cardiovascular mortality	All-cause and cardiovascular mortality	Hospital admission or myocardial infarction or death from cardiovascular disease	Sickness absence of >9 days due to mental disorder
<i>n</i> of cases	577 all-cause mental disorder hospitalisations	981 all-cause, 375 cardiovascular deaths	696 all-cause, 128 cardiovascular deaths	2358 incident coronary heart disease events	102 employees with a sickness absence
Covariates	Age, sex, occupational status, cardiac events, diabetes, physical work environment, supervisor support, co-worker support	Age, sex, occupational status, cardiac events, diabetes, supervisor support, co-worker support. Time pressure, smoking, alcohol use and physical activity in the 1986 cohort.	Age, sex, occupational status, cardiac events, diabetes, time pressure, smoking, alcohol use, physical activity, obesity	Age, sex	Age, length of employment, hospital district, specialty, smoking, physical activity, alcohol use, obesity.
Sensitivity analyses	Supervisor status, separate analyses for the two time cohorts	Supervisor status, separate analyses for the two time cohorts, preceding layoffs, early retirement, turnover	Supervisor status for ½ of the sample	-	-

* The characteristics of the 13 different cohorts are depicted in Fransson et al. (88)

4 RESULTS

4.1 Associations between decision authority, skill discretion and mental health

The associations between psychosocial work characteristics and mental health was studied in the Still Working cohort from 1986 and 1996 to 2005 (Study I). Descriptive statistics are presented in Table 2. During a mean follow-up of 15 years and one month, 577 subjects had been admitted to a hospital with a mental disorder diagnosis (458 men and 93 women). Figure 1 shows the associations of high skill discretion and high decision authority to all- and cause-specific mental disorders in the multivariate adjusted model. In this model adjusted for age, sex, occupational status, physical health (cardiac events, diabetes) and physical work environment, high skill discretion was associated with a reduced risk of all mental disorders (HR 0.74, 95% CI 0.58, 0.95) but in contrast high decision authority was associated with a significant increased risk (HR 1.48, 95% CI 1.17, 1.87). Skill discretion was also associated with a reduced risk for depressive (HR 0.59, 95% CI 0.37, 0.92) and other mental disorders (HR 0.60, 95% CI 0.39–0.94) whereas high decision authority was associated with an increased risk of alcohol-related (HR 1.62, 95% CI 1.19, 2.22) and depressive disorders (HR 1.70, 95% CI 1.12, 2.60). The analyses were repeated when treating the psychosocial predictors as continuous linear variables with similar results (Study I, p.121).

4 RESULTS

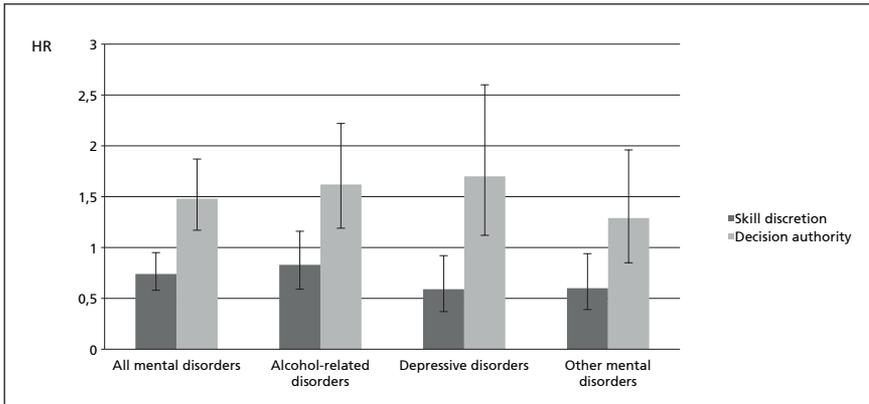


Figure 1. Associations of job control components and mental disorders. Job control variables were entered together and adjusted for age, sex, occupational status, physical health (hypertension, diabetes) and physical work environment. HRs and error bars for 95% CIs for high (reference low=1) tertile groups.

Because the effects of skill discretion and decision authority strengthened when examined together, the effects of decision authority were analyzed in the different skill discretion levels in the multivariate adjusted model. Here, decision authority had no significant effect on all mental disorders in the low skill discretion group, but a significant effect on both in the intermediate (HR 1.69, 95% CI 1.18, 2.44) and especially in the high skill discretion group (HR 2.11, 95% CI 1.16, 3.82). A stratified analysis according to occupational status showed that for blue collar workers both intermediate (HR 1.27, 95% CI 1.01, 1.59) and high decision authority (HR 1.45, 95% CI 1.13, 1.87) were significant risks and intermediate skill discretion (HR 0.80, 95% CI 0.64, 1.00) was a protective factor of all mental disorders. For white collar workers both intermediate (HR 0.57, 95% CI 0.32, 0.99) and high skill discretion (HR 0.39, 95% CI 0.21–0.70) were protective of all mental disorders. High decision authority was not a significant risk factor for white collar workers (HR 1.77, 95% CI 0.93, 3.38).

