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**Bending work time: Curvilinear relationship between working time dimensions and psychological and somatic symptoms**

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ACCEPTED

## **ABSTRACT**

**Objectives** Study examines the curvilinear associations of working time dimensions (working hours, time pressure, work schedules, and control of work time and pace) on psychological and somatic symptoms.

**Methods** Representative Finnish Quality-of-Work-Life Surveys conducted in 2003, 2008 and 2013 were restricted to those (N=11,165) regularly working over 10h/week with more than one-year tenure in their job. Generalised additive models were utilised in analysis.

**Results** Working hours had U-shaped relationships with psychosomatic symptoms, while time pressure had a threshold effect. Work pace control had linear effect. The effects of work time control and work schedules were insignificant. There were interaction effects between working time dimensions.

**Conclusions** Organisations should acknowledge the dynamics of working time dimensions. Notably, time pressure has a hazardous relation to psychosomatic symptoms, but working pace control can buffer the negative effect.

**Key terms** working hours; time pressure; work schedules; work time control; work pace control; psychological symptoms; somatic symptoms; curvilinear; general additive model

## INTRODUCTION

Work has changed substantially in the past decades due to a shift from an industrial to post-industrial era, in which working-times are characterised by diversification, irregularities and flexibilities[1, 2]. Different working hours (short and long days) have become more common, the timing patterns of working time have diversified outside of the typical day job, the intensity and time pressure have increased, and various company- and worker-based time flexibilities have emerged[1]. This study contributes to the literature by exploring several dimensions of working time (duration, tempo, timing and autonomy)[1] and their connections with health using a novel curvilinear methodology. More precisely, it investigates how working hours, time pressure, work schedules, and work time and pace control are simultaneously connected with psychological and somatic symptoms, and if the relationships have a curvilinear rather than linear form.

Several causal pathways connecting working times to health have been identified[2, 3]. Long work-days, working at unsocial hours and time pressure can be psychosocial stressors, specifically causing problems regarding recovering and getting enough rest and balancing work with other life domains, leading to stress reactions, such as psychological and somatic symptoms. Besides, behavioural mechanisms (e.g., unhealthy diet, lack of physical exercise) have also been suggested[2].

The dimensions of working time have been connected with several health indicators. Long working hours were found to predict, for example, problems with work–family balance, stress, fatigue, injuries, cardiovascular and musculoskeletal disorders[4–9] and, more specifically, were associated with psychosomatic and somatic symptoms[4, 7, 10].

Time pressure has been connected with psychosomatic symptoms[11, 12], and adversely associated for example with health, emotional exhaustion, musculoskeletal problems and sickness absences[11, 13, 14]. Associations of unsocial work schedules with

psychosomatic symptoms[11, 15], musculoskeletal complaints, sickness absence and cardiovascular disease[15–17] occur commonly in the literature.

Work time control can be beneficial for employees, enhancing well-being and health, and decreasing stress and the number of sickness absences[3, 13, 17, 18]. In addition, schedule control has been negatively associated with psychological well-being and somatic symptoms[14], and general job control has been negatively linked to psychological and somatic symptoms[19]. Working pace control has received less attention than working time control, but some empirical evidence connected the lack of control in working pace with stress-related cardiovascular responses[20] and ill-health[21].

However, the empirical evidence concerning the health effects of the working time dimensions is not unanimous, with the effects varying among small, non-significant or even contrary to expected[3, 11, 12, 14, 15, 22]. Furthermore, the working time dimensions have been mostly studied separately, so there is a lack of information regarding their simultaneous effects.

Working hours, time pressure and unsocial working schedules can be understood as job demands according to the job demands–control model (JDC)[23] and job demands–resources model (JD-R)[24], while work time and pace control can be viewed as a job resource for employees. The JDC and JD-R models state that job control buffers the adverse strain effect of high job demands. Furthermore, it is conceivable that job demands do not interact only with job resources, but also with other job demands and likewise job resources can have synergistic effects together[24]. That is to say, that accumulated job demands and resources can have excess effect beyond their main effects. High-strain jobs, where high job demands are combined with low control, have been connected with psychosomatic symptoms[25]. Previous studies also indicate that work time control reduces the negative impact of long work hours on work–family interference[5], buffers the adverse effect of time

pressure and job demands on sickness absence[18, 26] and vigour[27] and protects from the adverse effects of unsocial work schedules on vitality, mental health and somatic stress symptoms[22]. However, there are also examples of non-significant interaction effects, such as between time pressure and time autonomy on absences[13].

