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Chronic workplace stress and insufficient physical activity: a cohort study

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ABSTRACT

Objectives: To examine whether exposure to workplace stressors predicts changes in physical activity and the risk of insufficient physical activity.

Methods: Prospective data from the Finnish Public Sector Study. Repeated exposure to low job control, high job demands, low effort, low rewards, and compositions of them (job strain and effort-reward imbalance) were assessed at Time 1 (2000-02) and Time 2 (2004). Insufficient physical activity (<14 Metabolic-Equivalent-Task hours per week) was measured at Time 1 and Time 3 (2008). The effect of change in workplace stressors on change in physical activity was examined using fixed-effects (within-subject) logistic regression models (*N*=6665). In addition, logistic regression analysis was applied to examine the associations between repeated exposure to workplace stressors and insufficient physical activity (*N*=13,976). In these analyses, co-worker assessed workplace stressor scores were used in addition to individual level scores.

Results: The proportion of participants with insufficient physical activity was 24% at baseline and 26% at follow-up. Nineteen percent of the participants who were sufficiently active at baseline became insufficiently active at follow-up. In the fixed-effect analysis an increase in workplace stress was weakly related to an increase in physical inactivity within an individual. In between-subjects analysis, employees with repeated exposure to low job control and low rewards were more likely to be insufficiently active at follow-up than those with no reports of these stressors; fully adjusted odds ratios ranged from 1.11 (95%CI=1.00-1.24) to 1.21 (95% CI=1.05-1.39).

Conclusions: Workplace stress is associated with a slightly increased risk of physical inactivity.

Keywords: workplace stress; physical activity; prospective cohort study

INTRODUCTION

Insufficient physical activity is a widespread public health problem. Globally, around one third of adults are insufficiently active.[1] The current recommendation is that adults should take part in physical activities of moderate intensity for at least 30 minutes on at least five days a week or in vigorous-intensity aerobic physical activity for a minimum of 20 minutes on three days each week. Combinations of moderate- and vigorous-intensity activity can be performed to meet this recommendation.[2] However, many fail to achieve the recommended levels, and workplace stress may contribute to this. Stressful working conditions can result in fatigue and incomplete recovery. In addition, they may limit the individual's ability to make positive changes to their lifestyles,[3] and impede the implementation of exercise intentions.[4]

To date, evidence on the status of workplace stressors as a risk factor for insufficient physical activity is mixed, with some studies supporting this association,[4-11] while others reporting null findings.[12,13] Methodological limitations including the use of cross-sectional design in many studies, may have contributed to some of the inconsistencies in earlier studies. The assessment of workplace stress has typically been based on measurement at a single time point which may fail to capture the effects of change and longer-lasting exposure.[14] In addition, most studies have assessed job strain stressors only whereas research on the relationship between effort-reward imbalance and physical activity is scarce.

To overcome these limitations, we conducted a large-scale study in Finnish employees to investigate the association between change in workplace stressors and change in physical activity among those with a change in both the exposure and outcome across the 3 survey

phases. In addition, we examined whether repeated exposure to workplace stressors was associated with an increased risk of insufficient physical activity.

METHODS

Sample and design

Data were obtained from the Finnish Public Sector Study, which is an on-going cohort study of employees in the service of ten municipalities and 21 hospitals in Finland.[15] A total of 48,598 employees responded to the first survey in 2000-02 (Time 1) (response rate 68%). Of these respondents 36,440 were alive and still employed by the target organisations at the time of the second survey in 2004 (Time 2), and of them, 29,180 responded (response rate 80%). At Time 3 (2008), 18,431 participants responded (response rate 87% among those who were still employed by the target organisations and responded both at Time 1 and Time 2). The employers' records were used to identify the eligible populations for surveys and the work unit code for each employee. Using unique national ID numbers, the respondents were linked to comprehensive national health registers from 1994 through 2005. To determine workplace stressors, each participant's work unit at the lowest level of organisational hierarchy, such as a kindergarten or a hospital ward, was identified from employers' records. The study was approved by the Ethics Committee of the Finnish Institute of Occupational Health.