As a sensitivity analysis, the analyses were repeated in separate cohorts, i.e. respondents in 1986 with a 19-year follow-up and those in 1996 with a 9-year follow-up and also when excluding all supervisors (N=2 665). The results of these analyses were similar to the main analyses although not all factors remained statistically significant with the smaller numbers.

4.2 Associations of decision authority and skill discretion with all-cause and cause-specific mortality

The associations of decision authority and skill discretion with all-cause and cause-specific mortality were studied in the Still Working cohort and the Finnish Public Sector- cohort and are described in studies II and III. Table 2 presents the descriptive statistics of the cohorts. In the Still Working cohort 67% were blue-collar employees and 33% white-collar. During the mean follow-up of 15 years and 5 months, standard deviation (S.D.) 5 years 1 month, 981 subjects (868 men and 113 women, 7% of the sample) died. The average time from the survey to death was 11 years and 10 months, S.D. 5 years 5 months. In the FPSS cohort 82% were white-collar employees and 18% blue-collar. During the mean follow-up of 8.8 years, S.D. 1.7 years, 696 subjects (249 men and 447 women, 1% of the sample) had died. The average time from the survey to death was 5.6 years, S.D. 2.6 years.

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Table 3. Association of job control components with all-cause and cardiovascular mortality in the two cohorts.

		Unadjusted		Model 1 ^a	
	<i>n</i> (cases)	Hazard ratio	(95% CI)	Hazard ratio	(95% CI)
Still working cohort		All causes			
Skill discretion					
Low	4312 (283)	1		1	
Intermediate	4852 (344)	1.04	0.89, 1.22	0.87	0.74, 1.03
High	4346 (354)	1.15	0.99, 1.35	0.98	0.82, 1.17
Decision authority					
Low	4604 (293)	1		1	
Intermediate	4628 (343)	1.16	0.99, 1.35	1.12	0.95, 1.31
High	4278 (345)	1.29	1.11, 1.51	1.26	1.07, 1.49
FPSS					
Skill discretion					
Low	17915 (255)	1		1	
Intermediate	23298 (264)	0.81	0.68–0.96	0.91	0.76–1.09
High	18410 (172)	0.66	0.55–0.80	0.82	0.67–1.01
Decision authority					
Low	17707 (225)	1		1	
Intermediate	27516 (305)	0.86	0.72–1.02	0.90	0.76–1.07
High	14322 (158)	0.85	0.69–1.04	0.87	0.71–1.07
Still working cohort		Cardiovascular			
Skill discretion					
Low	4312 (101)	1		1	
Intermediate	4852 (140)	1.18	0.91, 1.53	0.94	0.72, 1.22
High	4346 (134)	1.22	0.94, 1.58	1.01	0.76, 1.34
Decision authority					
Low	4604 (101)	1		1	
Intermediate	4628 (139)	1.36	1.05, 1.76	1.30	1.00, 1.69
High	4278 (135)	1.47	1.14, 1.90	1.47	1.12, 1.93

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FPSS					
Skill discretion					
Low	17915 (53)	1		1	
Intermediate	23298 (43)	0.63	0.42–0.94	0.75	0.49–1.14
High	18410 (30)	0.56	0.36–0.87	0.75	0.46–1.23
Decision authority					
Low	17707 (43)	1		1	
Intermediate	27516 (56)	0.83	0.56–1.23	0.88	0.59–1.31
High	14322 (27)	0.76	0.47–1.23	0.79	0.48–1.29

Abbreviations: CI, confidence interval. ^aModel 1 job control variables entered separately, adjusted for age, sex and occupational status, and physical health (hypertension, diabetes).

Table 3 shows the associations of skill discretion and decision authority with all-cause and cardiovascular mortality in both the Still Working and FPSS cohorts. In the Still Working cohort a similar association found in Study I with mental disorders was also found as high decision authority was associated with increased all-cause and cardiovascular mortality both in the unadjusted model and also when adjusted for age, sex, occupational status and physical health. Figure 2 shows the survival function for levels of decision authority in the fully adjusted model. Skill discretion showed no significant associations with all-cause or cardiovascular mortality in the Still Working cohort.