Former research has mainly, implicitly and possibly even unconsciously, assumed linear relationships between working time dimensions and health, even though it is justified to consider the relationships as curvilinear[28]. According to Warr's vitamin model[29], working hours, time pressure, and working time and pace control have an inverted U-shaped relationship with well-being, where both low and high levels of these aspects are connected with reduced well-being. Low demands can be demotivating, decrease goal achievement and low-demand jobs may include unsatisfactory aspects of work, such as low control and poor skill utilisation. In contrast, excessive control can increase responsibilities and become an unavoidable requirement, which can cause overload. Employees might have to reciprocate high levels of control with more effort. Besides Warr's rationale[29], it might also be reasonable to think that long work hours and time pressure could negatively influence health, only after a certain critical threshold[28]. Work time and pace control can also be ineffective unless the employee has a sufficient amount of control.

Few studies have utilised the curvilinear methodology. Short and long working hours have been associated (inverted U-shape) with poor mental health[30]. A couple of studies found that time pressure has threshold effects with vigour[27] and emotional exhaustion[31]. In a recent meta-analysis, shift-work was connected with cardiovascular disease risk only after five years of exposure[16]. Furthermore, in one study time pressure[32] and in other study job demands, measured mainly with time pressure items[33], had an inverted U-shaped relationship with work engagement.

This study examines, simultaneously, several working time dimensions (work hours, time pressure, work schedules, work time and pace control) and their possible curvilinear relationship with employees' psychological and somatic symptoms by novel non-parametric methodology utilising a large representative sample of Finnish employees. The specific research questions of the study are:

R1: Are working time dimensions connected with psychological and somatic symptoms in simultaneous analysis?

R2: Are the connections linear or curvilinear?

R3: Is there synergistic effects between working time dimensions?

## **METHODS**

### **Sample**

The study combines three latest Finnish Quality-of-Work-Life Surveys (FQWLS) that were collected by Statistics Finland. FQWLS are representative samples of Finnish employees covering all sectors and occupations. The respondents were recruited from the participants of broad monthly Labour Force Surveys, and the sample was restricted to those aged 15–65 years who had worked at least 10 hours per week (5 hours/per week in 2003). The data were collected mainly by face-to-face interviews. A total of 4104 employees participated in 2003, 4392 employees in 2008, and 4876 employees in 2013, respectively. Every time point had a unique set of participants. A large sample ensures a representation of for example unusually short or long work durations, which enables improved estimation at both ends of the scales, which are usually the most critical in curvilinear modelling[28, 29]. Response rates were relatively high in every year, ranging between 68% and 78%. The present study was restricted to those who had worked in their current job at least one year and regularly worked over 10 hours per week (N=11 165). Due to the negligible amount of missing observations

(maximum of 0.5% of responses) within the study variables, the list-wise deletion of missing values was utilised in the analyses. Ethics approval was not required for the study as the data was collected by Statistics Finland following their ethical standards.

### **Dimensions of working time**

*Working hours* were defined through a self-assessed estimate of regular work time in hours per week, which ranged between 10 and 98 hours, in the final sample.

*Time pressure* was measured by four items assessing intensity and demands regarding time use at work[26]. The item "Does time pressure and tight time schedules cause adverse strain in your work?" was assessed on a five-point Likert scale, ranging from 1 ("Not at all") to 5 ("Very much"), while the three other items (e.g., "My work contains tight time schedules") were measured on four-point Likert scales, ranging from 1 ("Untrue") to 4 ("True"). All items were first rescaled to range 0–1 (with a function:  $(x - 1)/(max(x) - 1)$ ) and then their mean was calculated into a composite variable (Chronbach's  $\alpha=0.70$ ).

*Work schedules* were examined through four categories: 1) normal daytime job, 6 am–6 pm; 2) unsocial work schedule without night work (regular evening work or shift-work); 3) unsocial work schedule with night work (regular night work or shift-work); 4) other forms of working time.

*Working time control* was assessed by a four-item measurement[26]. The respondents were asked if they could change the start and end times of their workday (0="No", 1="Yes"), and if they had the possibility of taking brief absences from their work in the middle of the working day to run personal errands, which was assessed with a scale 1 ("Never") – 4 ("Always"). A four-point Likert scales were also utilised within statements: "I can use flexible working hours sufficiently for my own needs" 1 ("Untrue") – 4 ("True") and "How much can you influence on your working time" 1 ("Not at all") – 4 ("A lot"). Prior to forming



the working time control measurement (Chronbach's  $\alpha=0.72$ ) by calculating a mean, all items were rescaled to range 0–1.

