*This is a pre-copyedited, author-produced version of an article accepted for publication in American Journal of Epidemiology following peer review. The version of record American Journal of Epidemiology, **7**(175), p. 609-619 is available online at:[*https://doi.org/10.1093/aje/kws028.

Differential Associations of Job Control Components with Mortality: a Cohort Study, 1986-2006

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Abstract: 199 words

Text: 3488 words

3 tables

3 figures

Appendix: 4 tables

Key Words: Industry; Psychosocial Factors; Professional Autonomy; Risk Factors.

Running head: Job control and mortality

Abbreviations: HR, hazard ratio; CI, confidence interval; ICD, international classification of diseases; SD, standard deviation.

Abstract

Inconsistent evidence of the hypothesized favourable effects of high job control on health may have resulted from a failure to treat job control as a multifactor concept. The authors studied whether the 2 components of job control, decision authority and skill discretion, were differentially associated with cause-specific mortality in 13,510 Finnish forest company employees with no history of severe illness. Surveys on work characteristics were carried out in 1986 and 1996 and the respondents were followed-up until 2006 using the national death registry. During a mean follow-up of 15.5 years, 981 participants died. In the analyses adjusted for confounders, employees with high and intermediate levels of skill discretion had a lower overall mortality risk than those with low skill discretion, hazard ratios 0.85 (95% confidence interval (CI): 0.70, 1.04) and 0.81 (95% CI: 0.69, 0.96), respectively. In contrast, high decision authority was associated with an elevated risk of all-cause (1.28, 95% CI: 1.06, 1.54) and cardiovascular mortality (1.49, 95% CI: 1.11, 2.02), and alcohol related deaths (2.03, 95% CI 1.03, 4.00). The results suggest that job control is not an unequivocal concept in relation to mortality; decision authority and skill discretion show different and to some extent opposite associations.

[199 words]

The concept of job control (or decision latitude) is considered to be a key element in psychosocial stress at work (1). It is a multifactor concept (1, p. 58), with its 2 most prominent components being decision authority and skill discretion. Decision authority refers to the degree to which an employee can decide on the amount, tempo and method of his/her work. Skill discretion refers to opportunities for variable work in which the employee can use his/her competencies and learn new things. Higher job control has been associated with better organizational performance (2) and with better employee health, the associations being stronger with self-reported than with objective measures of health and well-being (3). Self-reported outcomes are, however, open to reporting and common source biases (4, 5).

To date, there are several studies of the effects of job control on cardiovascular morbidity, measured with medical records, with many of these studies reporting only a modest (6) or no association (7 - 9). Furthermore, in one study the level of job control was, unexpectedly, slightly lower among persons with normal arteries (10) as compared with patients with prevalent coronary disease; and in another study, low job control was not an important prognostic factor in patients with acute myocardial infarction (11). The relatively few prospective studies on job control and mortality have often used a composite job control measure (12), a measure of job control based on job title (13-16), or exclusively focused on job strain which is the combination of high job demands and low job control (17). Therefore it remains unclear whether the 2 components of job control might have different associations with health outcomes when analyzed independently, a potential explanation for mixed evidence of job control as a one-dimensional concept.

In the present study of industrial employees, we examined the associations of the 2 components of job control, decision authority and skill discretion, with all-cause and cause-specific mortality. Given the previous findings from this cohort suggesting that high decision authority may be a risk factor, rather than a protective factor, for hospitalization due to mental disorders (18), we

hypothesized a link between higher decision authority and increased mortality risk. This link could be in part explained by a greater incidence of severe mental disorders among employees with high decision authority. In contrast, high skill discretion was hypothesized to protect against mortality, in keeping with the original job demands-job control model (1).

MATERIALS AND METHODS

Study Population

The data were from the *Still Working Study*, a prospective cohort study of private sector industrial employees in a Finnish multinational forest industry corporation (19, 20). The enterprise has a long tradition in human resource development including the long-term research & development cooperation with the government funded research institute (the Finnish Institute of Occupational Health) which also coordinated the present study. An action program that led to the data collection was started in 1984 as a joint initiative of management, staff and trade unions (19). The Ethics Committee of the Finnish Institute of Occupational Health approved the study.

The description of the cohort is provided in Figure 1. A questionnaire on behavioral 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 9282 employees (response rate 76%) responded to the questionnaire in 1986 and 8371 (response rate 62%) in 1996. Those who had already responded in 1986 were excluded from the 1996 cohort. In addition, we excluded employees who had been admitted to hospital for cardiovascular, cancer, alcohol related or mental health reasons according to the Finnish Hospital Discharge Register (21) from 1969 until the time of the survey (n=945). Thus the final analytic cohort included 13 510 employees (3156 women and 10, 354 men, mean age 40.6 years, range 16-65 years). Using unique national

identification numbers the employees were linked to the Statistics Finland National Death Registry (22) which provided comprehensive data on dates and causes of mortality.

Dimensions of Job Control

The measure of job control consisted of 2 dimensions (20, 23). Skill discretion (Cronbach's alpha 0.82) was measured by 5 items (e.g. "Is your work monotonous or variable). Decision authority (alpha 0.79) was measured by 5 items (e.g. "Can you dictate your own work pace"). All items had a 5-point response scale. The items of all psychosocial scales used are presented in the supplementary online material. Associations of skill discretion and decision authority to the covariates are presented in Table 1. The factor structure of the dimensions has been previously confirmed (20). Correlations between the 2 time points (skill discretion r = 0.67, decision authority r = 0.59) show that the job control dimensions were relatively stable over time. We divided both summary scales into tertiles for the analyses.

Ascertainment of All-Cause and Cause-Specific Mortality

Mortality data from 1 March 1986 to 31 December 2005 were obtained from the National Death Registry maintained by Statistics Finland. The database provides virtually complete population mortality data (22). We obtained the dates and causes of death (from death certificates) of all the participants. Diagnoses were according to the International Classification of Diseases (ICD) versions 8, 9, or 10. For uniformity, the diagnoses 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).

Covariates

We measured age, sex, occupational status (blue-collar /white-collar), and supervisor status (yes/no) by questionnaire. Blue-collar employees were mainly employed as factory workers (e.g., monitors, forklift drivers) or maintenance staff (e.g., cleaners, repairmen). White-collar employees were office workers, such as secretaries, as well as those in expert and managerial positions (e.g., technical designers, laboratory technicians). Both blue-collar and white-collar supervisors worked as unit foremen. Co-worker support was measured with 4 items (alpha 0.72) and supervisor support was measured with 3 items (alpha 0.73).

Baseline data for entitlement to drug imbursement due to chronic diabetes or hypertension from 1962 until the survey was retrieved from the Drug Imbursement Register maintained by the Social Insurance Institution (24). Diabetes and hypertension were selected out of all possible illnesses covered in the register due to their large role in public health.