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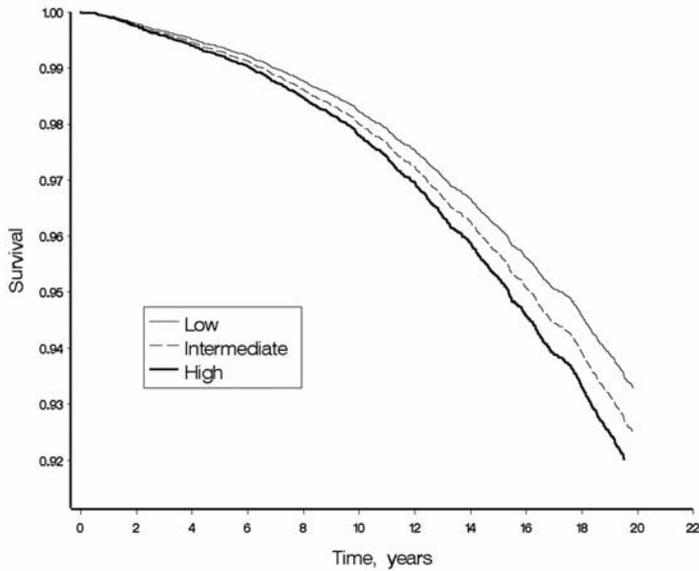


Figure 2. Survival for levels of decision authority, by fully adjusted Cox curve model in the Still Working cohort.

In the FPSS cohort high skill discretion had a protective effect for all cause and cardiovascular mortality in the unadjusted model. After adjusting for age, sex, occupational status and physical health, neither skill discretion nor decision authority showed significant effects.

In the Still Working cohort the stratified results for men and women and blue/white collar employees were in line with the overall analyses (Study II appendix). The associations stratified by sex and occupational status in the FPSS cohort are presented in Figure 3. High skill discretion was associated with decreased mortality risk among white collar men and women in combination, but when further stratified by sex the association remained only for white collar women (HR 0.74, 95% CI 0.56, 0.98). High decision authority was associated with lower mortality among white collar women (HR 0.71, 95% CI 0.53, 0.96). In contrast, high decision authority was associated with higher mortality among blue collar women (HR 1.82, 95% CI 1.04, 3.20).