*Working pace control* measurement included two items: “How much can you influence on your working pace”, with responses assigned points from 1 (“Not at all”) to 4 (“Very much”), and “Can you usually have breaks and rests at work?”, with response options equal to 1 (“All too seldom”), 2 (“A little too rarely”) and 3 (“Enough”). The items were scaled between 0 to 1 before combination into a mean composite variable.

## **Symptoms**

*Psychological symptoms* were evaluated by asking respondents how often they had been lately experiencing six symptoms: 1) fatigue, reluctance, loss of energy; 2) sleeping problems; 3) depression; 4) exhaustion; 5) tension, nervousness, irritation; 6) feeling that everything is going beyond one's strengths. The prevalence of these symptoms was assessed on a six-point scale, ranging from 1 (“Never”) to 6 (“Daily or almost daily”). A composite variable reflecting the amount and frequency of psychological symptoms was created from the items by calculating a mean.

*Somatic symptoms* were measured with four items: 1) headache; 2) heart palpitation or irregular heart-beat; 3) dizziness; 4) heartburns, acidity, stomach ache, diarrhoea. The frequency of the symptoms was assessed with the same six-point scale. A somatic symptom scale was formed by calculating a mean from the items.

The psychological and somatic symptoms scales are both causal indicator scales[10]. Unlike the customarily utilised effect indicator scales, where items are assumed to reflect a single underlying construct, causal indicator scales are comprised of or caused by the items that are combined to measure it. The measurement of internal consistency reliability (Chronbach's  $\alpha$ ) is not relevant for causal indicator scales.

## **Covariates**

Several covariates were adjusted in the analysis, as they were potential confounders.

Covariates were the year of survey, age, gender, education level (1=basic, 2=secondary, 3=high), family situation (1=living with a spouse and dependent children, 2=living with a spouse without dependent children, 3=living without a spouse, but with dependent children, 4=living without a spouse and dependent children), duration of employment, professional status (1=manager, 2=specialist, 3=expert, 4=employee), supervisory position, temporary contract and sector (1=public, 2=private). Table 1 presents the descriptive statistics of the sample regarding covariates.

## **Statistical analysis**

The generalised additive model (GAM) was utilised to analyse the data. GAM can estimate non-parametric regression splines for the connections[34]. The functional forms are estimated from the data without any prior supposition regarding the shape of the form. GAM were conducted with the R package mgcv[34] in R3.4.3[35]. This study applied thin plate regression splines, and their appropriate degree of smoothness was estimated from the data using generalised cross-validation. Degrees of freedom of the models were inflated with a constant multiplier ( $\gamma=1.4$ ) to avoid overfitting[34]. Furthermore, the upper limit for the effective degrees of freedom of the splines was set to four. As the outcome variables were skewed, the gamma distribution with a log link function was utilised in the analyses.

First, the main effects of working time dimensions were investigated with separate models for psychological and somatic symptoms. After that, the all bivariate (total of 10) interactions between working time dimensions were examined one-by-one. The covariates

were adjusted in all models, and all working time dimensions were included in the interaction models.

## RESULTS

Psychological ( $M=1.69$ ) or somatic symptoms ( $M=1.43$ ) were not highly experienced. Most of the respondents regularly worked 38 or 40 hours per week, 7% regularly worked <30 hours, and under 2% regularly worked >50 hours per week. The majority of employees (69%) did their work between 6 am and 6 pm, corresponding to a normal daytime job (see Table 2).

Overall, the GAM explained psychological symptoms better than somatic symptoms, as the explained deviance (pseudo- $R^2$ ) was 16.6% and 8.04%, respectively. Figure 1 presents the significant main effects of working time dimensions on psychological and somatic symptoms. Analysis indicated that working hours had a slightly U-shaped significant connection to psychological ( $p=0.008$ ) and somatic symptoms ( $p=0.003$ ). For long working hours, however, the symptoms even reduced until about 60 hours per week and only after that were more hours associated with more symptoms. Conversely, there is much uncertainty regarding the effects of long working hours, as they are rare in the sample. Time pressure had similar significant ( $p<0.001$ ) adverse associations with both psychological and somatic symptoms, though the relationship with psychological symptoms was comparatively stronger. There was a threshold effect, as a small amount of time pressure was not very harmful, but for those whose time pressure exceeded 0.6 (on a scale 0–1), the symptoms increased remarkably. Working pace control had significant negative linear connections with symptoms, but working time control did not have significant main effects on psychological ( $p=0.767$ ) or somatic symptoms ( $p=0.983$ ). Moreover, work schedules were not significantly connected with psychological ( $p=0.431$ ) or somatic symptoms ( $p=0.905$ ).