Additional covariates for cohort-specific analyses were smoking status (current smoker vs. non-smoker), alcohol use defined by how often the respondent felt him/herself heavily intoxicated (twice or more per month vs. less than twice per month), engagement in leisure physical activity (once a week or more vs. less), which all were measured by questionnaire in the 1986 cohort. Time pressure at work was measured with 3 items (alpha 0.70) in the 1996 cohort

We used data on hospital admissions collected from the Finnish Hospital Discharge Register (21) for testing the mediating effect of severe mental disorders during the follow-up. We did not differentiate whether the diagnosis was a main or a subsidiary diagnosis. For disorder-specific analyses we classified the diagnoses into 3 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 (18).

Statistical Analysis

The associations between the dimensions of job control and mortality were assessed using Cox proportional-hazards models. For each participant, person-days of the follow-up were calculated from the first baseline measurement on either March 1, 1986 or 1996 to the end of the follow-up period (31 December, 2005) or death, whichever came first. The time-dependent interaction terms between each predictor and logarithm of the follow-up period were non-significant, confirming that the proportional hazards assumption was justified (all p values >0.70). The hazard ratios (HRs) and their 95% confidence intervals (95% CIs) for categorical independent variables provided risk estimates. We conducted the analysis in 4 stages. First we separately examined the crude effect of skill discretion and decision authority on mortality. Next, in Model 1 job control variables were entered separately and adjusted for age, sex, occupational status, and physical health (hypertension, diabetes). In Model 2, skill discretion and decision authority were entered together adjusting for age, sex, occupational status, physical health (hypertension, diabetes), supervisor position, supervisor support and co-worker support. Finally, we examined the mediating effect of the new-onset mental disorders in Model 3, where hospitalization for mental disorders was additionally adjusted for as a time dependent variable, in which the first hospitalization of each individual was included.

All the analyses were performed with maximum data, which resulted in some variation in the number of participants between comparisons. The only exception was the multivariate models, which involved only the participants with no data missing for any of the predictors. The analyses were conducted using the PHREG procedure in the SAS 9.2 statistical software package.

RESULTS

Descriptive statistics of the cohort and the psychosocial variables are presented in table 1. Of them, 2/3 were blue-collar employees and 1/3 white-collars. 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) died. The average time from the survey to death was 11 years and 10 months, S.D. 5 years 5 months.

Table 2 presents the number of cases for all-cause and cause-specific mortality, hazard ratios for baseline covariates and their associations with skill discretion and decision authority. In the models adjusted for socio-demographic factors, older age, male sex, blue collar occupation, prevalent diabetes, prevalent hypertension, high co-worker support, smoking, high alcohol consumption and low physical activity were associated with all-cause mortality.

Associations with All-cause and Cause-specific Mortality

Table 3 shows the associations of skill discretion and decision authority with all-cause and cause-specific mortality. Skill discretion was not associated with all-cause mortality in the unadjusted model or when adjusted for demographics and physical health (model 1). The survival plot for levels of skill discretion is presented in Figure 2 After adjustment for other psychosocial characteristics at the workplace, an intermediate level of skill discretion had a protective effect (model 2), which remained after further adjustment for psychiatric hospital admissions due to mental disorders (model 3).

High decision authority was associated with increased all-cause mortality in the unadjusted model. The survival plot for levels of decision authority is presented in Figure 3. The association remained significant when adjusted for demographics and physical health (model 1) and additionally for other psychosocial characteristics at the workplace (model 2). An adjustment for psychiatric hospital

admissions both irrespective of cause and for specific disorder type (model 3) only marginally attenuated the effect and the association remained statistically significant.

In the unadjusted models, high decision authority but not skill discretion was associated with increased cardiovascular mortality (Table 3). The association between high decision authority and cardiovascular mortality was robust to adjustment for demographics and physical health (model 1) and for other psychosocial characteristics at the workplace (model 2). An adjustment for new-onset psychiatric hospital admissions, both irrespective of cause and for specific disorder type (model 3), attenuated the effect marginally, although a significant association remained.

Compared to low decision authority, both intermediate and high decision authority were associated with alcohol-related mortality in the unadjusted model and after adjustment for demographic and psychosocial factors (models 1, 2). When additionally adjusted for new-onset psychiatric hospitalizations (irrespective of cause and specific disorder type), the association between intermediate decision authority remained statistically significant whereas the association with high decision authority and alcohol-related mortality did not.

Skill discretion was not associated with alcohol-related mortality and neither skill discretion nor decision authority was associated with cancer deaths or mortality due to external causes. We additionally analyzed the association with suicide only (52 cases) and the other external causes of deaths, but found no significant associations.

Subsidiary Analyses

Results on subsidiary analyses separately for the 2 cohorts, men and women, blue/white collar employees and the individual job control items can be found in supplementary online material (appendix). The results were in line with the overall analyses. As a post hoc analysis, we also

assessed possible selection biases related to job control components. First, we re-ran the models after excluding those employees who had been laid-off in the year preceding the survey (n=869). The effects remained essentially the same, though with slightly wider confidence intervals, probably due to reduced statistical power (data not shown). Next, we analysed the association between job control components and early retirement by linking the participants to the retirement register of the Finnish Centre for Pensions (25). High skill discretion was associated with a lower likelihood of early retirement (high skill discretion, model 2 adjustments, HR 0.43, 95 % CI 0.31, 0.59), whereas there was no association between decision authority and early retirement (high decision authority, model 2 adjustments, HR 0.97, 95 % CI 0.73, 1.27). Finally, we compared the levels of skill discretion and decision authority between participants who remained employed in the target company during the follow-up (n=8049) and those who did not (n=4943) as indicated by the company's employment records from the years 1996 and 2000 (i.e. for the 1986 cohort we used the year 1996 employment records; and for the 1996 cohort the 2000 employment records). We excluded employees (n=518) who reached the old-age pension age (65 years) and those 297 who died. Employees who left the organization had a slightly higher level of decision authority (age, sex and occupational status adjusted means 3.66 vs. 3.46, *P* for difference <0.001, F- test, 2 sided) and a slightly lower skill discretion (age, sex and occupational status adjusted means 3.32 vs. 3.35, *P* for difference 0.038, F- test, 2 sided) compared to those who stayed with the company.

DISCUSSION

We examined the effect of components of job control, that is, decision authority and skill discretion, on mortality and found high decision authority at work to be associated with increased risk for all-cause, cardiovascular and alcohol-related mortality, a finding opposite to the effects proposed by the theory of Karasek & Theorell (1). In contrast, high skill discretion was associated with reduced all-cause and cause-specific mortality, although these associations were less consistent

and generally not robust to adjustments for baseline covariates. These associations were not attributable to the onset of serious mental disorders requiring hospital treatment, as the adjustment for hospitalisations had little effect on the results.