4 RESULTS

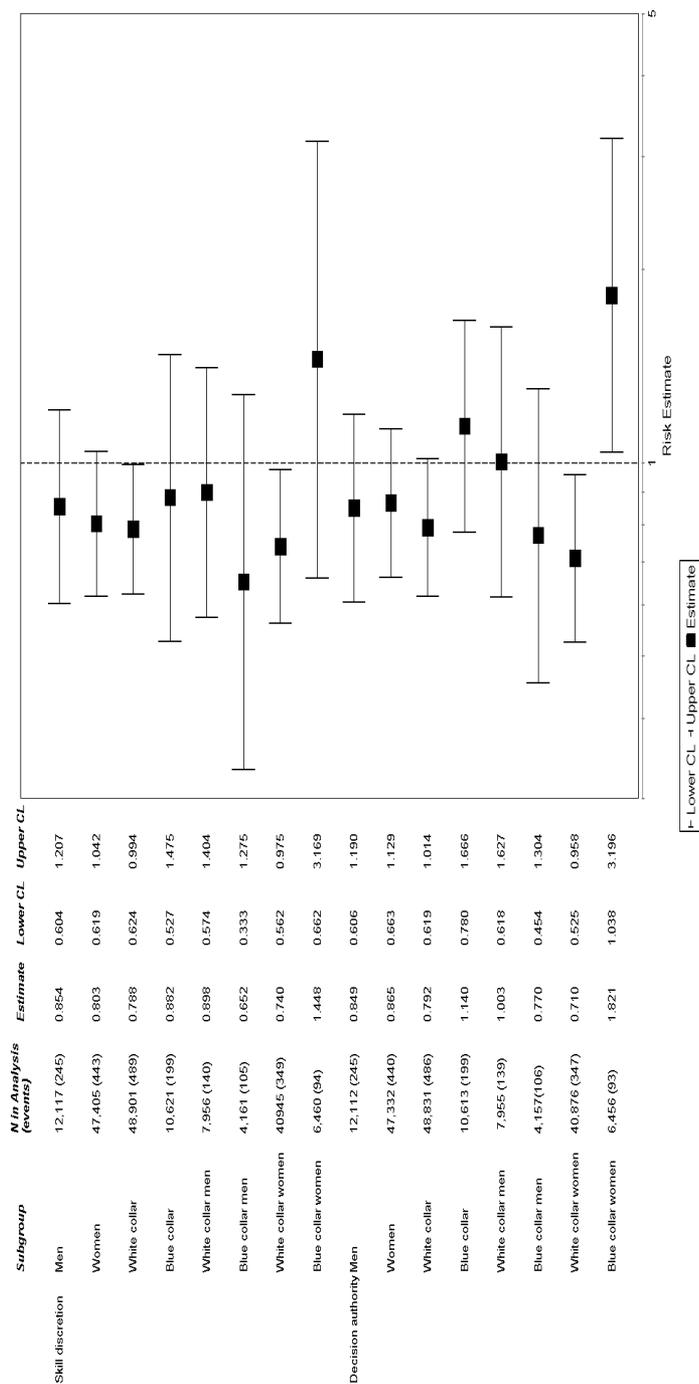


Figure 3. Subgroup analysis of all-cause mortality risk for skill discretion and decision authority. Job control variables were entered separately and adjusted for age, sex, socioeconomic status and physical health (hypertension, diabetes). HRs and 95% CIs for high vs low (reference) tertile groups.

The role of severe mental disorders as a pathway from psychosocial working environment to mortality was examined in the Still Working cohort. An adjustment of the final model between job control components and mortality for psychiatric hospital admissions both irrespective of cause and for specific disorder type only marginally attenuated the effect and the associations remained statistically significant: from HR 1.28 into 1.24 for high decision authority in all-cause and from HR 1.49 into 1.47 in cardiovascular mortality after adjusting for hospitalization for any mental disorder during the follow up (Table 3 in Study III, p. 614).

Sensitivity analyses were performed in a number of ways. Supervisor status was adjusted for in the Still Working cohort. In the FPSS cohort for information on supervisor status was available for approximately half of the sample, for which the analyses were repeated with all supervisors excluded. These results were in line with the overall analyses, though with wider confidence intervals. Possible selection biases related to job control components were also analyzed in the Still Working cohort by analyzing the effects of early retirement, previous lay-offs, and employee turnover (Study II p. 616). These analyses did not reveal any substantial effects of selection bias. Associations with all-cause mortality were also reported with each individual item of the job control scales used (Study II appendix, Study III p. 538). In the Still Working cohort analyses were also made separately in the 1986 cohort and the 1996 cohort, which were in the same direction as the overall analyses, but statistically significant only for high decision authority in the 1986 cohort (Study II appendix).

4.3 Job control and cardio-vascular mortality in a European large-scale individual meta-analysis

The association between job control as a unified construct and incident coronary heart disease was studied in the IPD cohort and described in Study IV. Descriptive statistics of the IPD cohort are presented in Table 2. In total 197 473 participants were included in the analysis. Mean age at study entry was 42.3 years (SD 9.8) and half of participants were women. During 1 488 728 person-years at risk (mean follow-up 7.5 years, SD 1.7), 2 358 incident coronary heart disease events were recorded. In the analysis of job

control (8 cohorts to which the authors had full access to the data) adjusted for age, sex high job control was associated with lower incident coronary heart disease (HR 0.80, 95% CI 0.67–0.97 for highest quartile vs. lowest quartile or HR 0.93, 95% CI 0.89–0.98 for standardized scores when treated as a continuous variable, Study IV appendix). However, when additionally adjusted for socioeconomic status, there was no association between job control and incident coronary heart disease (HR 0.95, 95% CI 0.75–1.19 for highest quartile vs. lowest quartile or HR 0.99, 95% CI 0.92–1.07 for standardized scores when treated as a continuous variable). This analysis adjusted for sex, age and socioeconomic status was not reported in Study IV.

4.4 Hospital ward overcrowding as an instrument between job demands, job control and mental health

The possibility of using instrumental variable regression as a novel method for examining the associations between psychosocial characteristics and health was studied in a subsample of female nurses in the FPSS cohort and is described in Study V. Descriptive statistics of the subsample of FPSS used are presented in Table 2. The mean age of the 2 784 female nurses was 42.2 years. Of the covariates used permanent employment contract and longer employment were associated with self-reported job demands but not with recorded ward overcrowding. Higher age was associated with greater self-reported job demands, but a lower extent of overcrowding. The association between job demands and alcohol intake was stronger than that between overcrowding and alcohol intake and only job demands were associated with body mass index. The extent of ward overcrowding provided a strong instrument for job demands ($F=67.15$), but not for job control ($F=2.57$). Similarly, Wald test of exogeneity was significant for job demands ($\chi^2(1)=9.84$, $p=0.0017$), but it was not possible to compute for job control, as the test assumptions were not met. Thus, further analyses are confined to job demands only.

