Original article

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Can favorable psychosocial work conditions and high work dedication protect against the occurrence of work-related musculoskeletal disorders?

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Objectives This study investigated whether work dedication and job resources are longitudinally related to work-related musculoskeletal disorders and whether job resources buffer the impact of job demands on these disorders?

Methods Data were used from a longitudinal three-phase study (2004, 2005, 2006) on health at work among a sample of Dutch workers. The first survey was sent in 2004 by e-mail to 3100 members of an existing panel. For the analyses, 1522 participants were included with full longitudinal data. The analyses were performed using an autoregressive model with generalized estimating equations.

Results The job-resource quality of communication was found to predict the risk of work-related musculoskeletal disorders over time. This effect was not mediated by work dedication. A high quality of communication was also found to buffer the negative effects of a high physical workload on the risk of work-related musculoskeletal disorders. Furthermore, a low level of social support by colleagues was found to buffer the negative effect of a medium physical workload on work-related musculoskeletal disorders.

Conclusions This study shows that job resources are not only important for promoting work dedication, but may also moderate the negative impact of high job demands on the risk of work-related musculoskeletal disorders. With respect to social support, the question is raised of whether this can also work negatively. The results of this study imply that, besides avoiding or reducing risks to health in the workplace and lowering job demands, strengthening job resources may additionally buffer harmful effects of job demands on musculoskeletal health.

Key terms health outcome; job resource; longitudinal study.

The search for ways to deter the development of work-related musculoskeletal symptoms or disorders is ongoing. It is now widely accepted that work-related musculoskeletal disorders are multifactorial in nature. In addition to the well-known physical risk factors, psychosocial aspects also play a role in their onset and exacerbation (1, 2). The concept "psychosocial" has encompassed variables such as worker perceptions about the job and the work setting (eg, job satisfaction, coworker and supervisory support) and personal characteristics of the worker (2). With the recognition that psychosocial factors may affect work-related musculoskeletal disorders, it became clear that preventive efforts should also be aimed at the psychosocial work environment. However, although several authors have suggested possible causal pathways from psychosocial factors to (work-related) musculoskeletal disorders (1, 2) and a substantial body of knowledge is available on other risk factors for these disorders, effective prevention has proved to be difficult (3).

Prevention efforts have focused on both minimizing the impact of risk factors and investing in good physical health, such as physical fitness training and lifestyle interventions. However, given the suggested effects of psychosocial factors, investments in a positive psychological state (well-being), such as improving job resources, may also prevent these disorders from occurring. In our present study, the relationship between psychosocial factors in the work environment and work-related musculoskeletal disorders was investigated.

Previous research has suggested separate and interacting pathways through which biomechanical and psychosocial strain and workstyle may contribute to the etiology of work-related musculoskeletal disorders (1, 2, 4). These pathways assume that psychosocial risk factors affect these disorders through job strain (1, 2).

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Job strain is hypothesized to have an impact on these disorders through, for instance, an increase in muscle tension, which may combine with existing sources of biomechanical strain, or through alterations in bodily systems that condition tissue injury and repair, like the endocrine and neurological systems (2, 4). Stress responses may also provoke responses that increase muscle co-activation and thus increase loading of the musculoskeletal system (4). Another hypothesis is that stress responses lead to a different appraisal of the work situation and of musculoskeletal symptoms (4). These and other potential pathways through which psychosocial factors may cause work-related musculoskeletal disorders have previously been described by Bongers et al (1, 4) and Faucett (2).

Many theoretical models in occupational health start from the premise that job strain is the result of an imbalance between the demands workers are exposed to and the control they have at their disposal (7) [eg, the well-known demand–control model by Karasek (5) and the demand–control–support model by Johnson & Hall (6)]. In addition to control and support, other job resources were introduced by Demerouti et al (8) with the job demands–resources model. At first, the job demands–resources model only considered the explanation of burnout, but it was soon extended to include a motivational axis and the concept of work engagement as the antipode of burnout (9). The important role of job demands, job control, and social support in determining work-related psychological health and work engagement was consistently supported by empirical studies (10).

The evidence regarding the relationship between job demands, job resources, and physical health outcomes is, however, inconclusive. In 2001, The National Research Council evaluated the scientific basis for a relationship between work factors and work-related musculoskeletal disorders (3). With regard to low-back pain, it concluded that there is solid evidence that psychosocial factors are important determinants. Strong evidence was found for six risk factors, including low job satisfaction, monotonous work, poor social support at work, high perceived stress, high perceived job demands, and perceived ability to return to work (3). Moderate evidence was found for job control, an emotionally demanding job, and the perception that the work could be dangerous for the back (3). With regard to upper-extremity disorders, the evidence is weaker. Reviews by Bongers et al (1, 4), for instance, concluded that the evidence that high job demands, poor control, and poor social support are associated with upper-extremity problems is weak. The National Research Council has also come to this conclusion. Most of the studies in its review did not report a significant effect for decision latitude and work-related social support, or nonwork-related social support (3). High job stress and high job demands however did seem to be related with the occurrence of symptoms and disorders in the upper extremities (3). However, since most of the studies were of a cross-sectional nature, the evidence remains inconclusive. A review by Ariëns et al (11) concluded that there is evidence that high job demands, poor control, and poor social support are related to neck pain.