Although the demand -control/job strain model has been influential in modern occupational epidemiology, it has also been a target of criticism (26) and inconsistent findings have been documented (3). One example of negative findings is provided by the Framingham Offspring study which found no association between job control and total mortality in a 10-year follow-up, whereas high decision authority and high skill discretion were associated with an increased risk of coronary heart disease in women, although not in men (9). A Danish study similarly emphasized the importance of differentiating between the 2 components, as skill discretion, unlike decision authority, mediated the effect of social position to myocardial infarction (27). In a similar way, our results also suggest that in relation to health, job control is not an unequivocal concept. Higher personal decision authority may in contemporary work life, instead of reducing stress, actually mark increased stress due to e.g. excessive work hours (28) and role conflicts (29). In addition, stress effects may also rise from a situation in which the employee has organizational responsibilities without the means, resources and the protection of a formal status.

We have previously reported evidence suggesting that high decision authority may be a risk factor, rather than protective factor, for future mental disorders requiring hospital treatment (18), which represent the most severe mental health problems. In the present study, we investigated whether the association between decision authority and mortality was explained by the onset of severe mental disorders, and found no support for this hypothesis. With the exception of alcohol-related mortality which substantially attenuated after adjustment, an adjustment for hospitalization for mental disorders during the follow-up period only marginally explained the association between decision authority and mortality. The fact that decision authority was a risk for specific stress-related causes

of mortality i.e. cardiovascular and alcohol related deaths, but not for mortality from cancer or external causes, increases the plausibility of the suggested link between high (rather than low) decision authority and higher levels of stress.

In some previous studies, increased alcohol intake has been observed among women reporting high job control; however, it was measured as a composite index (30, 31). In addition, a higher degree of 'say in one's work' has been associated with an increased likelihood of heavy drinking among female employees (32). If high decision authority marks extensive responsibility and thus a stressful job, then high alcohol consumption could be one of the mechanisms linking high decision authority, pathological processes (33, 34), behavioral risk factors (35 - 37), and mortality. In future studies, a more differentiated picture of psychosocial factors at work and their interplay should be examined (38).

Our analyses do not support selection bias as an explanation for our findings, because we found neither an association of job control components with preceding lay-off nor an effect of decision authority on early retirement. Moreover, those employees who had left the company during the follow-up had only slightly higher levels of decision authority and lower skill discretion. However, the career paths of employees, who had left the company, either voluntarily or through downsizing, could influence the observed associations if, for example, employees with higher decision authority were more likely to experience downturn social mobility after leaving the company.

In efforts to improve psychosocial work environment, a general notion has been that the more job control an individual employee has, the better. If our findings are generalizable to other working populations, this rationale needs to be re-examined. Even though the benefits of increased decision authority, in terms of e.g. increased productivity and job satisfaction have been demonstrated (2), also the possible downside of high decision authority similarly needs to be evaluated. For example,

organisational 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. Our findings suggest that the health risk associated with non-optimal job control might not be limited to the socially disadvantaged groups but may similarly concern those in higher socioeconomic positions; possibly in the form of burden arising from too high responsibility and freedom of choice associated with high decision authority.

There are several limitations to our study. As the measurement of job control components was not based on the standard survey instrument (39), it is important to replicate our analyses in an independent dataset. Our study was based on a population of a single industrial company and cannot therefore be generalized to other populations. Only a limited range of baseline risk factors was available precluding any inferences regarding whether the observed associations were causal and independent of conventional risk factors (5). There is some evidence that the association between job control and cardiovascular disease may be explained by early life factors (16). Unmeasured confounders in terms of socioeconomic circumstances before the study entry and their changes during the follow-up could therefore bias the observed associations. Furthermore, residual confounding by ill health and the effect of unmeasured risk factors cannot be excluded.

Moreover, the mediation analysis presented in this study should be interpreted as preliminary because it is based on assumptions that are not directly tested (40). The causal chain of working conditions- mental ill health - mortality seems plausible, but there might be also reciprocal directions in the causal order between working conditions and mental ill health (41). In addition, imperfect measurement of the variables in the mediation model can bias the observed associations. Our findings of the mediation analysis suggest that there are indeed other intervening variables than those assessed in our study (i.e., severe mental disorders). Future studies should examine a wider

range of potential mediating factors, including mild and moderate mental disorders, lifestyle factors, and social circumstances.

Conclusions

Our findings from a prospective industrial cohort with the mean follow-up of 15-years, suggest different associations of decision authority and skill discretion with mortality, particularly from cardiovascular and alcohol-related causes. There is a need for further research to better understand the effects of psychosocial working conditions on employee health in the contemporary work context. Furthermore, if our findings are replicated in other working populations, there may also be a need to re-evaluate the current developmental recommendations for workplaces regarding certain aspects of psychosocial work environment. This should also include a careful analysis of the pros and cons of issues of decision authority, organizational responsibilities and related means and resources.

[3488 words]