There were some significant interaction effects between working time dimensions on psychological and somatic symptoms. Work schedules moderated significantly ( $p=0.039$ ) the connection of time pressure on psychological symptoms. For those with an unsocial working schedule (with or without night work), the relationship between time pressure and psychological symptoms was linear and positive.

The interaction between working hours and working time control ( $p=0.044$ ) indicated that working time control increased psychological symptoms when the working hours were long (Figure 2). Thus, among those working long hours, more psychological symptoms were observed in employees with the highest level of working time control, whereas those with low levels of working time control had the fewest symptoms. In the case of normal working hours, the working time control did not have any influence.

Working pace control buffered significantly ( $p=0.008$ ) the detrimental association between time pressures and somatic symptoms (Figure 3). Employees with high levels of both time pressure and working pace control had fewer somatic symptoms compared with those who also had high time pressure but could not control the pace.

Figure 4 presents the significant ( $p=0.024$ ) interaction between working time control and working pace control on psychological symptoms. A similar interaction effect ( $p=0.026$ ) was associated with somatic symptoms. Contrary to the previous figures, the scales are in the opposite direction (decreasing) to improve the interpretation of the results. The interaction indicates that the working pace control was more negatively connected to symptoms when the employee had more working time control. Contrarily, for employees with the lowest levels of working pace control, the working time control was even positively associated with symptoms.

Some covariates were connected with psychological and somatic symptoms. Women had significantly more psychological ( $b=0.08$ ) and somatic symptoms ( $b=0.10$ ) than men. Single parents with dependent children ( $b=0.09$ ) and those without a spouse and dependent children ( $b=0.05$ ) experienced more psychological symptoms than those living with a spouse and children. In addition, employees experienced more psychological symptoms compared to those who are in a supervisory position or managers. Furthermore, those with high education ( $b=-0.04$ ) had fewer somatic symptoms compared to those with basic education. However, survey year, age, education level, employment duration, contract or sector did not have an effect on psychological or somatic symptoms.

## DISCUSSION

The results of the study suggest that several working time dimensions are connected with employee's psychological and somatic symptoms (R1) and some working time dimensions have curvilinear relationships with the symptoms (R2). The effects of working hours and time pressure were curvilinear, while the connections of working time control and working pace control were linear. Furthermore, there were curvilinear interaction effects between working time dimensions and symptoms (R3).

The working hours had a U-shaped relationship with psychological and somatic symptoms, meaning that both short and long working weeks were connected with increased symptoms. This outcome supports the previous literature that has connected long working hours with stress, sleep problems, tiredness, anxiety, depression, health concerns and poor work-family balance[4–7]. It is easy to understand that a long working week causes strain on employees, leading to stress and psychosomatic symptoms, but the effect of short working hours is probably caused by different mechanisms, such as economical insecurity or overall job insecurity, which has been connected with psychosomatic symptoms and general ill-

health[36]. Previous studies have often investigated working hours only by separating a long week from the rest. Thus, short working hours have been implicitly paralleled with normal length work hours, which, based on this study, might have even distorted the results of the studies.

The association of time pressure on psychological and somatic symptoms was dualistic. In general, time pressure was positively connected with symptoms, supporting a previous study[11]. The connection was relatively stronger regarding psychological symptoms. In the case of low and moderate time pressure, the connection with psychosomatic symptoms, contrary to Warr's vitamin model[29], was positive, but weak. However, after a threshold, the connection was stronger. Therefore, the results highlight the adverse effect of high time pressure on psychosomatic symptoms.

Work schedules showed no significant association with psychological or somatic symptoms when studied simultaneously with other working time dimensions. This outcome was surprising because night work, particularly, has been connected with health problems[16, 17]. However, the interaction analysis revealed that for those working unsocial schedules, lower levels of time pressure increased symptoms also. Insufficient recovery of those with unsocial schedules might make them more sensitive to the intensity of work.

While working pace control was negatively related with psychological and somatic symptoms, the working time control did not have a significant main effect on symptoms, even though it has been previously connected with, for example, fewer long-term sickness absences[17]. The working pace control buffered the adverse effect of time pressure on somatic symptoms, as expected. However, working time control had interaction effects with working hours and working pace control, in which a higher level of working time control was paradoxically associated with a higher level of symptoms. A high level of working time control combined with long working hours was connected with the highest level of

psychological symptoms, while the combination with low working pace control was associated with the highest levels of psychological and somatic symptoms. Those having access to working time control might not use flexibilities or are unable to use them. Furthermore, employees can reciprocate higher autonomy by making more effort, which could explain this working time control paradox. Importantly, working time control was positively correlated ( $r=0.11$ ) with working hours, and it has previously been connected with longer working hours and overtime[37] and higher work intensification[38].