In conclusion, the epidemiologic evidence provides some support for associations between psychosocial factors and work-related musculoskeletal disorders. In our current study, we investigate two possible mechanisms that relate job resources to work-related musculoskeletal disorders.

Our first research question is whether work dedication and job resources are longitudinally related to work-related musculoskeletal disorders. This question is based on the job demands–resources model (8), which posits that job resources may lead to positive health outcomes and fewer health complaints through a process of "motivation". The availability of resources is assumed to lead to work engagement and subsequently to positive work attitudes and better health (12). Job resources may play either an intrinsic motivational role, because they foster people's growth, learning, and development [compare with the job characteristics model of Hackman & Oldham (13)], or they may play an extrinsic motivational role through the achievement of work goals (12) [compare with the effort–recovery model by Meijman & Mulder (14)]. The outcome of both is positive, and engagement is likely to occur (12). Engagement is a positive and fulfilling state, characterized by high energy levels (vigor), absorption, and work dedication. It can be hypothesized that this positive state has a protective effect on the risk of work-related musculoskeletal disorders since highly engaged workers experience lower levels of job strain.

The second research question was based on the buffering hypothesis underlying the demand–control–support (6) and job demands–resources (8) models, which state that social support (demand–control–support model) and other resources (job demands–resources model) can moderate the negative impact of high strain on well-being (6, 8, 15). Job demands are the physical, psychological, social, or organizational aspects of a job that require sustained physical or psychological effort and are therefore associated with certain physiological or psychological costs (9). Several different job resources can buffer several different job demands (16). On the basis of this balancing principle, we hypothesized that psychosocial job resources like decision latitude, the support of coworkers and supervisors, and worker input may buffer the effect of high job demands on the risk of work-related musculoskeletal disorders. They may, for instance, prevent an increase in the frequency and duration of exposure because they enable workers to prioritize tasks, or they involve coworkers or supervisors in busy times. The second research question was, therefore, do job resources buffer the impact of job demands on work-related musculoskeletal disorders?

In addition to the well-known resources social support and decision latitude, the literature cites many other job resources that can influence work engagement and positive health outcomes, for instance, communication, feedback, pay, career opportunities, and participation in the decision-making processes (8, 9, 15). The presence of the job resources "job control" and "good-organization-based self-esteem" was prospectively found to predict work engagement in a study by Mauno et al (17). In this study, the following job resources were considered: decision latitude, supervisory support, social support by colleagues, and the quality of the communication in the company.

Study population and methods

Study population

The Study on Health at Work is a longitudinal three-phase study of a representative sample of Dutch workers (18). The data were gathered through an internet panel of a market research organization in the Netherlands. The measurements took place in 2004, 2005, and 2006 by means of electronic questionnaires. The first survey was sent in 2004 by e-mail to 3100 members of an existing panel. A total of 2502 replies were received—a response of 81%. These 2502 participants were approached again by e-mail in May 2005 and in May 2006 for the second and the third measurements. At the time of the second measurement, 1934 participants responded (77%), and, at the third, 1921 participants responded (77%). The participants who reported conflicting demographic variables (gender, age, length) at the different measurements and those whose demographic variables differed from those in the files of the market research organization were deleted from the data file. In the resulting data file, there were 1522 participants with full longitudinal data.

To assess whether there was a selective response, the distribution of the gender, age, educational qualifications, and income of the nonrespondents after the 2004 and 2005 measurements were compared with that of the respondents with full longitudinal data. This analysis showed a slight selectivity in the full sample. In the full sample, a slight overrepresentation was found for middle-aged workers (41–45 years and 51–55 years) and a slight underrepresentation was found for workers 56 years of age and older. The underrepresentation seems related to the fact that those who turned 65 during the period of study, or those who obtained early retirement, were no longer considered to belong to our target population of workers. Within the group of dropouts, we further observed a small overrepresentation of the youngest group (younger than 20 years) and an underrepresentation of those with higher vocational qualifications. Although these selection effects of age and educational qualifications were significant, we did not find selectivity with regard to income. Nor did we find selectivity in the full sample with regard to gender. For more information on the dropout analyses, the reader is referred to the report of Ybema et al (18, page 18–19, available in English on request).