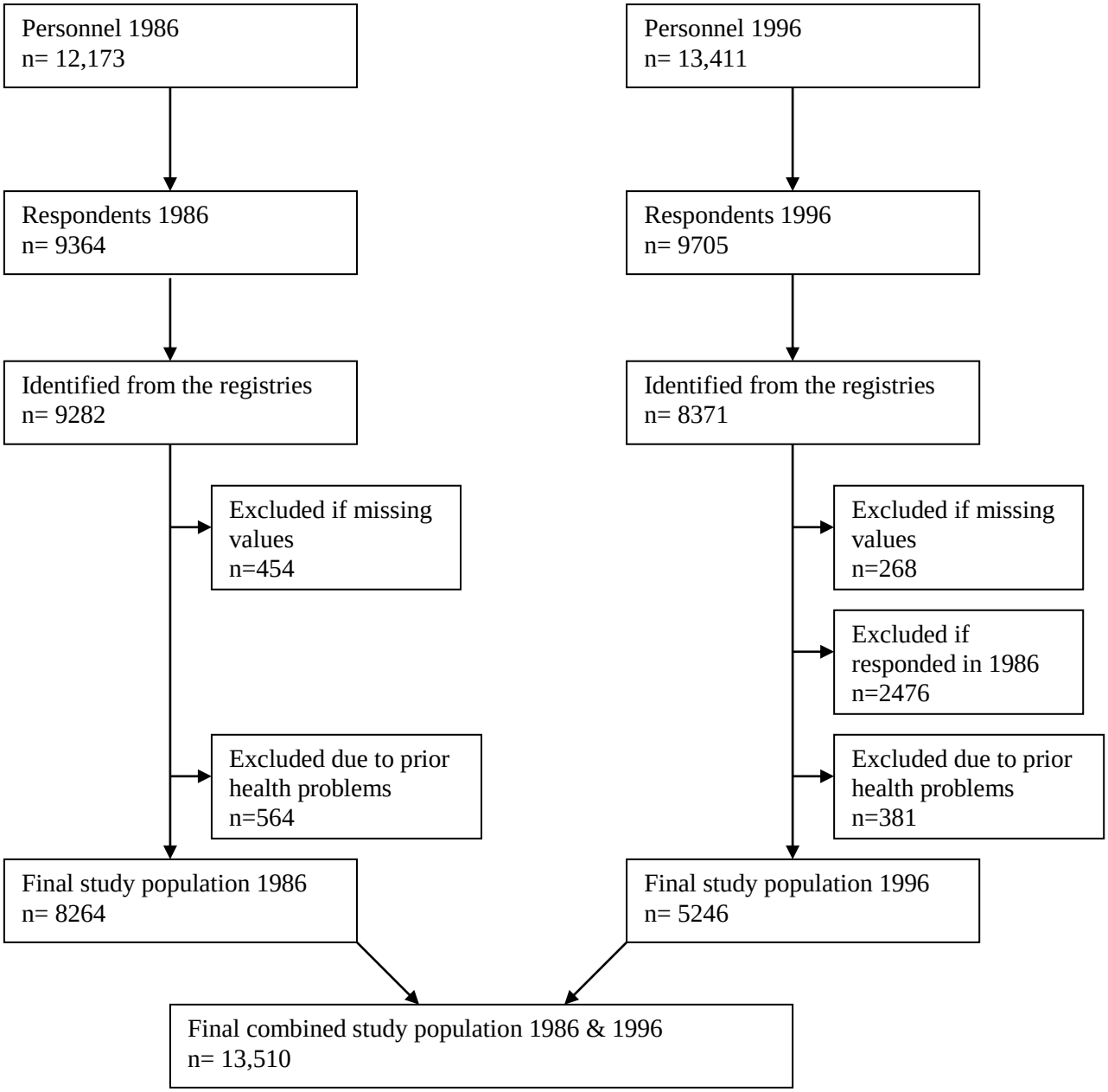

Personnel 1986
n= 12,173
Respondents 1986
n= 9364
Identified from the registries
n= 9282
Excluded if missing values
n=454
Excluded due to prior health problems
n=564
Final study population 1986
n= 8264
Personnel 1996
n= 13,411
Respondents 1996
n= 9705
Identified from the registries
n= 8371
Excluded if missing values
n=268
Excluded if responded in 1986
n=2476
Excluded due to prior health problems
n=381
Final study population 1996
n= 5246
Final combined study population 1986 & 1996
n= 13,510

Table 1. Baseline Characteristics of a Forest Industry Cohort, Finland, 1986 & 1996.

	n	%	Mean (95% CI) of Skill Discretion	*P*-value	Mean (95% CI) of Decision Authority	*P*-value
Age at baseline *(years)*				<0.001		0.167
≤ 35	4207	31	3.38 (3.36-3.40)		3.52 (3.50-3.54)	
36-50	7163	53	3.39 (3.35-3.42)		3.55 (3.51-3.58)	
≥ 51	2140	16	3.29 (3.27-3.32)		3.51 (3.48-3.53)	
Sex						<0.001
Women	3156	23	3.03 (3.01-3.06)	<0.001	3.37 (3.34-3.40)	
Men	10,354	77	3.45 (3.44-3.46)		3.57 (3.55-3.58)	
Occupational status				<0.001		<0.001
White-collar	4489	33	3.81 (3.79-3.84)		3.91 (3.89-3.93)	
Blue-collar	9021	67	3.13 (3.11-3.14)		3.32 (3.31-3.34)	
Supervisor position				<0.001		<0.001
No	11,045	82	3.20 (3.18-3.21)		3.39 (3.38-3.41)	
Yes	2465	18	4.07 (4.04-4.09)		4.08 (4.05-4.11)	
Diabetes				0.374		0.110
No	13,417	99	3.36 (3.34-3.37)		3.52 (3.50-3.53)	
Yes	93	1	3.43 (3.27-3.59)		3.66 (3.49-3.83)	
Hypertension				0.653		0.448
No	12,925	94	3.36 (3.34-3.37)		3.52 (3.50-3.53)	
Yes	585	4	3.37 (3.30-3.44)		3.55 (3.48-3.61)	
Smoking[a]				<0.001		0.007
No	5473	67	3.35 (3.33-3.37)		3.60 (3.58-3.63)	
Yes	2720	33	3.28 (3.24-3.31)		3.55 (3.52-3.58)	
Alcohol use where the respondent felt him/herself heavily intoxicated [c]				0.518		0.246
Less than twice / month	7122	87	3.33 (3.31-3.35)		3.59 (3.57-3.61)	
Twice or more / month	1044	13	3.31 (3.26-3.36)		3.56 (3.51-3.61)	
Leisure physical activity[c]				<0.001		0.242
less than once a week	2919	36	3.28 (3.25-3.31)		3.57 (3.54-3.60)	
once a week or more	5203	64	3.35 (3.33-3.37)		3.60 (3.57-3.61)	
	Mean	SD	Correlation	*P*-value	Correlation	*P*-value
Skill Discretion	3.36	0.81	N/A			
Decision authority	3.52	0.84	0.544	<0.001	N/A	
Supervisor Support	3.40	0.75	0.327	<0.001	0.354	<0.001
Co-worker Support	3.82	0.65	0.188	<0.001	0.191	<0.001
Time pressure[b]	2.78	0.75	0.109	<0.001	-0.063	<0.001

Abbreviations: SD, Standard Deviation.; 2 sided *P*- values according to F-test for means, t-test for correlations. [a]Assessed only in the 1986 cohort. [b]Assessed only in the 1996 cohort.