Participants with missing information on any study variables (*N*=3695) were excluded. The final sample with repeated measures of workplace stressors therefore included 13,976 participants. The final cohort did not substantially differ from those who had participated at earlier phases but had left the organization or did not respond to the follow-up surveys (*N*=10,749) in terms of mean age (44.0 years in the sample vs. 46.2 years in the excluded

population), the proportion of women (82% vs. 81%), and socio-economic status (SES) (16% vs. 20% low).

Measures

Workplace stressors

Multiple workplace stressors based on two leading stress models, the job strain model (also known as the demand-control model),[16] and the effort-reward imbalance (ERI) model,[17] were measured. As previously,[18] workplace stressors were assessed in two ways: (a) using each individual's own assessment, and (b) summing up the assessments of co-workers and linking that score to each employee in the work unit. In other words, in addition to workplace stressor scores based on self-report, every participant was linked to scores that were compiled from all co-workers' responses in the same work unit but excluded the participant's own response. Co-worker assessed scores were constructed to address potential reporting bias, i.e. to eliminate artificial inflation of associations due to common methods to assess the exposure and the outcome.

Assessment of job strain was based on the modified Job Content Questionnaire.[16] Three questions addressed job demands, that is, having high workload and working at a high pace and not having enough time to complete work tasks (Cronbach's alpha = 0.76). Job control was assessed with nine questions about the worker's ability to use and develop skills and exert decision authority (Cronbach's alpha = 0.82). The responses were given on a Likert scale ranging from 1 = "very little" to 5 = "very much". To construct a job strain measure, the means of job demand scores were subtracted from the means of job control scores.[19] As in

previous studies,[18,20] for both self-reported and co-worker assessed job control, demands and strain, scores were further divided into tertiles for between-subjects analysis. Repeated exposure to workplace stress over Time 1 and Time 2 was measured by adding together the number of times (0, 1, or 2) the participant was in a low control, high demands, or a high strain job, respectively. In within-subject analyses, job strain stressors were dichotomised using the median split (high vs. low).

Effort was measured with the following item: "How much do you feel you invest in your job in terms of skill and energy?" Rewards were assessed with a scale containing three questions about feelings of getting in return from work in terms of income and job benefits, recognition and prestige, and personal satisfaction (Cronbach's alpha = 0.64).[21] Response format for all the questions was a 5-point Likert scale ranging from 1=”very little” to 5=”very much”. The indicator of ERI was obtained by calculating the ratio between the response score in the effort scale and the mean response score in the reward scale. The present measure of ERI has been shown to be an independent measure of workplace stress and has been associated with health and health behavioural outcomes in earlier cross-sectional studies.[11,21,22] As in previous studies, the distributions of the individual and co-worker assessed effort, rewards, and ERI scores were divided into tertiles for between-subjects analysis.[11,20] The accumulation of exposure to low effort, low rewards, and high ERI over the two measurement points was computed by adding together the number of times the participant was in the most unfavourable tertile. In within-subject analyses, ERI stressors were dichotomised using the median split (high vs. low).

Insufficient physical activity

Participants reported the average amount of time spent per week on leisure and on the journey to and from work in physical activity corresponding to the activity intensity of walking, vigorous walking, jogging, and running. The time spent at each activity in hours per week was multiplied by its typical energy expenditure, expressed in metabolic equivalent tasks (METs). We used the following MET values (work metabolic rate divided by resting metabolic rate): 4 (for exercise intensity corresponding to walking), 6 (vigorous walking to jogging), 10 (jogging), and 13 (running) and express the activity MET index as the sum score of MET-hours/week.[23] Moderate-intensity physical activity for about 30 minutes at least five times a week is recommended by physical activity guidelines;[2] approximately 14 MET hours per week correspond to the energy expenditure (1000 kcal, e.g. brisk walking for 2.5 hours/week equals 15 MET hours) needed for reducing health risks. Therefore the respondents whose volume of activity was <14 MET-hours/week were classified as being insufficiently active.[24] This cut-point was further used in the fixed effects analysis to assess change in physical activity (i.e. from physically active to insufficiently active).