During the 12-month follow-up, 102 individuals had at least one sickness absence with a diagnosis of mental disorder. Both a greater exposure to overcrowding and higher self-reported job demands were associated with increased risk of sickness absence due to a mental and behavioural

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disorder. The latter association was stronger, but less precisely estimated, in the instrumental variables analysis which took into account only the variation in self-reported job demands that was explained by overcrowding. Based on an age-adjusted instrumented model, the estimated probability of having a sickness absence with a diagnosis of mental or behavioural disorder was 0.6 (95% confidence intervals 0.4–0.9) percent for individuals in the bottom quartile for self-reported job demands and 26.1 (9.7–50.7) percent for those in the top quartile. The corresponding figures in standard non-instrumented analyses were 2.1 (1.4–3.2) and 5.0 (3.9–6.4) percent, respectively. Repeating the analyses with sickness absence due to depressive disorders as the outcome produced similar associations. The findings were little affected by additional adjustment for all baseline characteristics.

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5.1 Main findings

Skill discretion and decision authority, the main components of job control, showed different and, to some extent, opposite and subgroup-specific associations with mental and cardiovascular health. In general, high decision authority was associated with an increased risk of future mental or cardiovascular ill health. High skill discretion, on the other hand, showed no association with the health outcomes or was associated with a decreased risk of future mental or cardiovascular ill health. These findings were consistent in the Still Working cohort, but replicated only in a subgroup of blue collar women in relation to total mortality in the FPSS cohort. In contrast, both high skill discretion and high decision authority were associated with a reduced risk for all-cause mortality for white collar women in the FPSS cohort. Job control as a combined construct of skill discretion and decision authority did not show associations to incident cardiovascular disease in a large-scale meta-analysis of European prospective studies. Objective data (hospital ward overcrowding) on psychosocial work characteristics succeeded in an instrumental variable regression to confirm the association of subjectively evaluated job demands, but not job control, with future mental health disorders measured by sickness absences of over 10 days.

5.2 Comparison of the findings with previous studies

Although the distinction between the components of job control, skill discretion and decision authority, is clearly made in the formulation of

the concept (17), and it has been suggested that it may be important to analyze the components separately (28, 105), the majority of studies so far have used a combined measure (3, 4, 6). The findings from this study reiterate that job control is not an unequivocal concept which could be used as a single construct to predict health outcomes. Also, two recent studies have reported similar findings that contradict the notion that components of high job control are always beneficial for employee health. A study of older workers found that high influence at work (a measure close to decision authority) was associated with higher blood pressure (106) and another study found that for employees working longer hours (>40 h a week) higher work time control was associated with an increased risk of sleep disturbances (107). As can be seen from Table 1, only one prospective study (39) on mental health was found that reported the effects of decision authority and skill discretion separately, and there were no differences as neither showed significant effects. There is a possibility for a biased interpretation of the non-reporting of separate effects, as many studies might have tested the effects separately, but if they show similar results, they are combined in the reporting of the study.

5.3 Interpretation of the findings

It is important to consider the social structures and social contexts when trying to understand why high decision authority at work could be a risk of mortality or mental disorders (108). The influence of social context became evident after Study III as the results from the Still Working cohort were replicated only in a subsample in the FPSS cohort. Given that Study III found effects for women but not for men, it might be argued that there is a gender difference in the associations of job control components with mortality. However, as there was an increased risk of mortality in men and women with high decision authority in Study II in the Still Working cohort, it is more likely that the gender differences in Study III reflect something other than genuine gender differences. It is possible, for example, that the types of jobs or organization practices in which women work have a role. Gender may also mark differences in resources and management which may explain the observed gender differences. Indeed, there is a discrepancy between the subjectively

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reported and external assessments of working conditions between men and women; women in 'active' jobs with high perceived demands and control have more externally evaluated hindrances and less externally evaluated influence than men in active jobs (32). This could explain why an active job has been associated with cardiovascular disease outcomes (109, 10) and all-cause mortality (11) in women. Also, there is more variation between job control levels in women than in men between occupational classes, i.e. men with low levels of job control were closer to men with high levels than women with low levels of job control were to women with high levels (110).

The reasons for differences in the job control component-health associations between the cohorts and between the subgroups within cohorts are not known. One possibility is that co-existing organizational features, such as resources or management styles, make higher decision authority burdensome for some of the employees. For some groups, such as the white collar women in the FPSS cohort, individual decision authority may be more part of the overall management structure, whereas for other groups the high decision authority could relate to an 'unofficial' supervisor status with an expectation for the employees to carry extra responsibility. Higher job control in some circumstances could also be related to a role conflict or role ambiguity (111, 112), where the employee can make autonomous decisions but is faced with conflicting or implicit demands from different sources in the organization, and does not know what is expected of him.