The results of this study suggest that the intensity of working is a more influential predictor of stress and psychosomatic symptoms than a large number of work hours. The study supports, partly, the JDC and JD-R models, as time pressure as a job demand was positively connected with psychological and somatic symptoms. In addition, long working hours were connected with symptoms. Working pace control can be defined as a job resource, and it had a negative connection with psychosomatic symptoms, as expected. Furthermore, the buffering effect of working pace control can be interpreted through the JDC and JD-R models. However, the effects of working time control and work schedules did not follow the assumption of the models.

This study has several strengths as it is one of the first to show that working time dimensions have curvilinear relationships with employee health. In addition, the working time dimensions were studied simultaneously, which has not been typical in previous studies. A large and representative sample was analysed using an advanced statistical methodology.

Despite the strengths of the study it has limitations. First, the analysis is based on cross-sectional data, which prevents causal inference. Nonetheless, it is unlikely that those who already suffer from psychosomatic symptoms seek a job that has unsocial working schedules, high time pressure or where there are only poor possibilities to control working time or pace. The reverse causality might however explain the positive relationship of short

working hours on psychosomatic symptoms, as those with poor health might only be able to work part-time. Future studies should utilise a longitudinal design to confirm the findings. Second, even though the sample was large, there was still only a low amount of variation regarding specially working hours, which left the results concerning short and long working weeks relatively uncertain. It would be fruitful to study working hours within the industries where short and long working weeks are typical. This study could inspire future research to examine the possible curvilinear effects of working time dimensions with the broader spectre of health and organisational outcomes.

As diverse and irregular working time patterns become increasingly common, the organizations should pay attention to the different dimensions of working time and their dynamics, which could be complex and have curvilinear relationships with health outcomes. Especially, the results of the study suggest that high time pressure has strong adverse effect on psychosomatic symptoms and that working over 60 hours per week can be damaging to the health as well. Organisations should ensure that work intensity stays tolerable and employees have sufficient time to rest and balance work with other life domains. Workplace practices, policies and interventions that reduces for example high workload and tight deadlines should be implemented. In addition, study found working pace control to be important, as it buffers against psychosomatic symptoms. Human resource practices can be developed to increase possibilities to control pace of work. The reduction of psychosomatic symptoms is beneficial besides the employees also for the organisations and the whole society, as psychosomatic symptoms reduce work ability and have substantial economic cost[39].