Covariates

Sex, age, employer type (municipality vs. hospital), and SES were obtained from employers' records. SES was assessed using the occupational-title classification of Statistics Finland: high (e.g. physicians, teachers), intermediate (e.g. technicians, registered nurses), and low (e.g. cleaners, maintenance workers).[25] Marital status (married or cohabiting vs. other) was obtained from the survey. Working hours were summed from the respondent's reports of their (i) official working hours per day and (ii) mean hours of paid or unpaid overtime and their mean hours in another job per day. The daily working hours were multiplied by 5 to obtain the weekly hours in paid work and then dichotomised as less than 40 hours vs. 40 hours or

more per week. Standard questionnaires were used to assess heavy drinking (>210 g of absolute alcohol per week vs. less), and smoking status (current smoker vs. non-smoker). The respondents self-reported their weight and height. Body mass index (BMI) was calculated as self-reported weight (kilograms) divided by self-reported height (meters) squared.

The presence of chronic physical illness was derived from the Drug Reimbursement Register which contains information on persons entitled to special reimbursement for the treatment of chronic conditions and diseases, and the date when the special reimbursement is granted. Patients who apply for special reimbursement must submit a detailed medical statement prepared by the treating physician confirming the diagnoses. All participants with hypertension, cardiac failure, ischemic heart disease, diabetes, asthma or other chronic obstructive lung disease, and rheumatoid arthritis at the end of the baseline survey year were identified.[26] Data on cancer diagnosed during the baseline survey year or four preceding years were obtained from the Finnish Cancer Registry.[27] The presence of any of these illnesses was coded (yes/no). Sub-optimal self-rated health was assessed with the question "In general, would you say your health is very good, good, fair, poor, or very poor?" (fair to very poor indicated sub-optimal health).[28] The presence of common mental disorders was assessed with the 12-item version of the General Health Questionnaire (scores ≥4 indicated common mental disorder).[29] The selected covariates have been associated with physical activity in earlier studies.[24,30]

Statistical analysis

To analyse within-subject changes, the fixed-effects methods using conditional logistic regression with time-discrete variables was applied to model the effect of change in workplace stress on change in physical activity among those with a change in both the

exposure and outcome across the 3 survey phases (N=6665). In relation to the exposure, 'change' refers to moving from the low-stress group to the high-stress group during the follow-up; or from the high-stress group to the low-stress group. In a similar way, in relation to the outcome, 'change' refers to moving from the insufficiently active group to the sufficiently active group, or vice versa. In within-subjects analysis the aim is to examine whether in repeated measurements the changes in the exposure and outcome variables of interest are in the same direction. Fixed effects methods can be applied in cohort studies using a case-control design, in which the individual is at the same time his/her own case and control. This is possible with repeated measurements when the same individual is, for example, insufficiently active (case) at one study phase and sufficiently active (control) at another study phase. The research question is whether the indvidual reports high workplace stress when he/she is a case compared to when he/she is a control. More specifically, this analysis enabled us to examine whether physical activity decreases when workplace stress increases. In the analysis of longitudinal data, the fixed-effects method offers the advantage of controlling for stable characteristics of individuals, whether measured or not, by using within-subject variation only to estimate the regression coefficients.[31] Because the case and the control share all stable (e.g. sex, genes) and non-measured (e.g. personality) characteristics, all examined exposures and covariates need to be time variant.

In addition, logistic regression analysis was applied to examine the associations between repeated exposure to workplace stressors at Time 1 and Time 2 and insufficient physical activity at Time 3. The results are presented as adjusted odds ratios (ORs) and their 95% confidence intervals (CIs). The contribution of the covariates to the associations between workplace stressors and insufficient physical activity was examined by including each of the following sets of factors in turn: baseline insufficient physical activity, socio-demographics (sex, age, SES, marital status, working hours, and employer type), and health status and

health behaviours (chronic illness, sub-optimal self-rated health, common mental disorders, BMI, smoking and heavy drinking). Finally, the analysis was conducted with a simultaneous adjustment for all these factors. To test the robustness of our findings and to further examine the temporality between the variables, a sensitivity analysis excluding those participants who were insufficiently active at baseline was run.

The analyses were conducted in the combined sample of men and women, and in all SES groups together, since the sex and SES interactions were not significant (all $p>0.05$ in the final models).