Table 2. All-cause and cause-specific mortality and hazard ratios for the covariates in the Forest Industry Cohort, Finland, 1986 & 1996 - 2005[a]

	All-cause		Cardiovascular		Cancer		Alcohol related		External causes	
	n=981		n=375		n=286		n=85		n=154	
	Hazard ratio	(95% CI)	Hazard ratio	(95% CI)	Hazard ratio	(95% CI)	Hazard ratio	(95% CI)	Hazard ratio	(95% CI)
Age at baseline *(years)*										
≤ 35	1		1		1		1		1	
36-50	3.19	2.58, 3.93	5.80	3.77, 8.95	5.29	3.24, 8.63	2.20	1.26, 3.85	1.28	0.88, 1.86
≥ 51	8.02	6.45, 9.97	17.05	10.99, 26.46	14.59	8.87, 24.02	1.66	0.78, 3.52	1.68	1.05, 2.70
Sex										
Women	1		1		1		1		1	
Men	2.52	2.07, 3.06	4.00	2.74, 5.84	1.77	1.29, 2.43	2.15	1.14, 4.07	2.67	1.56, 4.56
Occupational status										
White-collar	1		1		1		1		1	
Blue-collar	1.37	1.19, 1.57	1.65	1.30, 2.09	1.06	0.83, 1.35	0.97	0.61, 1.53	1.81	1.22, 2.70
Supervisor position										
No	1		1		1		1		1	
Yes	1.23	0.96, 1.56	1.47	0.96, 2.04	1.34	0.90, 2.08	1.59	0.72, 3.57	1.41	0.69, 2.86
Diabetes										
No	1		1		1		-		1	
Yes	3.21	2.15, 4.78	5.71	3.49, 9.33	0.80	0.20, 3.24			0.99	0.14, 7.07
Hypertension										
No	1		1		1		1		1	
Yes	1.55	1.25, 1.93	2.21	1.64, 2.99	1.33	0.88, 2.01	0.49	0.12, 2.01	0.97	0.45, 2.09
Supervisor Support										
Low	1		1		1		1		1	

Intermediate	1.04	0.89, 1.21	1.05	0.82, 1.35	1.16	0.87, 1.54	1.24	0.75, 2.05	0.86	0.58, 1.25
High	1.12	0.96, 1.31	1.14	0.89, 1.47	1.17	0.87, 1.56	1.00	0.58, 1.73	0.96	0.66, 1.42
Co-worker Support										
Low	1		1		1		1		1	
Intermediate	1.04	0.88, 1.22	0.98	0.75, 1.28	0.89	0.66, 1.21	1.36	0.80, 2.31	1.10	0.73, 1.64
High	1.28	1.09, 1.49	1.33	1.04, 1.71	1.26	0.95, 1.66	1.07	0.61, 1.86	1.13	0.76, 1.68
Time pressure[b]										
Low	1		1		1		1		1	
Intermediate	1.20	0.84, 1.70	1.11	0.60, 2.06	1.16	0.64, 2.10	1.67	0.56, 4.99	1.52	0.65, 3.57
High	1.07	0.73, 1.56	0.76	0.37, 1.56	0.99	0.52, 1.88	1.51	0.48, 4.70	1.64	0.67, 4.02
Smoking[c]										
No	1		1		1		1		1	
Yes	2.58	2.25, 2.96	2.73	2.20, 3.40	2.49	1.93, 3.23	2.06	1.27, 3.36	2.15	1.51, 3.05
Alcohol use where the respondent felt him/herself heavily intoxicated [c]										
Less than twice / month	1		1		1		1		1	
Twice or more / month	1.78	1.49, 2.12	1.76	1.33, 2.33	1.50	1.05, 2.16	3.25	1.92, 5.49	2.28	1.53, 3.34
Leisure physical activity[c]										
less than once a week	1		1		1		1		1	
once a week or more	0.63	0.55, 0.73	0.56	0.45, 0.69	0.71	0.55, 0.93	0.65	0.40, 1.04	0.82	0.57, 1.16

Abbreviations: CI, confidence interval.

[a] Age adjusted for sex and occupational status; Sex adjusted for age and occupational status; occupational status adjusted for age and sex. Other variables adjusted for age, sex and occupational status. [b]Calculated only in the 1996 cohort. [c]Calculated only in the 1986 cohort.

Table 3. Association of Job Control Components with All-Cause and Cause-Specific Mortality in the Forest Industry Cohort, Finland, 1986 & 1996 - 2005

		Unadjusted		Model 1[a]		Model 2[b]		Model 3[c]	
	n (cases)	Hazard ratio	(95% CI)	Hazard ratio	(95% CI)	Hazard ratio	(95% CI)	Hazard ratio	(95% CI)
					All causes				
Skill discretion									
Low	4312 (283)	1		1		1		1	
Intermediate	4852 (344)	1.04	0.89, 1.22	0.87	0.74, 1.03	0.81	0.69, 0.96	0.83	0.70, 0.98
High	4346 (354)	1.15	0.99, 1.35	0.98	0.82, 1.17	0.84	0.69, 1.02	0.85	0.70, 1.04
Decision authority									
Low	4604 (293)	1		1		1		1	
Intermediate	4628 (343)	1.16	0.99, 1.35	1.12	0.95, 1.31	1.16	0.98, 1.37	1.14	0.97, 1.35
High	4278 (345)	1.29	1.11, 1.51	1.26	1.07, 1.49	1.28	1.06, 1.54	1.24	1.03, 1.50
					Cardiovascular				
Skill discretion									
Low	4312 (101)	1		1		1		1	
Intermediate	4852 (140)	1.18	0.91, 1.53	0.94	0.72, 1.22	0.83	0.63, 1.09	0.84	0.64, 1.10
High	4346 (134)	1.22	0.94, 1.58	1.01	0.76, 1.34	0.80	0.58, 1.09	0.81	0.59, 1.11
Decision authority									
Low	4604 (101)	1		1		1		1	
Intermediate	4628 (139)	1.36	1.05, 1.76	1.30	1.00, 1.69	1.36	1.03, 1.79	1.35	1.03, 1.78
High	4278 (135)	1.47	1.14, 1.90	1.47	1.12, 1.93	1.49	1.11, 2.02	1.47	1.09, 1.99
					Cancer				
Skill discretion									
Low	4312 (89)	1		1		1		1	
Intermediate	4852 (92)	0.88	0.66, 1.18	0.73	0.54, 0.99	0.72	0.52, 0.98	0.72	0.52, 0.98
High	4346 (105)	1.08	0.82, 1.44	0.83	0.60, 1.15	0.75	0.53, 1.08	0.76	0.53, 1.09