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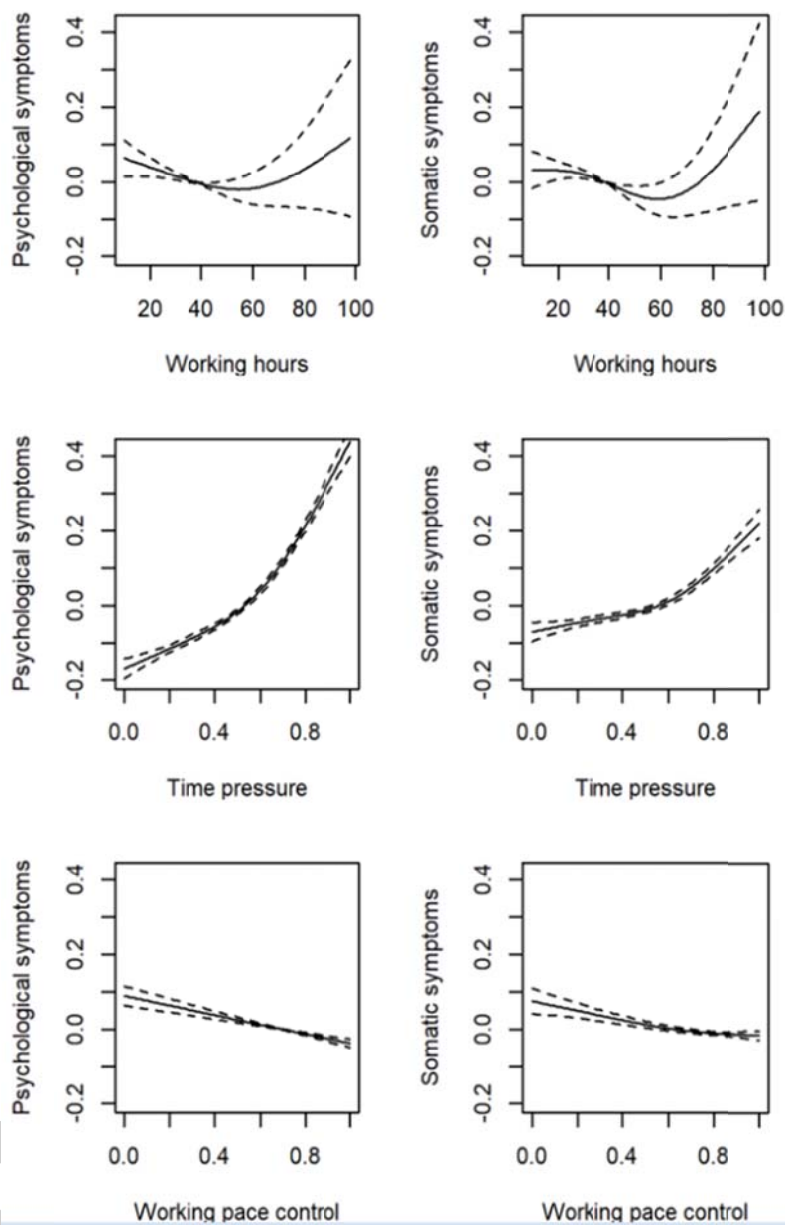
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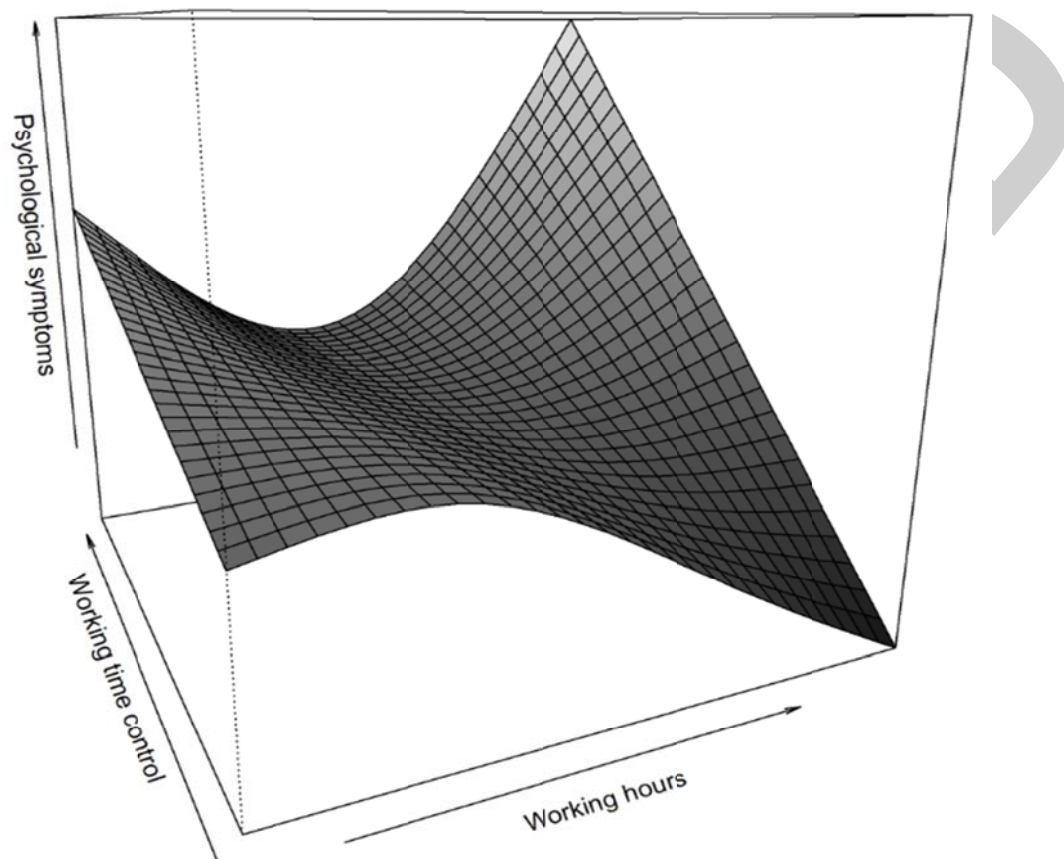
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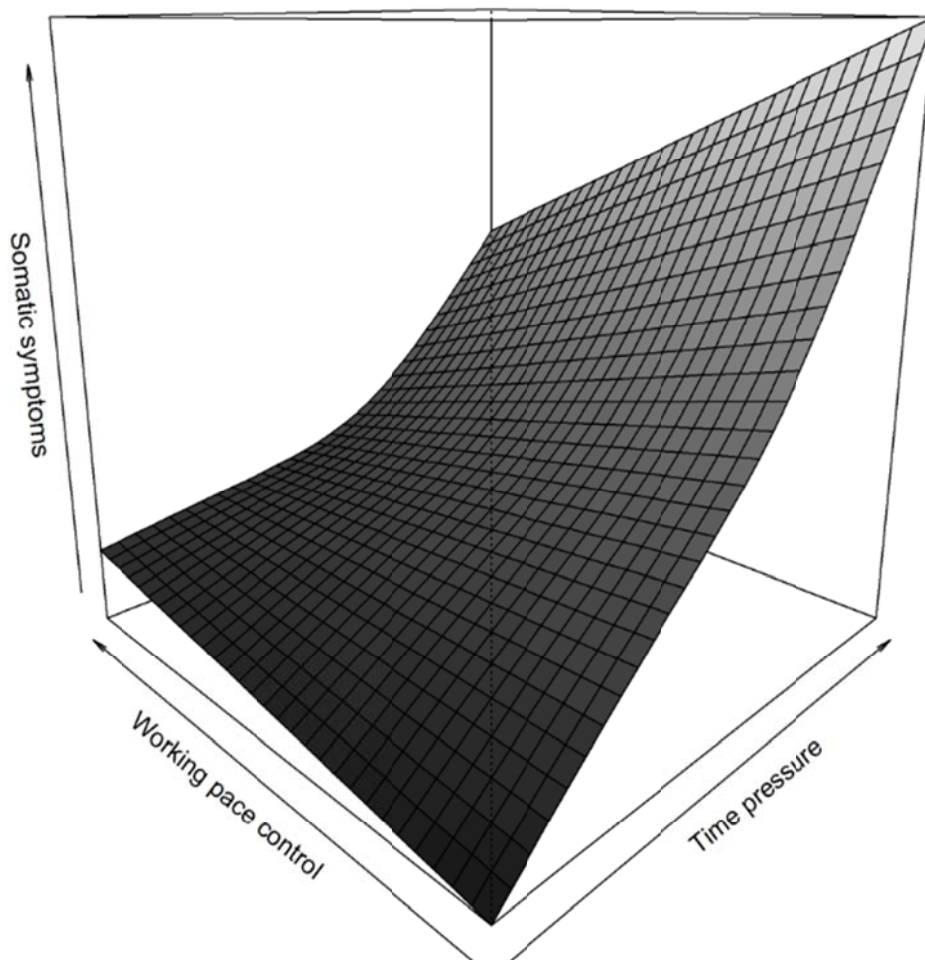
**Figure 1.** Statistically significant main effects of working time dimensions on psychological and somatic symptoms. Dashed lines represent the 95% confidence intervals.