SAS 9.2 program package was used for all analyses (SAS Institute Inc, Cary, North Carolina).

RESULTS

The characteristics of the study cohort and the associations between the study variables at baseline (Time 1) and insufficient physical activity at baseline (Time 1) and at follow-up (Time 3) are displayed in Table 1. The majority (81%) of the participants were women and 53% represented intermediate SES group. Eighty-two percent were contracted to municipalities. The proportion participants with insufficient physical activity was 24% at baseline and 26% at follow-up. Nineteen percent of the participants who were sufficiently active at baseline became insufficiently active at follow-up. Both at Time 1 and Time 3, insufficient physical activity was more prevalent in men, increased with age, and was related to low SES. Participants with chronic illness, common mental disorder, suboptimal self-rated health, and current smokers reported significantly more often insufficient physical activity

both at Time 1 and Time 3 than their counterparts. Moreover, participants living without a partner, municipal employees and heavy drinkers reported more insufficient physical activity at Time 3. Mean BMI at baseline was higher in insufficiently active employees both at Time 1 and Time 3.

Table 1 Baseline (Time 1) characteristics of the participants and the prevalence of insufficient physical activity (<14 MET hours/week) at baseline (Time 1) and follow-up (Time 3), the Finnish Public Sector Study, 2000-2008 (*N*=13,976)

Characteristic at Time 1	*N* (%)	Insufficiently active participants at Time 1 *N* (%)	*p* value[a]	Insufficiently active participants at Time 3 *N* (%)	*p* value[a]
Age			<.0001		<.0001
Mean (SD)	44.0 (7.2)	44.5 (7.1)		45.1 (7.1)	
Sex			.04		.0003
Women	11,352 (81)	2636 (23)		2844 (25)	
Men	2624 (19)	660 (25)		747 (28)	
Married or cohabiting			.4		.001
Yes	10,860 (78)	2578 (24)		2720 (25)	
No	3116 (22)	718 (23)		871 (28)	
Socio-economic status (SES)			<.0001		<.0001
High	4372 (31)	1001 (23)		969 (22)	
Intermediate	7343 (53)	1632 (22)		1839 (25)	
Low	2261 (16)	663 (29)		783 (35)	
Employer			0.6		<.0001
Municipality	11,436 (82)	2733 (24)		3046 (27)	

Hospital district	2540 (18)	563 (22)		545 (21)	
Self-rated health			<.0001		<.0001
Very good or good	10,835 (78)	2211 (20)		2441 (23)	
Suboptimal	3141 (22)	1085 (35)		1150 (37)	
Chronic illness			<.0001		<.0001
No	12,444 (89)	2849 (23)		3082 (25)	
Yes	1532 (11)	447 (29)		509 (33)	
Current smoking			<.0001		<.0001
No	11,479 (82)	2540 (22)		2720 (24)	
Yes	2497 (18)	756 (30)		871 (35)	
Heavy drinking			.9		.002
No	12,737 (91)	3002 (24)		3228 (25)	
Yes	1239 (9)	294 (24)		363 (29)	
Common mental disorder			<.0001		.0002
No	10,544 (75)	2376 (23)		2625 (25)	
Yes	3432 (25)	920 (27)		966 (28)	
Weekly working hours			.9		.3
>40	9130 (65)	2155 (24)		2373 (26)	
40+	4846 (35)	1141 (24)		1218 (25)	
Insufficiently active at			N/A		<.0001

Time 1					
No	10,680 (76)	N/A		1990 (19)	
Yes	3296 (24)	N/A		1601 (49)	
Body mass index, kg/m^2			<.0001		<.0001
Mean (SD)	25.0 (4.1)	26.1 (4.7)		26.3 (4.7)	

MET, metabolic equivalent task; SD, standard deviation

a. For heterogeneity from Chi-square test (percentages) or analysis of variance (means).

Table 2 presents the results from the within-individual analyses among the 6665 participants who had a change in physical activity between the study phases. As the table shows, slightly higher odds ratios of insufficient physical activity at Time 3 were observed among those who had experienced an increase in workplace stress while these odds were lowered among those who had experienced a decrease in workplace stress, measured as low job control, high strain and low effort. These associations changed little after adjustment for self-rated health.