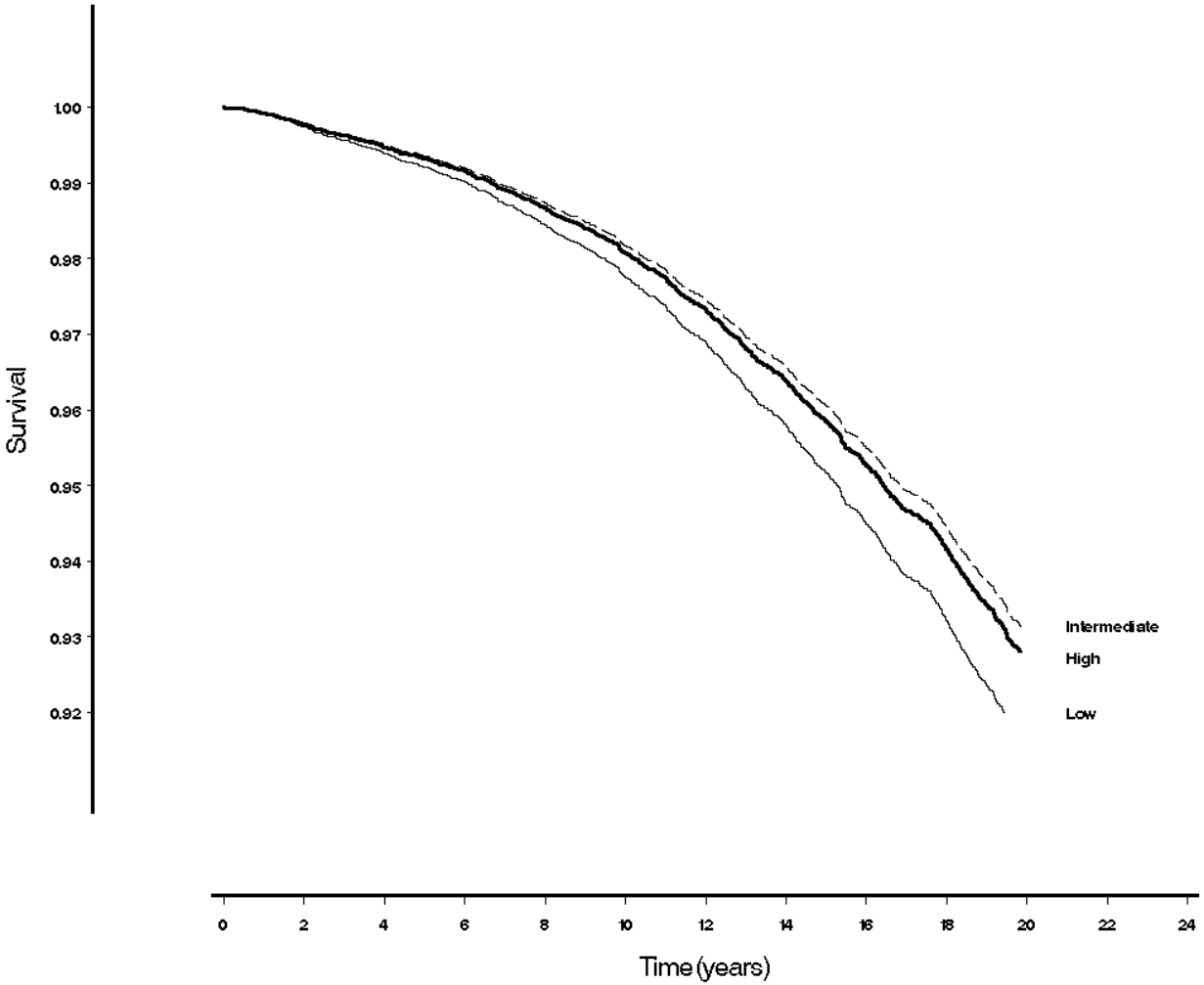
Decision authority									
Low	4604 (93)	1		1		1		1	
Intermediate	4628 (96)	1.02	0.77, 1.36	0.94	0.70, 1.26	0.99	0.73, 1.35	0.99	0.73, 1.35
High	4278 (97)	1.15	0.86, 1.53	1.01	0.75, 1.36	1.01	0.71, 1.42	1.00	0.71, 1.41
					Alcohol related				
Skill discretion									
Low	4312 (16)	1		1		1		1	
Intermediate	4852 (37)	1.99	1.11, 3.58	1.78	0.98, 3.23	1.48	0.79, 2.75	1.56	0.83, 2.94
High	4346 (32)	1.87	1.03, 3.41	1.61	0.83, 3.11	1.23	0. 60, 2.50	1.27	0.62, 2.63
Decision authority									
Low	4604 (16)	1		1		1		1	
Intermediate	4628 (37)	2.29	1.27, 4.11	2.27	1.25, 4.12	2.12	1.14, 3.94	2.00	1.07, 3.76
High	4278 (32)	2.19	1.20, 3.99	2.13	1.14, 4.00	2.03	1.03, 4.00	1.77	0.89, 3.53
					External causes				
Skill discretion									
Low	4312 (54)	1		1		1		1	
Intermediate	4852 (52)	0.84	0.57, 1.23	0.77	0.52, 1.14	0.74	0.49, 1.12	0.77	0.51, 1.30
High	4346 (48)	0.85	0.58, 1.25	0.86	0.56, 1.31	0.78	0.48, 1.25	0.81	0.50, 1.30
Decision authority									
Low	4604 (54)	1		1		1		1	
Intermediate	4628 (51)	0.94	0.64, 1.37	0.98	0.67, 1.45	1.08	0.71, 1.62	1.06	0.70, 1.60
High	4278 (49)	0.89	0.67, 1.46	1.12	0.74, 1.68	1.23	0.78, 1.94	1.18	0.74, 1.86

Abbreviations: CI, confidence interval.

[a] Model 1 job control variables entered separately, adjusted for age, sex and occupational status, and physical health (hypertension, diabetes).

[b] Model 2 job control variables entered together adjusted for age, sex, occupational status, physical health (hypertension, diabetes), supervisor position, supervisor support and co-worker support.