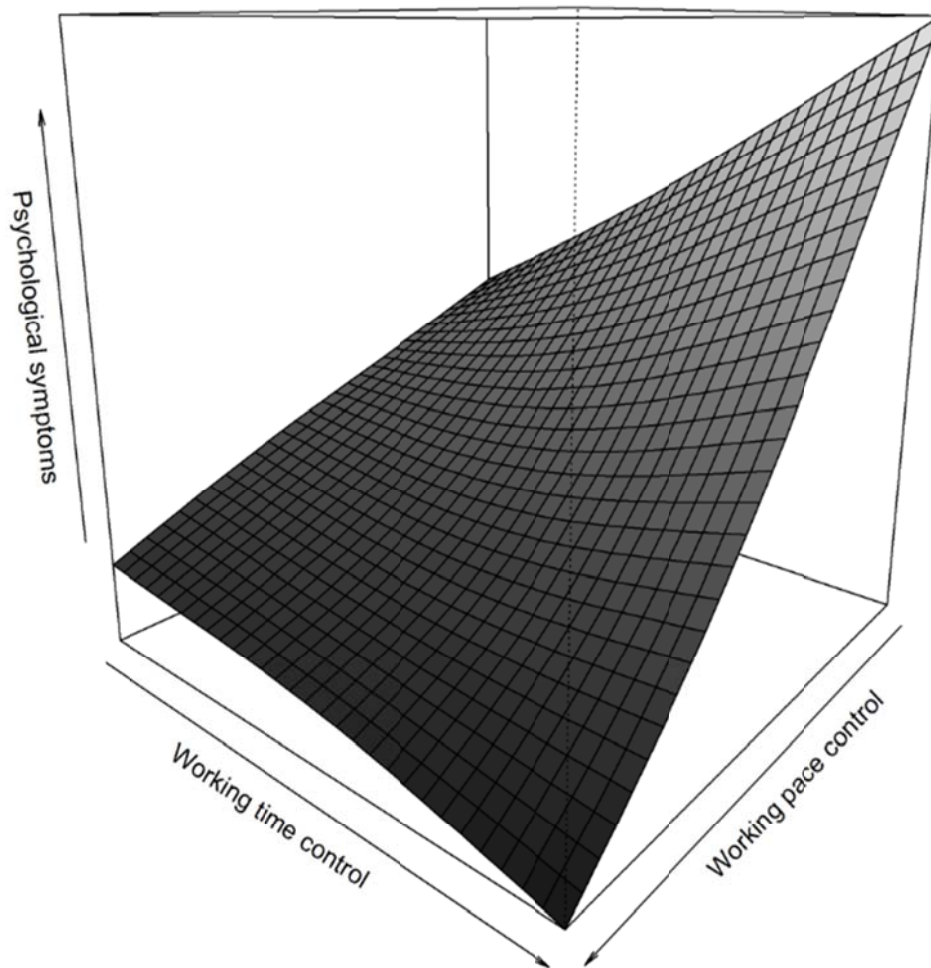
**Figure 2.** The interaction between working hours and working time control on psychological symptoms