When workplace stressors were assessed by co-worker reports, higher odds ratios of insufficient physical activity at Time 3 were observed among those whose co-workers reported decrease in job control.

Table 2 Within-individual analyses of the effect of workplace stressors on insufficient physical activity. Odds ratios (95% confidence intervals) of insufficient physical activity by workplace stress derived from conditional logistic regression models among the participants who had a change in physical activity between the surveys, the Finnish Public Sector Study, 2000-2008

Workplace stressors	***N***[a]	**Odds Ratio (95% CI): unadjusted**	**Odds Ratio (95% CI): adjusted for self-rated health**
Job control	6625		
High		1.00 (reference)	1.00 (reference)
Decreased (individual)		1.14 (1.04-1.24)	1.12 (1.03-1.22)
Decreased (co-worker assessed)		1.09 (1.00-1.19)	1.09 (1.00-1.18)
Job demands	6622		
Low		1.00 (reference)	1.00 (reference)
Increased (ind.)		1.08 (1.00-1.16)	1.06 (0.98-1.14)
Increased (co-w.)		1.03 (0.95-1.10)	1.02 (0.94-1.09)
Job strain	6616		
Low		1.00 (reference)	1.00 (reference)

Increased (ind.)		1.13 (1.05-1.22)	1.11 (1.03-1.20)
Increased (co-w.)		0.97 (0.90-1.05)	0.97 (0.89-1.04)
Effort	6602		
High		1.00 (reference)	1.00 (reference)
Decreased (ind.)		1.09 (1.01-1.18)	1.09 (1.01-1.18)
Decreased (co-w.)		0.97 (0.91-1.04)	0.98 (0.91-1.05)
Rewards	6431		
High		1.00 (reference)	1.00 (reference)
Decreased (ind.)		1.06 (0.98-1.14)	1.04 (0.96-1.12)
Decreased (co-w.)		1.01 (0.94-1.09)	1.01 (0.94-1.09)
ERI	6404		
Low		1.00 (reference)	1.00 (reference)
Increased (ind.)		1.05 (0.97-1.13)	1.04 (0.96-1.12)
Increased (co-w.)		0.99 (0.92-1.06)	0.98 (0.92-1.05)

ERI, effort-reward imbalance

[a]*N* when using self-reported workplace stressors.

Note. *N* in adjusted models ranged from 6381 to 6598 depending on the number of missing values in the exposure and covariate variables. *N* in models using co-worker assessed workplace stressors ranged from 6385 to 6611.

Table 3 (Web Only) summarises the results from logistic regression analyses on the associations between repeated exposure to job strain stressors at Time 1 and Time 2, assessed by individuals and co-workers, and insufficient physical activity at Time 3. In unadjusted model, the odds ratio for insufficient physical activity was 1.5-fold higher in employees with repeated reports of low individual job control compared with their counterparts with no reports of low job control. Adjustments led to attenuation in the odds ratio but the relationship remained statistically significant (OR=1.18, 95% CI: 1.06-1.31; Model 5). The result was replicated when repeated exposure to low job control was assessed using co-worker reports (OR=1.11, 95%: 1.00-1.24; Model 5). Job strain and high job demands were not associated with insufficient physical activity.

When those who were insufficiently active at baseline (*N*=3296) were excluded from the analysis, the weak dose-response association between repeated exposure to low job control at Time 1 and Time 2 and insufficient physical activity at Time 3 remained statistically significant (OR=1.15; 95% CI: 1.01-1.31 in the final model, at the individual level; data not shown).

The associations between repeated exposure to ERI stressors at Time 1 and Time 2 and insufficient physical activity at Time 3 are presented in Table 4 (Web Only). After adjustment for all covariates, those participants who reported repeated exposure to low rewards had a slightly higher likelihood of insufficient physical activity compared to those participants who did not report any low rewards at Times 1 and 2 (OR=1.14, 95% CI: 1.02-1.28; Model 5), and the association was to the same direction when co-worker assessed scores were used. Experiencing low effort at one time point was associated with an increased likelihood of insufficient physical activity (OR=1.19, 95% CI: 1.06-1.34; Model 5) but this result was not

replicated when co-worker assessments were used. ERI was not associated with insufficient physical activity.