The larger societal context could also play a role in the findings that go against the common theories of job control (108). The concept of job control was developed in the late 1970s during an era of growing industrialization. The job content in such settings often was to perform simple, repetitive tasks, with minimal breaks in a tight production rate. This type of situation has indeed been shown to increase physiological stress reaction in experimental settings (113). In this earlier context the challenges to better the working situation of employees were to enrich the job description and raise the status of the employees and promote their viewpoints. However, contemporary work life has changed quite a lot from previous decades and the pace of change is accelerating (114). Project work, fixed-term contracts, flexible working arrangements and outsourcing are trends in modern work life (115). Higher decision authority

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could actually be a marker of a job, where these trends have been felt and the change has brought with it, for example, excessive working hours (116) and role conflicts (112). The skill discretion challenges of today relate to keeping up with the changes and learning requirements of new jobs. The decision authority of today's working life could be described as "self-management" or "self-leadership" (117) where the employee has to figure out how to solve the often ambiguous and unpredictable challenges in his/her work.

A recent experimental study found that increasing autonomy over breaks in a word processing task elevated the physiological stress levels of female participants (68). The participants perceived to have more autonomy but also performed worse when given control over the breaks. The possibility to control when to have a break could actually increase the complexity of the task and increase cognitive load as it adds one more element, which should be taken into account when performing the task. A distinction should be made between the *sense* and the *means* of control an employee has. Job control is conceptualized as a characteristic of a particular job, where the employee has *means* of control, i.e. the power to choose tasks. However, a sense of control would be the feeling of an employee that the work is proceeding as it should. Therefore an increase in means does not necessarily bring about an increase in the sense of control. If the employee already has a high sense of control in his job, introducing more means of control might not be beneficial. High decision authority has been found to be associated with an elevated risk of hospitalization due to anxiety disorders in women (40). It may not only be a resource for the employee, but also a burden, and common method variance may bias associations in the short term, especially as decision authority may be viewed as desirable by the employees without realizing the long-term detrimental effects associated with cumulated stress. High skill discretion, on the other hand, might protect against apathy and boredom at work, which can influence the deterioration of mental health.

The findings of this study call into question the timeliness of existing theories of psychosocial work environment and health, most notably the Demand – Control model (17, 18). In Study IV there was no association between the combined job control construct and incident coronary heart disease adjusted for age, sex and socioeconomic status. The overall effect of the full Demand-Control model reported was that a high strain job

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was associated with a 1.17 fold increased risk. The age and sex adjusted population attributable risk of job strain was 3.4%. All these estimates are lower than what previous reviews have found (5, 6). The differential effects of the job control components and subgroup- and between sample differences could explain why the effects are so modest, but further research is needed to confirm this.

The Demand-Control model has been criticized, on the one hand, for its simplistic nature and, on the other hand, for its vague and imprecise formulations of its components and the analysis strategies suggested (83, 118). Nevertheless, it has been the dominant theory of associations between the psychosocial work context and employee health. Based on the finding of this study it cannot be concluded that higher job control would be a bad or a good thing for employee health as such. However, the problem with more complex models of work characteristics, such as the Vitamin model (22) or the job demands-resources model (21), is that the models become too complex to test in practice and to interpret. Also recommendations based on these models can be difficult to make as the precise level of a factor can be hard to pinpoint and, due to the vagueness in operationalizations, anything can be interpreted as a positive or a negative factor depending on the outcome. In his commentary, Rugulies (108) presents a hierarchical framework which takes the societal, organizational and personal context better into account, but also acknowledges that even this framework is both oversimplified and too complex at the same time. In order to build a robust study design with a large sample size and high response rates, simple concepts that are easy to measure and interpret are needed. However, this makes the depiction of the actual work context easily too simplified. Also the actual meanings and content of the job are not always easy to interpret as the same question or situation can mean different things to different people or in different occupations (83).

A novel approach to evaluate the psychosocial working conditions is instrumental variable regression (99). In Study V this method was adopted in order to gain a clearer, and a more valid picture of psychosocial factors as predictors of mental health. The external instrument used, hospital ward overcrowding, was successful in validating self-reported job demands, and these combined evaluations of ward overcrowding and self-reported demands showed an exceptional effect on sickness

absences due to psychiatric disorder. The probability of sickness absence in the following year was 26.1% for employees in the highest quartile of the instrumented variable and only 0.6% in the lowest quartile. This effect is exceptionally large compared to effects of job demands measured with self-reports only, which have yielded modest effects (2, 3, 4). Instrumental variable regression has been also used in a study in elderly care, where the influence of job demands and job strain could be corroborated by using staffing level as an external instrument (119). However, ward overcrowding was not a suitable instrument for job control. In the future, new external indicators of decision authority and skill discretion are needed to validate the concepts and to facilitate the interpretations. These indicators could involve, for example, structures like flat organizations with low levels of hierarchy.