**Figure 3.** The interaction between time pressure and working pace control on somatic symptoms



**Figure 4.** The interaction between working pace and working time control on psychological symptoms.





**Table 1.** Descriptive statistics of the covariates variables.

	Range	% / Mean (SD)
Survey year: 2003	0/1	30.7%
Survey year: 2008	0/1	32.5%
Survey year: 2013	0/1	36.8%
Age	17–65	44.11 (11.06)
Male	0/1	47.3%
Female	0/1	52.7%
Basic education	0/1	13.3%
Secondary education	0/1	42.7%
High education	0/1	44.0%
Living with a spouse and dependent children	0/1	36.6%
Living with a spouse without dependent children	0/1	39.4%
Living without a spouse, but with dependent children	0/1	4.0%
Living without a spouse and dependent children	0/1	20.0%
Duration of employment	1–50	12.18 (10.3)
Manager	0/1	6.3%
Specialist	0/1	23.0%
Expert	0/1	19.1%
Employee	0/1	51.6%
Supervisory position	0/1	40.2%
No supervisory position	0/1	59.8%
Fixed contract	0/1	93.8%
Temporary contract	0/1	6.2%
Public sector	0/1	38.1%
Private sector	0/1	61.9%

Note. Range indicates the minimum and maximum response options, but for age and duration of employment the range represent minimum and maximum observed values.

SD = standard deviation.

**Table 2.** Descriptive statistics and correlations of the main variables.

	Range	Mean (SD)	1	2	3	4	5	6
1. Psychological symptoms	1–6	1.69 (0.72)	-					
2. Somatic symptoms	1–6	1.43 (0.56)	0.51 ***	-				
3. Working hours	10–98	37.67 (6.54)	-0.01	-0.04 ***	-			
4. Time pressure	0–1	0.46 (0.24)	0.32 ***	0.15 ***	0.14 ***	-		
5. Working time control	0–1	0.61 (0.29)	-0.07 ***	-0.08 ***	0.11 ***	-0.01	-	
6. Working pace control	0–1	0.70 (0.25)	-0.23 ***	-0.15 ***	0.04 ***	-0.39 ***	0.38 ***	-
7. Daytime job	0/1	0.69 (0.46)	-0.04 ***	-0.04 ***	0.06 ***	0.03 **	0.35 ***	0.16 ***
8. Unsocial work schedule without night work	0/1	0.11 (0.31)	0.03 **	0.03 ***	-0.10 ***	-0.06 ***	-0.20 ***	-0.07 ***
9. Unsocial work schedule with night work	0/1	0.10 (0.30)	0.01	0.02	-0.04 ***	-0.04 ***	-0.31 ***	-0.13 ***
10. Other work time	0/1	0.10 (0.30)	0.02 **	0.01	0.05 ***	0.06 ***	-0.02 *	-0.05 ***

Note. Range indicates the minimum and maximum response options, but for working hours the range represent minimum and maximum observed values.

SD = standard deviation.

\*\*\*  $p < 0.001$ ; \*\*  $p < 0.010$ ; \*  $p < 0.050$ .