The weak dose-response relationship between repeated exposure to low rewards at Time 1 and Time 2 and subsequent insufficient physical activity at Time 3 remained after exclusion of participants who were physically inactive at baseline (OR=1.21; 95% CI: 1.05-1.39 in the final model, at the individual level; data not shown).

DISCUSSION

The present study investigated the relationship of repeated exposure to and a change in workplace stressors, and insufficient physical activity in a large sample of Finnish public sector employees. The results from the fixed-effect analyses suggest that an increase in workplace stress is related only to a very slight increase in insufficient physical activity within an individual. Moreover, the between-individual comparisons showed that repeated exposure to low job control and low rewards were weakly associated with an elevated likelihood of insufficient physical activity in a dose-response manner. c effects were obtained using both individual and co-worker assessed scores, which supports the assumption that the health behavioural consequences of workplace stress may not depend only on the perceptions of an individual but also on external working conditions. However, again the effect sizes were small.

Previous research on workplace stress and leisure-time insufficient physical activity predominantly relates to the job strain model. Some earlier cross-sectional,[6,8] and

prospective[9] studies have demonstrated an association between low job control and low physical activity.

We found evidence for a weak association between chronic exposure to low job control and low rewards and the risk of insufficient physical activity. Lack of control at work may spill over to leisure time and be connected to feelings of helplessness, which may make participation in physical activities more challenging.[9] Furthermore, it has been suggested that employees with low job control may have less time to plan opportunities or adjust their leisure time for participating in physical activities.[9] Repeated exposure to low rewards may be associated with insufficient physical activity potentially through its association with fatigue. Low rewards have predicted fatigue in previous studies.[32]

Study strengths and weaknesses

To our best knowledge, this is the first large-scale study which examined the relationship between repeated exposure to both job strain and ERI stressors in relation to insufficient physical activity. A particular strength of this study is its longitudinal design where we can employ analysis of change. Other merits of this study include simultaneous inclusion of a number of covariates, non-response patterns that are unlikely sources for major selection bias, and the operationalisation of insufficient physical activity corresponding to the contemporary recommended guidelines of minimum level of physical activity for adults.[2]

Moreover, co-worker assessment was used to measure workplace stress. The advantage of using co-worker assessment is that common method bias, which of particular concern when both the independent and dependent variables are perceptual measures derived from the same

respondent, can largely be avoided. A further strength was the use of fixed-effects regression, which examines the effect of change in workplace stressors to a change in physical activity within an individual, a robust method to take into account all the observed and unobserved variables that are constant over time, thereby controlling for potential omitted time-invariant variables that could confound the associations.[31]

Nevertheless, some limitations need to be taken into account. First, physical activity was measured by self-reports. This method is common practice in large-scale epidemiological studies,[24] but is affected by reporting bias. Second, the use of co-worker assessed scores in measuring workplace stress may reduce self-report bias, but at the same time it is insensitive to true differences in workplace stressors between the employees within a work unit. Third, even if prospective data were used it is not possible to fully exclude the possibility of reverse causation, that is, if employees experience more workplace stress because of lack of physical activity. Lastly, although the large size and diversity of the sample guarantees a certain generalisation of the results, the present data were female-dominated and from the Finnish public sector and cannot be assumed to represent the general population.

CONCLUSIONS

This large-scale prospective study shows that an increase in workplace stressors, such as low control, high job strain and low effort, was weakly associated with an increase in insufficient physical activity within an individual. In addition, we found a weak dose-response association between repeated exposure to workplace stressors and the likelihood of insufficient physical activity. Our findings provide one plausible mechanism mediating the previously observed effects of workplace stressors on morbidity, such as depression[33] and

heart disease.[34] This study suggests that interventions to support physical activity among stressed employees could prevent from some of the adverse health effects of chronic workplace stress, but job stress intervention studies are needed to confirm this. The fact that in the present study the effect sizes were small indicates that other factors such as physical inactivity in childhood[35] may be more important predictors of insufficient physical activity in working populations.

COMPETING INTERESTS

None declared.

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WHAT THIS PAPER ADDS?