Measures

Musculoskeletal complaints were measured with the Dutch Musculoskeletal Questionnaire (an adapted version of the Nordic questionnaire) (19). The workers were asked to rate the occurrence of pain or discomfort in the neck, shoulders, elbows, wrists, hands, and back in the previous 12 months on a 5-point scale. The range of the scale was 1 (never), 2 (once only, but of a short duration), 3 (once only, of a long duration), 4 (more than once, but always of a short duration), and 5 (frequently and prolonged).

The workers were identified as cases if they reported regular or prolonged pain in these regions during the previous 12 months. After the question on the presence of musculoskeletal disorders, work-relatedness was inquired about in the following question: "Were the above complaint(s) related to your work?" The respondents could answer (i) not applicable (no complaints), (ii) had complaints, but not work-related, or (iii) complaints were partly or completely caused by work. Cases in which the complaints were not work-related were dropped from the data file.

Work engagement is a concept that refers to a positive, fulfilling work-related state of mind that is characterized by vigor, dedication, and absorption (9). In our study, due to practical reasons, only the dedication subscale was measured. Work dedication is defined as "a strong involvement in one's work, accompanied by feelings of enthusiasm and significance, and by a sense of pride and inspiration" (20). This subscale highly correlates with the other two subscales (21). Four items of the engagement scale of Schaufeli, et al (22) were used. Sample items are "My job inspires me" and "I am proud of the work that I do". The items were measured on a 5-point scale ranging from 1 (never) to 5 (always). The reliability of the scale was found to be high, with a Cronbach's alpha of 0.91 (2004 measurement), 0.91 (2005 measurement), and 0.93 (2006 measurement). For our current analyses, a dichotomous variable was created, denoting "high versus very high work dedication". The cut-off point was determined in a similar manner as with the Utrecht Work Engagement Scale (21), at the 75th percentile score.

The following job resources were measured: decision latitude, coworker support, supervisory support, and communication.

Decision latitude refers in the extent to which someone is able to control the organization of his or her work, as well as his or her workpace, and it was measured with a scale by Karasek (23). A sample item is "Do you determine the order in which you carry out your tasks?" The respondents were asked to rate their decision latitude on a 4-point scale ranging from 1 (never) to 4 (always). This scale was found to have the following reliabilities (Cronbach's α): 0.81 (2004 measurement), 0.83 (2005 measurement), and 0.82 (2006 measurement). Using the 25th and the 75th percentile scores, three levels of decision latitude (low, medium and high) are distinguished.

Coworker support and supervisory support were also measured with scales adapted from Karasek (23). Sample items are "My co-workers usually help me to get through the work", and "My boss usually pays attention to what I say." A 5-point rating scale was used, ranging from 1 (totally disagree) to 5 (totally agree). The coworker support scale was found to have a reliability (Cronbach's α) of 0.82, 0.84, and 0.82 for the first, second, and third measurements, respectively. For supervisory support, the corresponding Cronbach α values were 0.89, 0.89, and 0.90 in 2004, 2005, and 2006, respectively. With the use of the 25th and the 75th percentile scores, the following three levels of coworker and supervisory support were distinguished: low, medium, and high.

The quality of communication was measured with a self-constructed scale comprised of 7 items. Sample items are "I am well informed about plans and developments in my team/department" and "I have enough opportunities to pass on my ideas to management." A 5-point rating scale was used, ranging from 1 (very dissatisfied) to 5 (very satisfied). With the use of the 25th and the 75th percentile scores, the following three levels of communication were distinguished: low, medium, and high.

The following measured job demands were included: heavy physical work, computer work, quantitative job demands, and emotional job demands. Heavy physical work was measured with a self-constructed 3-item scale on lifting, carrying, and pushing. A sample item is "Could you indicate if and how long you have to . . . (on a normal workday), carry loads of more than 5 kilograms?" A 5-point response scale was used, ranging from 1 (never) to 5 (6–8 hours a day). The Cronbach's α values were 0.75, 0.77, and 0.75 for 2004, 2005, and 2006, respectively. With the use of the 25th and the 75th percentile scores, the following three levels of physical work were distinguished: low, medium, and high.

Computer or static work was measured with two items (24). The first was "On a normal workday, do you work with a computer?" A 5-point response scale was used, ranging from 1 (never), to 5 (6–8 hours a day). The second item in this scale regarded the amount of time spent in the same work posture. The Cronbach's α values were 0.68, 0.68, and 0.64 for 2004, 2005, and 2006, respectively.

Quantitative job demands were measured with a self-constructed 4-item scale. A sample item was "Do you have to get through a lot of work?" The 4-point response scale ranged from 1 (never) to 4 (always). The Cronbach's α values were 0.78, 0.77, and 0.78 for 2004, 2005, and 2006, respectively. With the use of the 25th and the 75th percentile scores, the following three levels of quantitative job demands were distinguished: low, medium, and high.