5.4 Strengths and limitations

Several strengths and limitations of this study involve study design and assessment of job control and its components as well as the health outcomes.

5.4.1 Study designs

All the cohort studies included in this thesis were prospective and had information about baseline health status which was controlled for in the analysis (either by adjustment or exclusion of baseline cases) strengthening inferences about temporal associations. A possible limitation is overcontrol as the exclusion criteria could be too strict if the baseline health condition actually reflected the effects of job control and its components. On the other hand, as the health status was based on medical records, there could also be a certain degree of undercontrol as preclinical health and undiagnosed diseases would not have been taken into account. However, it seems unlikely that an existing unmeasured health condition would have “caused” higher decision authority meaning as the results would be attributable to reversed causation bias. Another strength is the use of different sources of information to assess the predictors and the outcomes providing protection against common method bias (79).

The follow-up periods in the present analyses varied between 1 and 20 years and were much longer than in previous studies (see Table 1), which observed different effects than in this study. It is possible that long follow-ups contribute to effect dilution and thus underestimation of the associations as the working conditions may have changed since the measurement, a source of exposure misclassification. However, the association of high decision authority with health outcomes was consistent over time and can be seen in the difference between levels of decision authority and mortality during the 20 years of follow-up in Study II.

Another strength was the large samples sizes, reasonable high response rates (62–78%) and coverage of different areas of work, such as industrial vs. public service, private vs. public, male vs. female dominated occupations. The IPD work consortium included a large number of major high quality cohort studies in Europe in the meta-analysis.

5.4.2 Assessment of exposures

A feature which could be considered either a strength or a limitation was that two different versions of scales were used to measure job control components. Both versions have shown good psychometric properties, but some of the differences between studies II and III could be due to the differences in the scales. The job control components were measured only at a single time point. It is uncertain whether such measurement provides an accurate estimate of the long-term effect although employees in both the forest industry and the public sector appear to have rather long and stable careers with regard to psychosocial characteristics. Any such inaccuracy in measurement should, in theory, attenuate rather than exacerbate the effects.

Because major drawbacks in working conditions in developed countries are relatively rare due to highly developed occupational legislation and policies, variation in psychosocial work-related factors is constricted, reducing opportunities to observe strong associations (118). This may also apply to the organizations participating in the Still Working cohort and the FPSS cohort as they represent very responsible employers.

In Study V, ward overcrowding was informative in relation to job demands, but not job control, which was not associated with the instrument. This result is plausible since overcrowding is conceptually closer

to job demands than job control is. Also, there are three important assumptions behind the instrumental variables analysis: First, the variable should influence the outcome only via its association with the exposure variable of interest, i.e., perceived job demands. There should not be a direct path from the instrument to the outcome variable. Second, there should not be a shared common prior cause of the instrument and the outcome variable. Third, there should not be a path between the instrument and the set of unobserved confounding variables. It is unclear whether the third assumption can be met in occupational settings, such as the one in this study.

5.4.3 Ascertainment of disease endpoints

The outcomes used in the study, hospital admissions for mental disorder diagnosis, mortality records and long-term (≥ 10 days) sickness absences, are objective, distinct endpoints which facilitate the interpretation of the findings. However, hospital admissions and sickness absences can be confounded by factors affecting the likelihood whether or not the individual seeks treatment for his/her condition (120, 121). Sickness absence and hospitalization from psychiatric diagnosis can also be subject to misclassification when used as outcomes for disease, because, for example, only a small proportion of those depressed will be admitted to a hospital (122). Also, despite the large sample sizes, the number of outcome events in some of the subgroups was fairly small, increasing the possibility of chance findings. The outcomes used represent the extreme endpoints of ill health. Therefore they may show different associations than symptom based self-reports.

The specificity of the findings strengthens the evidence. Because decision authority was associated with specific stress-related causes of mortality, i.e. cardiovascular and alcohol-related deaths, but not with mortality from cancer or external causes, it is plausible that the effects are mediated by the stress response. The associations were not attributable to the onset of serious mental disorders requiring hospital treatment, as the adjustment for hospitalizations had little effect on the results. This implies that the associations between components of job control and cardiovascular diseases are not driven by the effect of severe mental disorders only, but that high decision authority may be linked to cardiovascular

deaths through other potential mediating factors, including mild and moderate mental disorders, lifestyle factors, and social circumstances.