- Many fail to achieve the recommended levels of physical activity, and workplace stress may contribute to this
- However, the evidence on the status of workplace stress as a risk factor for physical inactivity is mixed, and the assessment of workplace stress has typically been based on a measurement at a single time point and/or an assessment of job strain stressors only

- Our study shows that an increase in workplace stressors was weakly related to an increase in insufficient physical activity in within-individual analysis
- Moreover, our study showed a weak dose-response association between chronic exposure to workplace stressors and the likelihood of insufficient physical activity
- Interventions to support physical activity among stressed employees might prevent from some of the adverse health effects of chronic workplace stress

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Table 3 (Web Only) Associations between repeated exposure to individual and work unit level job strain stressors over two phases (Time 1 and Time 2) and insufficient physical activity (<14 MET hours/week) at follow-up (Time 3) (*N*=13,976), the Finnish Public Sector Study, 2000-2008

		Odds Ratio (95% CI), Adjusted for—				
	***N*/cases**	**Unadjusted model (Model 1)**	**Baseline insufficient physical activity (Model 2)**	**Socio-demographics (Model 3)**	**Health status and health behaviours (Model 4)**	**All (Model 5)**
Individual						
Low job control						
None	7656/1778	1.00	1.00	1.00	1.00	1.00
1 phase	2996/777	1.16 (1.05-1.28)	1.12 (1.01-1.24)	1.06 (0.96-1.18)	1.08 (0.97-1.19)	1.01 (0.90-1.12)
2 phases	3324/1036	1.50 (1.37-1.64)	1.43 (1.30-1.57)	1.26 (1.14-1.39)	1.33 (1.21-1.46)	1.18 (1.06-1.31)
High job demands						
None	6979/1805	1.00	1.00	1.00	1.00	1.00

1 phase	3854/1000	1.00 (0.92-1.10)	0.99 (0.90-1.08)	1.06 (0.97-1.16)	0.99 (0.91-1.09)	1.01 (0.92-1.12)
2 phases	3143/786	0.96 (0.87-1.05)	0.92 (0.83-1.02)	1.03 (0.93- 1.14)	0.89 (0.80-0.98)	0.92 (0.83-1.03)
High job strain						
None	7553/1813	1.00	1.00	1.00	1.00	1.00
1 phase	3764/1002	1.15 (1.05-1.26)	1.12 (1.02-1.23)	1.13 (1.03-1.24)	1.11 (1.01-1.21)	1.09 (0.99-1.20)
2 phases	2659/776	1.31 (1.18-1.44)	1.24 (1.12-1.37)	1.23 (1.11-1.36)	1.17 (1.05-1.29)	1.11 (0.99-1.24)
Co-worker assessed						
Low job control						
None	7929/1848	1.00	1.00	1.00	1.00	1.00
1 phase	2466/666	1.22 (1.10-1.35)	1.23 (1.10-1.36)	1.11 (1.00-1.23)	1.12 (1.01-1.25)	1.09 (0.97-1.21)
2 phases	3432/1041	1.43 (1.31-1.57)	1.40 (1.28-1.54)	1.15 (1.04-1.27)	1.26 (1.15-1.38)	1.11 (1.00-1.24)
High job demands						
None	7821/2057	1.00	1.00	1.00	1.00	1.00

1 phase	3752/938	0.93 (0.85-1.02)	0.92 (0.84-1.01)	1.01 (0.92-1.11)	0.98 (0.90-1.08)	1.00 (0.91-1.10)
2 phases	2255/561	0.93 (0.83-1.03)	0.90 (0.81-1.01)	1.05 (0.93-1.17)	1.00 (0.89-1.11)	1.03 (0.91-1.16)
High job strain						
None	8004/1989	1.00	1.00	1.00	1.00	1.00
1 phase	3292/868	1.08 (0.99-1.19)	1.08 (0.98-1.19)	1.06 (0.96-1.16)	1.08 (0.98-1.18)	1.06 (0.96-1.17)
2 phases	2531/698	1.15 (1.04-1.27)	1.13 (1.01-1.25)	1.09 (0.98-1.22)	1.13 (1.02-1.26)	1.07 (0.96-1.20)

MET, metabolic equivalent task

Socio-demographics include sex, age, marital status, socio-economic status, employer type and weekly working hours; health status includes self-rated health, chronic illness, common mental disorders, and body mass index; health behaviours include smoking and heavy drinking.