Emotional job demands were measured with a 3-item scale from the Copenhagen Psychological Questionnaire (25). A sample item is "Does your work put you through emotionally difficult situations?" The responses were scored on a 4-point scale ranging from 1 (never) to 4 (always). The Cronbach's α values were 0.77, 0.80, and 0.82 for 2004, 2005, and 2006, respectively. Using the 25th and the 75th percentile scores, the following three levels of emotional job demands were distinguished: low, medium, and high.

Other explanatory variables that were used in the analyses were age, gender, and occupation. Occupation was measured in the following categories: (i) trade and industry, (ii) commerce, (iii) service, (iv) health and social work, (v) teaching, (vi) technicology, (vii) management, and (viii) other (including agriculture and transport).

Statistical analyses

In order to study the relationships of work-related musculoskeletal disorders with dedication, job resources, and other predictors, we used generalized estimating equations (GEE). GEE analyses are used to adjust for the within-subject correlations arising from repeated measurements within each subject (26). An exchangeable correlation structure was chosen.

In GEE analyses, basically, the regression coefficient for a particular predictor variable relates the vector of outcomes over time to the vector of the predictor variable over time. The analysis includes a pooled analysis of longitudinal and cross-sectional relationships (ie, it combines a within-subject relationship with a between-subject relationship) and results in a single odds ratio. A GEE model with a time lag and an autoregression component was used (27, 28). The model included the independent variables at t-1 (1 year prior to the outcome) and was used to study the temporal sequence of the relationship. In addition, as we expected that the risk of work-related musculoskeletal disorders at each time point would be primarily influenced by the experience of work-related musculoskeletal disorders in the past, in the model, we also included a measure of the outcome at t-1 (1 year earlier). This is another way to "remove" the cross-sectional part of the relationships (26). All of the models included dummies for time.

For our second hypothesis, the simple effects of job demands were assessed at the different levels of job resources. The interaction terms were constructed using reverse Helmert coding for job demands (which compares each level of a categorical variable to the mean of the previous levels) and simple coding for job resources.

Table 1. Baseline characteristics of the study population (N=1522). (SE = standard error)

Characteristic	N	%	Mean	SE
Gender				
Male	865	56.8	.	.
Female	657	43.2	.	.
Age			39.1	0.27
Industry				
Manufacturing industries	282	18.5	.	.
Construction and agriculture	79	5.2	.	.
Trade, hotel and catering	267	17.5	.	.
Transport and communication	80	5.3	.	.
Financial and business services	245	16.1	.	.
Government and education	252	16.6	.	.
Health care and other services	317	20.8	.	.
Occupation				
Industrial and craft	145	9.5	.	.
Administrative	210	13.8	.	.
Commercial	182	12.0	.	.
Service providers	136	8.9	.	.
Health services and health care worker	176	11.6	.	.
Teachers	92	6.0	.	.
Specialists	203	13.3	.	.
Managers and professionals	147	9.7	.	.
Other (including agricultural and transport)	231	15.2	.	.
Educational qualifications				
No education or primary education	48	3.2	.	.
Lower vocational education	222	14.6	.	.
Intermediate vocational education	387	25.4	.	.
Higher general secondary or preuniversity education	230	15.1	.	.
Higher vocational education	461	30.3	.	.
(post) Academic education	174	11.4	.	.
Job demands				
Computer work				
Never	339	22.3	.	.
1–2 hours	308	20.2	.	.
2–4 hours	243	16.0	.	.
4–6 hours	318	20.9	.	.
6–8 hours	314	20.6	.	.
Physical workload (5-point scale)	.	.	1.7	0.02
Quantitative job demands (4-point scale)	.	.	2.4	0.02
Emotional workload (4-point scale)	.	.	1.7	0.02
Job resources				
Decision latitude (4-point scale)	.	.	3.0	0.02
Supervisory support (5-point scale)	.	.	3.4	0.02
Social support of colleagues (5-point scale)	.	.	4.0	0.02
Quality of communication (5-point scale)	.	.	3.4	0.02

Results

The baseline characteristics of the study population are presented in table 1. The yearly prevalence of work-related musculoskeletal symptoms in the study population is given in table 2. Of all the work-related musculoskeletal disorders, back pain was the most prevalent complaint; per year, an average of 10% of the workers reported regular or prolonged back pain. The second most prevalent condition was shoulder pain (average prevalence of 8.7%).

Do job resources and work dedication predict the risk of work-related musculoskeletal disorders?

We tested whether job resources were longitudinally related to work-related musculoskeletal disorders, whether work dedication was longitudinally related to such disorders, and whether work dedication was an intermediate variable in the relationship between job resources and such disorders.

To test whether a mediation effect was present, following Baron & Kenny (29), we started with an analysis testing the direct effect of job resources on work-related musculoskeletal disorders. For the first research question, we estimated a crude model and an adjusted model (table 3). The results showed that the risk of work-related musculoskeletal disorders was primarily predicted by the existence of such disorders 1 year earlier. None

Table 2. Prevalence of musculoskeletal symptoms in the study population.