5.4.4 Control for confounders

Confounding due to socioeconomic status is a major source of bias in studies on job control and health (83). To reduce this bias, samples of defined employment sectors were chosen and analyses were stratified by occupational status within the cohort. This strategy controls for the confounding effect more completely than a simple adjustment for socioeconomic status in population samples. However, the fact that men and women were not evenly divided between different tasks and jobs with women being overrepresented in white collar occupations may have affected the results. For example, in the Still Working cohort, men had a higher, though not statistically significant, risk of depressive disorders than women, which is generally not found. This implies that controlling for occupational class only as blue/white collar might not control for all differences between socioeconomic factors between genders.

To reduce bias, analyses were adjusted for age, sex and a number of other sources of confounding, such as health behaviours (smoking, obesity, sedentary life style and alcohol use), health status, other work-related factors (e.g. time pressure, supervisor status, supervisor support, co-worker support and physical work environment) and career factors such as preceding lay-offs, early retirement and turnover. However, residual confounding of unmeasured risk factors remains a potential explanation for results in observational studies. For example, socioeconomic circumstances before the study entry and their changes during the follow-up could have affected the observed associations. Data were missing for important cardiovascular risk factors, such as blood pressure, cholesterol and glucose levels and therefore these could not be adjusted for.

A limitation is that as the analyses were based on existing cohorts, individual characteristics that were not included in the original surveys could not be adjusted for and their possible moderating effects studied. For example, locus of control is a personality trait where a person has a tendency to think either that outcomes are under his/her personal control (internal locus) or that they are determined by external forces beyond their control (external locus) (123). High job control has been found to

increase the effects of stressors on well-being for employees with external locus of control (124). Also, high commitment to work has been shown to moderate the association between job control and somatic symptoms among persons in a leadership position (125). Other individual characteristics that could be included as moderators of the job control-health association are, for example, sense of coherence and self-efficacy. High sense of coherence describes individuals who could maintain a sense of control and hope in devastating circumstances (126). Self-efficacy, on the other hand, refers to the individual's belief that he can succeed in the task at hand, i.e. the task is within the scope of his abilities (127). Both of these constructs come closer to the sense of control the employee may feel as opposed to the means of control the employee may have, which is captured by the definition of job control as a job characteristic.

5.5 Implications and directions for future research

In efforts to improve to the psychosocial work environment, a general notion has been that the more job control an individual employee has, the better (1). However, the findings of this study imply that job control as such might not be an unequivocal concept and that high levels of job control as defined in the basic theories of work stress might not be possible to straightforwardly attribute as a risk or protective factors in terms of health. In efforts to improve the working conditions and employee health, a more differentiated and holistic approach could be adopted. Although some single factors, such as bullying (128), can be interpreted as totally negative, the majority of other psychosocial concepts might work in many directions and cannot be easily separated from each other. For example, organizational structures that, on the one hand, limit individual decision authority may, on the other hand, have benefits for the overall functioning of the work unit, by providing continuity and support for the employee, and allowing the employee to focus on his/her basic task, which may reduce the overall psychological workload.

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Future studies could examine what the key concepts in current working life in developed countries are, and how the concepts such as job control and decision authority manifest in different work situations. Insights into the influence of different social contexts could be gained through, for example, meta-regression which allows for the quantification of the different moderating effects of social circumstances (129). Also, further efforts to identify external indicators to corroborate self-reported data, such as the instrumental variable regression used in this study, should be encouraged. Concrete organizational changes, such as work and team restructuring, outsourcing of work and the formulation of work into projects could be depicted in detail and their health effects analyzed as quasi-experiments (130). Analysis of the relations that these changes have on the components of job control and employee health is likely to increase insight into the effects of psychosocial work environment on employee health.

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Job control has been a key concept in research on the psychosocial work environment and employee health for decades. A general hypothesis is that the more job control employees have, the lower their risk of stress-related diseases. However, the evidence to date has been inconclusive. The two components of job control, skill discretion and decision authority, may be differentially associated with health, which is a possible explanation for previous mixed findings. Therefore, this study examined the longitudinal associations of job control and its components separately, along with mental health and incident cardiovascular disease in large prospective cohorts with up to 20 years of follow-up. The analyses showed that skill discretion and decision authority had different, to some extent opposite and subgroup specific associations with mental and cardiovascular health. Furthermore, contrary to previous understanding, high decision authority was found in some circumstances to associate with an increased risk of mental disorders and cardiovascular mortality. Job control appears to be an equivocal concept in terms of health risk.

Orders:

Finnish Institute of Occupational Health
Arinatie 3
FI-00370 Helsinki
Finland

E-mail kirjakauppa@ttl.fi

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