Note. *N*=13,827 in models using co-worker assessment.

Table 4 (Web Only) Associations between repeated exposure to individual and work unit level effort-reward imbalance (ERI) stressors over two phases (Time 1 and Time 2) and insufficient physical activity (<14 MET hours/week) at follow-up (Time 3) (*N*=13,976), the Finnish Public Sector Study, 2000-2008

		Odds Ratio (95% CI), Adjusted for—				
	***N* (cases)**	**Unadjusted model (Model 1)**	**Baseline insufficient physical activity (Model 2)**	**Socio-demographics (Model 3)**	**Health status and health behaviours (Model 4)**	**All (Model 5)**
Individual						
Low effort						
None	11455/2837	1.00	1.00	1.00	1.00	1.00
1 phase	1877/564	1.31 (1.17-1.45)	1.26 (1.13-1.42)	1.24 (1.11-1.39)	1.24 (1.11-1.39)	1.19 (1.06-1.34)
2 phases	644/190	1.27 (1.07-1.51)	1.17 (0.97-1.41)	1.18 (0.99-1.42)	1.19 (1.00-1.43)	1.09 (0.90-1.32)
Low rewards						

None	8253/2000	1.00	1.00	1.00	1.00	1.00
1 phase	3511/901	1.08 (0.99-1.18)	1.06 (0.96-1.16)	1.03 (0.93-1.13)	1.02 (0.93-1.12)	0.98 (0.89-1.08)
2 phases	2212/690	1.42 (1.28-1.57)	1.33 (1.20-1.49)	1.28 (1.15-1.42)	1.24 (1.11-1.38)	1.14 (1.02-1.28)
High ERI						
None	6701/1662	1.00	1.00	1.00	1.00	1.00
1 phase	4429/1142	1.05 (0.97-1.15)	1.04 (0.95-1.14)	1.02 (0.93-1.11)	1.01 (0.92-1.10)	0.98 (0.90-1.08)
2 phases	2846/787	1.16 (1.05-1.28)	1.13 (1.02-1.25)	1.10 (0.99-1.21)	1.04 (0.93-1.15)	1.00 (0.90-1.12)
Co-worker assessed						
Low effort						
None	7387/1830	1.00	1.00	1.00	1.00	1.00
1 phase	3781/950	1.02 (0.93-1.12)	1.00 (0.91-1.10)	1.01 (0.92-1.11)	0.98 (0.89-1.07)	0.97 (0.88-1.07)
2 phases	2689/776	1.25 (1.13-1.38)	1.22 (1.10-1.35)	1.08 (0.97-1.21)	1.11 (1.00-1.22)	1.04 (0.93-1.17)
Low rewards						

None	7026/1665	1.00	1.00	1.00	1.00	1.00
1 phase	4086/1072	1.15 (1.05-1.25)	1.14 (1.04-1.25)	1.06 (0.97-1.16)	1.09 (1.00-1.20)	1.05 (0.95-1.16)
2 phases	2714/819	1.39 (1.26-1.54)	1.38 (1.24-1.52)	1.13 (1.01-1.25)	1.20 (1.08-1.33)	1.09 (0.97-1.22)
High ERI						
None	6866/1667	1.00	1.00	1.00	1.00	1.00
1 phase	4447/1179	1.13 (1.03-1.23)	1.12 (1.02-1.23)	1.04 (0.95-1.14)	1.09 (1.00-1.19)	1.04 (0.95-1.15)
2 phases	2513/710	1.23 (1.11-1.36)	1.20 (1.08-1.34)	1.05 (0.94-1.17)	1.12 (1.01-1.25)	1.01 (0.90-1.14)

MET, metabolic equivalent task

Socio-demographics include sex, age, marital status, socio-economic status, employer type, and weekly working hours; health status includes self-rated health, chronic illness, common mental disorders, and body mass index; health behaviours include smoking and heavy drinking.

Note. *N*=13,286 in models using co-worker assessment.