[c] Model 3 job control variables entered together adjusted for age, sex, occupational status, physical health (hypertension, diabetes), supervisor support, co-worker support and hospitalisation for mental disorders.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0.99
0.98
0.97
0.96
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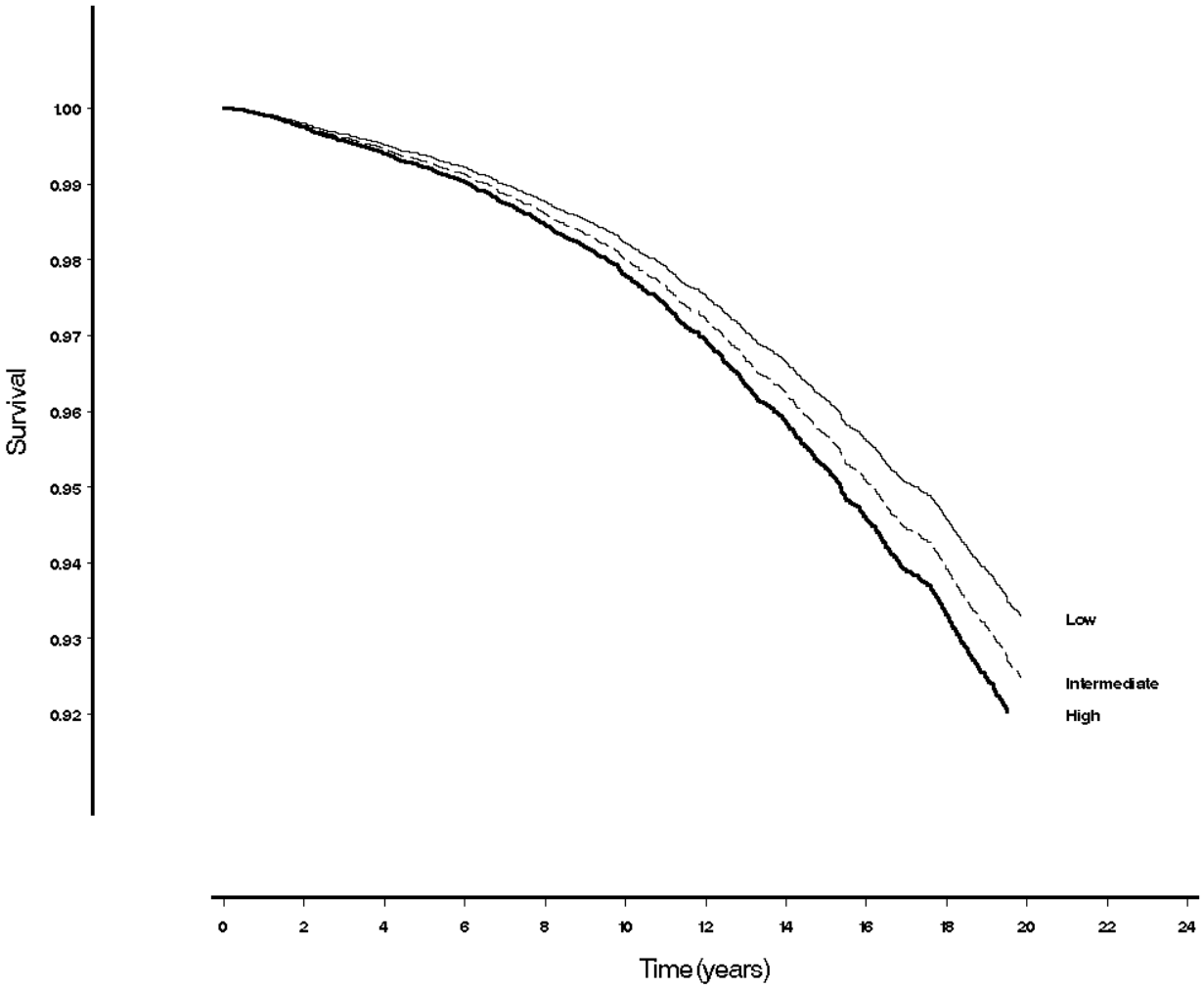
Time (years)
Intermediate
High
Low


Survival
1.00
0.99
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8
10
12
14
16
18
20
22
24
Time (years)
Low
Intermediate
High

Funding

This work was supported by the Academy of Finland (grant 110451, and grants 117604, 124271, 124322, 129264 to MK and JV, and grant 123621 to LP).

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Figure 1. Flow-chart of the Characteristics of a Forest Industry Cohort, Finland, 1986 & 1996.

Figure 2. Survival for Levels of Skill Discretion, Adjusted Cox Curve Model 2, in All-cause Mortality in the Forest Industry Cohort, Finland, 1986 & 1996.

Figure 3. Survival for Levels of Decision Authority, Adjusted Cox Curve Model 2, in All-cause Mortality in the Forest Industry Cohort, Finland, 1986 & 1996.

Appendix. Differential Associations of Job Control Components with Mortality: a Cohort Study, 1986-2006

Psychosocial scales

Responses to these items were given on 5-level rating scales (e.g. Very little, Fairly little, Somewhat, Fairly much, Very much)

Skill Discretion:

"How monotonous or variable your work is?"

"Can you use your knowledge and skills in your work?

"Does your work require deliberation and decision-making?

"Is your job a repetition of one or only few tasks?

"Do you need to learn new things in your work?"

Decision authority:

"Can you dictate your own work pace?"

"Can you leave your work station for a short while without being replaced?"

"Can you plan your work yourself?"

"It is possible to use your own judgement at work, there is no predetermined method for work?"

"How much influence do you have on the objectives of your work, i.e. on what you are expected to achieve?"

Co-worker support

"Do your colleagues provide support and help to you when needed?"

"How do your colleagues get along at your workplace?"

"How well your work unit cooperates?"

"How well different work units cooperate".

Supervisor support

"Does your supervisor provide support and help when needed?"

"Does your supervisor take into account your opinion concerning your work?"

"Do your supervisors take employee well-being into account?"

Time pressure

"Do you have to hurry in order to do your work?"

"Do you feel that you are not able to do your work properly in the time given?"

"Do you have breaks or moments to rest during your work?"

Subsidiary analyses

We repeated the analyses in the 2 separate study cohorts, i.e. respondents in 1986 with a 20- year follow-up and those in 1996 with a 10-year follow-up. Since smoking, alcohol consumption, physical activity and time pressure were not measured in both cohorts, we were able to also adjust the analyses for these variables in the cohort specific models. The results were similar to the main the analysis in the 1986 cohort for all-cause and cardiovascular mortality, but in the 1996 cohort there was little effect on all-cause mortality (data on cardiovascular mortality not shown). For cardiovascular deaths in the 1996 cohort the effects were similar to the combined cohort, but non-significant with only 52 cases. We also ran the analyses separately for blue and white collar workers and for men and women, and found no major differences in the associations between the subgroups in all-cause mortality. To test whether the association was observable irrespective of supervisor status, we conducted a subgroup analysis where employees in a supervisory position (N=2465) were excluded (data not shown). This did not change the results. The risks for all cause and cardiovascular mortality for each individual item used in the skill discretion and decision authority scales are presented in table 7.

Table 4. Association of Job Control Dimensions with All-Cause Mortality in the Forest Industry Cohort, Finland, separately for the 1986 and the 1996

	1986 cohort [a]			1996 cohort [b]		
	n (cases)	Hazard ratio	(95% CI)	N (cases)	Hazard ratio	(95% CI)
Skill discretion						
Low	2466 (241)	1		2453 (61)	1	
Intermediate	2961 (294)	0.77	0.63, 0.93	2645 (63)	0.87	0.60, 1.27
High	2837 (326)	0.85	0.68, 1.05	2403 (57)	0.90	0.57, 1.42
Decision authority						
Low	2749 (249)	1		2573 (67)	1	
Intermediate	2887 (304)	1.17	0.97, 1.41	2552 (54)	0.89	0.61, 1.31
High	2583 (308)	1.30	1.07, 1.60	2376 (60)	1.08	0.70, 1.66

Abbreviations: CI, confidence interval.