Musculoskeletal complaints [a]	2004		2005		2006	
	N	%	N	%	N	%
Neck	121	8.0	117	7.7	117	7.7
Shoulder	141	9.3	129	8.5	128	8.4
Arm–elbow	96	6.3	89	5.9	93	6.1
Wrist–hand	97	6.4	87	5.7	78	5.1
Back	168	11.0	169	11.1	124	8.2
Total number of cases with a work-related musculoskeletal symptom or disorder	354	23.3	320	21.0	288	18.9

[a] Workers were identified as cases if they reported regular or prolonged pain in the neck, shoulders, arms–elbows, wrists–hands, or back (see also the Methods section) and reported that these complaints were partially or totally caused by their work.

Table 3. Results of the autoregressive GEE (generalized estimating equation) models for the longitudinal relation between job resources and work-related musculoskeletal symptoms or disorders (WRMSD).[a] The odds ratios (OR) in bold face are significant (P<0.05). (95% CI = 95% confidence interval)

	Crude				Adjusted OR [b]	95% CI
	Resources adjusted for each other		Resources not adjusted for each other			
	OR	95% CI	OR	95% CI		
WRMSD (t-1)	**11.67**	**9.49–14.33**	[c]	·	**10.52**	**8.50–13.02**
Job resources						
Decision latitude						
Low	1.00	·	1.00	·	1.00	·
Medium	0.87	0.69–1.10	0.84	0.66–1.07	0.96	0.74–1.24
High	0.83	0.62–1.10	0.77	0.58–1.01	0.87	0.65–1.18
Supervisory support						
Low	1.00	·	1.00	·	1.00	·
Medium	1.03	0.78–1.36	0.97	0.75–1.26	1.09	0.82–1.44
High	0.94	0.71–1.24	0.84	0.66–1.06	0.98	0.73–1.31
Coworker support						
Low	1.00	·	1.00	·	1.00	·
Medium	1.19	0.93–1.52	1.12	0.88–1.42	1.19	0.93–1.52
High	1.09	0.83–1.44	0.97	0.75–1.25	1.08	0.81–1.43
Quality of communication						
Low	1.00	·	1.00	·	1.00	·
Medium	0.89	0.69–1.15	0.89	0.70–1.12	0.93	0.71–1.21
High	0.78	0.58–1.07	**0.75**	**0.59–0.96**	0.81	0.59–1.11

[a] All of the models included dummies for time.
[b] Adjusted for age, gender, occupation, physical job demands, quantitative job demands, and emotional job demand.
[c] Was included in all of the models.

of the job resources under study were found to predict the risk of work-related musculoskeletal disorders over time. As the job resources were correlated, we also estimated their effect separately (not adjusted for each other). These analyses showed that the workers who reported a high quality of communication in their company had a 25% lower risk of developing work-related musculoskeletal disorders than the workers who reported low levels.

The estimation results of the models predicting dedication are presented in table 4. As expected, high levels (compared with low levels) of several job resources were positively related to dedication. Workers who reported high levels of decision latitude and coworker support and medium and high levels for the quality of communication in the company had a significantly higher probability of becoming highly dedicated to their work, in comparison with those who reported low decision latitude, low coworker support, and low levels of communication quality.

In separate models, we assessed the effect of high work dedication on the risk of work-related musculoskeletal disorders. High work dedication did not significantly predict the risk of such disorders (see table 5).

Table 4. Results of the simple, time-lag, and autoregressive GEE (generalized estimating equation) models for the longitudinal relation between job resources and work dedication.[a] The odds ratios (OR) in bold face are significant (P<0.05). (95% CI = 95% confidence interval)

	Crude				Adjusted OR [b]	95% CI
	Resources adjusted for each other		Resources not adjusted for each other			
	OR	95% CI	OR	95% CI		
Dedication (t-1)	**15.6**	**12.7–19.1**	[c]	·	**13.84**	**11.25–17.02**
Job resources						
Decision latitude						
Low	1.00	·	1.00	·	1.00	·
Medium	1.10	0.85–1.41	1.14	0.89–1.46	1.11	0.85–1.45
High	1.53	1.18–2.00	**1.69**	**1.30–2.19**	**1.61**	**1.21–2.15**
Supervisory support						
Low	1.00	·	1.00	·	1.00	·
Medium	0.73	0.54–0.99	0.88	0.67–1.17	0.73	0.54–0.98
High	0.86	0.64–1.16	1.23	0.97–1.56	0.86	0.64–1.16
Coworker support						
Low	1.00	·	1.00	·	1.00	·
Medium	1.03	0.80–1.33	1.09	0.86–1.39	1.05	0.82–1.35
High	1.16	0.89–1.52	**1.36**	**1.06–1.74**	1.21	0.93–1.59
Quality of communication						
Low	1.00	·	1.00	·	1.00	·
Medium	**1.35**	**1.25–2.32**	1.27	0.97–1.65	**1.36**	**1.02–1.82**
High	**1.70**	**0.63–0.99**	**1.74**	**1.37–2.21**	**1.69**	**1.23–2.31**

[a] All of the models included dummies for time.
[b] Adjusted for age, gender, occupation, physical job demands, quantitative job demands, and emotional job demands.
[c] Was included in all of the models.

Table 5. Results for the longitudinal relation between work dedication and the occurrence of work-related musculoskeletal symptoms or disorders (WRMSD).[a] The odds ratios (OR) in bold face are significant (P<0.05). (95% CI = 95% confidence interval)

	Crude OR	95% CI	Adjusted OR [b]	95% CI
WRMSD (t-1)	**12.04**	**9.82–14.78**	**10.74**	**8.70–13.27**
Work dedication				
Low–medium	1.00	·	1.00	·
High	0.83	0.67–1.03	0.83	0.67–1.04

[a] All of the models included dummies for time.
[b] Adjusted for age, gender, occupation, physical job demands, quantitative job demands, and emotional job demands.

Work dedication was therefore not found to be an intermediate variable in the relationship between job resources and work-related musculoskeletal disorders.

Do job resources buffer the impact of job demands on work-related musculoskeletal disorders?

To test the second hypothesis, the main effects and interaction effects were estimated for the following job resources: decision latitude, supervisory support, social support from colleagues, and communication on one hand, and physical workload, computer work, emotional workload, and quantitative job demands on the other. In this analysis, reverse Helmert coding was used for job demands, comparing each level with the mean of the previous level(s). The estimation results showed that the workers performing heavy physical work had a 1.39-fold risk of work-related musculoskeletal disorders when compared with workers with medium and low levels of physical work (table 6). The workers performing >6 hours of computer work had a 1.34-fold risk of work-related musculoskeletal disorders when compared with those performing <6 hours of computer work.

In subsequent interaction analyses, we investigated whether the effect of physical workload and computer work on work-related musculoskeletal disorders was dependent on different levels of job resources. First, the interaction terms (as it concerns two ordinal variables with three levels each: 3 × 2 interaction terms) were included in the model, and it was determined whether the inclusion of the interaction terms improved the fit. This was only the case for the interactions between physical workload and social support from colleagues and those between physical workload and the quality of communication. For these calculations, the estimated probabilities of work-related musculoskeletal disorders have been plotted in figures 1 and 2.

Figure 1 shows the interaction between physical job demands and the quality of communication in the company. This figure shows that, in the case of a low physical workload, the workers who experienced a high quality of communication ran a significantly lower risk of work-related musculoskeletal disorders than the workers who reported a low or medium quality of communication. Furthermore, in the case of a high physical workload, a low quality of communication seemed to reinforce the negative effect of a high physical workload and lead to a higher risk of work-related musculoskeletal disorders.

Figure 2 shows the interaction between the physical job demands and perceived social support from colleagues. The effect of physical workload on the risk of work-related musculoskeletal disorders differed for different levels of social support from colleagues. Somewhat surprisingly, figure 2 shows that low levels of social support from colleagues buffered the negative effect of a medium physical workload (when compared with the effect of a low physical workload) on the risk of work-related musculoskeletal disorders. When the workload increased further, the effect of a high physical workload on the risk of such disorders was no longer significantly affected by the levels of social support from colleagues.

Table 6. Results for the longitudinal relation between job demands and the occurrence of work-related musculoskeletal symptoms or disorders (WRMSD).[a] The odds ratios (OR) in bold face are significant (P<0.05). The model was adjusted for job resources. (95% CI = 95% confidence interval)

	OR	95% CI
WRMSD (t-1)	**10.83**	**8.8–13.4**
Job demands		
Physical work load		
Low	1.00	·
Medium versus low	1.09	0.82–1.46
High versus medium + low	**1.39**	**1.11–1.75**
Computer work		
Never	1.00	·
1–2 hours a day versus never	0.96	0.71–1.31
2–4 hours a day versus <2 hours a day	0.91	0.66–1.25
4–6 hours a day versus <4 hours a day	1.07	0.82–1.39
6–8 hours a day versus < 6 hours a day	**1.34**	**1.04–1.73**
Quantitative job demands		
Low	1.00	·
Medium versus low	1.20	0.93–1.55
High versus medium + low	1.16	0.93–1.45
Emotional workload		
Low	1.00	·
Medium versus low	1.06	0.85–1.48
High versus medium + low	1.00	0.85–1.32

[a] All of the models included dummies for time.