[a] Job control variables entered together adjusted for age, sex, occupational status, physical health (hypertension, diabetes), supervisor support, co-worker support, alcohol consumption, smoking and physical exercise. [b] Job control variables entered together adjusted for age, sex, occupational status, physical health (hypertension, diabetes), supervisor support, co-worker support and time pressure.

Table 5. Association of Job Control Dimensions with All-Cause Mortality for Blue Collar and White Collar Employees in the Forest Industry Cohort, Finland, 1986 & 1996

	Blue collar [a]			White collar [a]		
	N (cases)	Hazard ratio	(95% CI)	N (cases)	Hazard ratio	(95% CI)
Skill discretion						
Low	3713 (259)	1		599 (24)	1	
Intermediate	3453 (278)	0.82	0.69, 0.99	1399 (66)	0.67	0.40, 1.10
High	1855 (178)	0.86	0.69, 1.06	2491 (176)	0.70	0.42, 1.14
Decision authority						
Low	3916 (269)	1		688 (24)	1	
Intermediate	3057 (245)	1.11	0.93, 1.34	1571 (98)	1.41	0.88, 2.28
High	2048 (201)	1.35	1.10, 1.65	2230 (144)	1.31	0.79, 2.16

Abbreviations: CI, confidence interval.

[a] Job control variables entered together adjusted for age, sex, physical health (hypertension, diabetes), supervisor position, supervisor support and co-worker support

Table 6. Association of Job Control Dimensions with All-Cause Mortality for Men and Women in the Forest Industry Cohort, Finland, 1986 & 1996

	Men [a]			Women [a]		
	N (cases)	Hazard ratio	(95% CI)	N (cases)	Hazard ratio	(95% CI)
Skill discretion						
Low	2771 (220)	1		1541 (63)	1	
Intermediate	3808 (315)	0.80	0.68, 0.95	1044 (29)	0.73	0.46, 1.17
High	3775 (333)	0.81	0.68, 0.98	571 (21)	1.06	0.59, 1.90
Decision authority						
Low	3325 (250)	1		1279 (43)	1	
Intermediate	3585 (304)	1.13	0.94, 1.35	1043 (39)	1.42	0.91, 2.24
High	3444 (314)	1.24	1.02, 1.51	834 (31)	1.67	1.00, 2.79

Abbreviations: CI, confidence interval.

[a] Job control variables entered together adjusted for age, occupational status, physical health (hypertension, diabetes), supervisor position, supervisor support and co-worker support

Table 7. Association of Individual Items of Job Control Dimensions with All-Cause and Cardiovascular Mortality in the Forest Industry Cohort, Finland, 1986 & 1996

	All causes [a]			Cardiovascular [a]		
	N (cases)	Hazard ratio	(95% CI)	N (cases)	Hazard ratio	(95% CI)
Skill Discretion:						
How monotonous or variable your work is						
Very monotonous, Fairly monotonous	2182 (147)	1		2182 (53)	1	
Not monotonous but not variable	4782 (321)	0.93	0.76, 1.13	4782 (115)	0.92	0.66, 1.27
Very variable, Fairly variable	6541 (513)	1.00	0.82, 1.21	6541 (207)	1.08	0.79, 1.50
Can you use your knowledge and skills in your work						
Very little, Fairly little	1749 (123)	1		1749 (42)	1	
Somewhat	3818 (269)	0.89	0.72, 1.10	3818 (107)	0.97	0.67, 1.39
Very much, Fairly much	7929 (586)	0.88	0.72, 1.09	7929 (225)	0.93	0.65, 1.32
Does your work require deliberation and decision-making						
Very little, Fairly little	1883 (122)	1		1883 (45)	1	
Somewhat	4149 (287)	0.91	0.73, 1.13	4149 (110)	0.86	0.60, 1.23
Very much, Fairly much	7470 (571)	0.93	0.75, 1.16	7470 (220)	0.89	0.63, 1.25
Is your job a repetition of one or only few tasks						
Constantly, Fairly often	6377 (479)	1		6377 (182)	1	
Sometimes	2701 (161)	0.84	0.70, 1.01	2701 (57)	0.78	0.58, 1.06
Hardly ever, Seldom	4357 (322)	0.95	0.81, 1.01	4357 (133)	1.00	0.79, 1.27
Do you need to learn new things in your work						
Very little, Fairly little	2467 (178)	1		2467 (60)		
Somewhat	5239 (339)	0.88	0.74, 1.05	5239 (167)	1.05	0.78, 1.41
Very much, Fairly much	5794 (404)	0.81	0.67, 0.98	5794 (148)	0.85	0.62, 1.17
Decision authority:						
Can you dictate your own work pace						
Never, Seldom	3393 (213)	1		3393 (74)	1	
Sometimes	2668 (174)	1.12	0.92, 1.37	2668 (63)	1.20	0.86, 1.68

Always, Fairly often	7430 (592)	1.19	1.01, 1.40	7430 (238)	1.38	1.05, 1.80
Can you leave your work station for a short while without being replaced						
Never, Seldom	2207 (129)	1		2207 (50)	1	
Sometimes	2244 (132)	1.00	0.82, 1.21	2244 (47)	0.92	0.62, 1.38
Always, Fairly often	9035 (717)	0.98	0.77, 1.25	9035 (276)	1.00	0.73, 1.37
Can you plan your work yourself						
Not at all, Very little	2291 (210)	1		2991 (73)	1	
Somewhat	3401 (210)	0.92	0.76, 1.11	3401 (89)	1.17	0.88, 1.56
Completely, Quite a lot	7104 (560)	1.07	0.90, 1.27	7104 (213)	1.11	0.81, 1.52
It is possible to use your own judgement at work, there is no predetermined method for work						
Very little, Fairly little	3115 (220)	1		3115 (73)	1	
Somewhat	2201 (119)	0.74	0.59, 0.92	2201 (41)	0.74	0.51, 1.09
Very much, Fairly much	8146 (635)	1.02	0.86, 1.20	8146 (258)	1.25	0.95, 1.64
How much influence do you have on the objectives of your work, i.e. on what you are expected to achieve						
Very little, Fairly little	1972 (123)	1		1972 (36)	1	
Somewhat	4351 (298)	1.04	0.84, 1.29	4351 (120)	1.41	0.97, 2.06
Very much, Fairly much	7123 (557)	1.12	0.91, 1.38	7123 (219	1.48	1.03, 2.15

Abbreviations: CI, confidence interval.

[a] Items entered separately adjusted for age, sex, occupational status, physical health (hypertension, diabetes), supervisor position, supervisor support and co-worker support.