Discussion

In this study, we investigated whether favorable psychosocial work conditions and high work dedication protect against the occurrence of work-related musculoskeletal symptoms and disorders. On the basis of theories and existing empirical evidence, we specified two questions regarding the way in which job demands, job resources, and work dedication could be related to work-related musculoskeletal disorders.

The first question concerned the relationship between job resources, work dedication, and work-related musculoskeletal disorders. Only one of the studied resources, the quality of communication within the company, was found to predict the risk of work-related musculoskeletal disorders. Work dedication was not found to predict such disorders over time. Our results show that the risk of work-related musculoskeletal disorders is mainly predicted by the existence of such disorders the previous year (ie, the autoregression coefficient). This result has been previously found in other studies on risk factors for work-related musculoskeletal disorders (30–32). It has been hypothesized that this phenomenon could be related to increased tissue vulnerability, sensitization of the pain system in general, or sustained exposure after the initial symptom period (30, 33, 34). However, the underlying mechanisms are largely unknown, and it seems worthwhile to explore these mechanisms in further research.

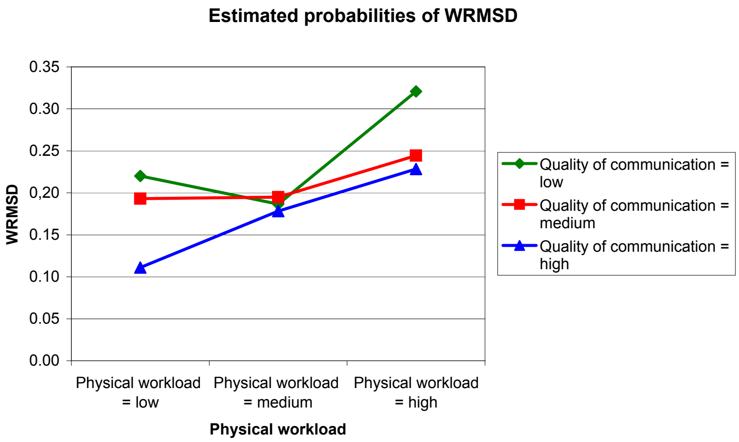

Figure 1. Interaction between physical job demands and the quality of communication in the company. (WRMSD = work-related musculoskeletal disorders)

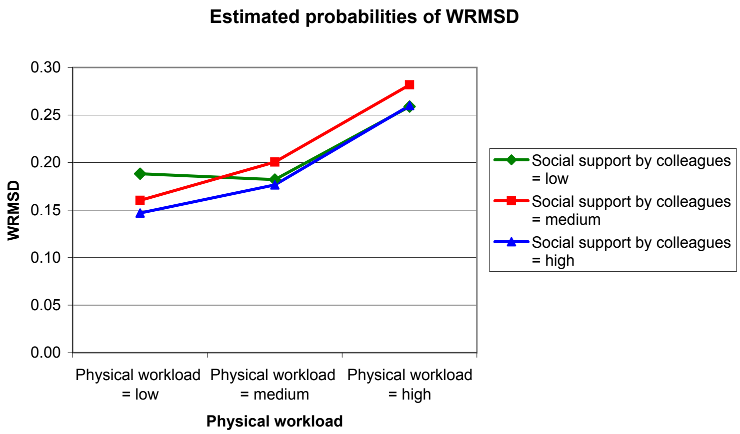

Figure 2. Interaction between physical job demands and social support from colleagues. (WRMSD = work-related musculoskeletal disorders)

In some studies, the autoregressive component (previous complaints) is not included in the estimation models because of the risk of over adjustment. Obviously, the effect of the independent variables is included both in their own right, and they partly determine the autoregressive component (work-related musculoskeletal disorders at t-1). However, as the autoregressive GEE model is considered to be the best approach to separating cross-sectional and longitudinal relationships (compared with a standard GEE model and a time-lag GEE model) and we are interested in the factors that predict the onset of work-related musculoskeletal disorders, we chose to use it.

With respect to job resources, higher levels of the quality of communication were found to be protective against work-related musculoskeletal disorders. This effect was not mediated by work dedication. Therefore, the question is raised of whether this outcome was caused by the way in which we measured the concepts or whether a motivational mechanism other than that supposed in the job demand–resources model is related to these two variables. The first research question was based on the motivational potential of job resources. Cross-links were assumed between work dedication on one hand and job strain and health outcomes on the other (7). We did find that job resources were linked to work dedication, and this finding provides evidence for the existence of a motivational process. This result is in line with the findings of previous studies using the job demand–resources model (8, 10). However, we could not confirm the hypothesis that high work dedication leads to lower levels of job strain and, consequently, to lower risks of work-related musculoskeletal disorders over time. Yet the fact that we did not find a significant longitudinal relationship does not rule out the possibility that there are cross-links between engagement and work-related musculoskeletal disorders. For one, the absence of a significant mediation effect may be related to the fact that we measured only one dimension of work engagement (ie, dedication). It is a limitation of this study that we were only able to measure one dimension of engagement. In addition to work dedication, work engagement is also characterized by vigor and absorption (9, 20). Although, according to confirmatory factor analyses, the work engagement concept, as measured by the Utrecht Work Engagement Scale, seems to have a three-dimensional structure, these three dimensions are closely related (21). Correlations between the three scales usually exceed 0.65 (21). It is, however, theoretically conceivable that the "vigor" dimension is related to musculoskeletal health outcomes. According to Maslach et al (20), vigor refers to “high levels of energy and resilience, the willingness to invest in one’s job, the ability to not be easily fatigued, and persistence in the face of difficulties”. Workers with high levels of positive energy may be less susceptible to work-related musculoskeletal disorders because they experience less job strain. On the other hand, when arousal is too high, for instance, generated by a need for achievement or approval, the situation may increase high-risk behavior (35). High levels of vigor may, therefore, have either a positive or a negative effect on the risk of work-related musculoskeletal disorders. It seems worthwhile to explore this relationship in further research.

This situation brings us to the second question: Do job resources buffer the impact of job demands on work-related musculoskeletal disorders? We found some evidence that supports this possibility. First, we saw that a high quality of communication was found to buffer the negative effects of a high physical workload on the risk of work-related musculoskeletal disorders. It is possible that this effect occurs through the mechanism that is hypothesized in the job demand–resources model, that is, that a high quality of communication alleviates the strain caused by high physical job demands. However, we cannot draw firm conclusions on the basis of this result alone. Further research is necessary. The other interaction effect that was found, between social support and physical workload, although small, raises the question of whether social support by colleagues can also work in a negative way. After all, we saw that some situations with little social support can lead to better outcomes. The possibility that this effect was caused by other occupational factors was considered by additionally adjusting for occupation (results not reported), but the results did not change. This finding raises the question of whether social support may, for instance, in some cases facilitate symptom reporting.

Previously, buffering effects of job resources were found for the risk of burnout (16). According to the job demand–resources model, many different types of job demands and job resources may interact to predict job strain (7) and health outcomes. Social support is the most well-known situational variable that has been proposed as a potential buffer against job strain (7). The results of our study, however, indicate the merit of further research into potentially negative influences of social support as well.

The second research question was based on the job demand–resources model. This model states that, under demanding conditions, the maintenance of performance stability leads to a depletion of energy. In line with the model, we hypothesized that the presence of such job resources as social support or possibilities for worker input may buffer this energy depletion process and diminish the risk of work-related musculoskeletal disorders. By analyzing all possible interactions, we implicitly assumed that the presence of job resources in general is at least as important as their relevance in a specific situation. There are, however, authors who state that workers will preferably use functional, matching, job resources to counteract specific job demands (36). These authors hypothesize that the strongest interactive relationships exist among these concepts if they are based on qualitatively identical dimensions and processes (eg, emotional demands are mostly compensated by emotional resources in the prediction of emotional exhaustion) (ie, the “triple match” principle) (36). Thus far mostly cross-sectional evidence has been found for this theory (37). In our current study, we investigated a “double match” idea rather than a “triple match” one; among other things, emotional job resources (social support) were matched to opposing job demands (emotional job demands), but were related to a physical outcome (work-related musculoskeletal disorders). Our analyses did not reveal compensation between the emotional resource social support and emotional job demands in predicting work-related musculoskeletal disorders. Neither did we find that decision latitude compensated for quantitative job demands. It is a limitation of our study, however, that we did not measure physical job resources (eg, measures or instruments that can alleviate physical job demands). We can therefore not rule out the possibility that the triple-match principle holds and that physical job resources in particular are important in compensating (buffering) for job demands in their effect on work-related musculoskeletal disorders.

In general, as we did, many studies have measured only the well-known job resources (mostly control and support). It has been mentioned before that many other job resources are conceivable at the individual, job, team, supervisor, and corporate levels, which were found to be related to positive outcomes like work engagement (7). For instance, at the team level, cooperation, team spirit, and cohesion may be considered important. Furthermore, for instance, at the level of the supervisor, trust and feedback are important, and, at the company level, more participation in the decision-making processes and communication are considered to be important job resources (7, 38). We measured the latter in our current study (communication), but it seems worthwhile to measure more (and different types of) job resources in future studies.

In conclusion, this study shows that job resources are not only important in promoting work engagement, but may also moderate the negative impact of high job demands on the risk of work-related musculoskeletal disorders. The results of our study imply that, in addition to avoiding or reducing risks to health in the workplace and lowering job demands, strengthening job resources may also buffer the harmful effects of job demands on musculoskeletal health. Because job resources are—in principle—factors that can be manipulated in the work situation, it seems worthwhile to explore their relationship with work-related musculoskeletal disorders in further research.

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