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Multi-site pain and work ability among an industrial population

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Background Multi-site pain is a common phenomenon among working-age people and it strongly increases work disability risk. Little is known about the impact of musculoskeletal pain on work ability.

Aims To investigate whether the number of musculoskeletal pain sites predicts future poor work ability.

Methods The study was conducted in 2005 and 2009 in a food processing company. A total of 734 workers participated in the study. The information on self-perceived work ability and musculoskeletal pain during the preceding week was obtained through a structured questionnaire distributed to employees. The risk of poor work ability at follow-up related to the number of pain sites at baseline was estimated with logistic regression.

Results The proportion of poor work ability increased in 4 years from 15 to 22%, parallel to the increase in the number of pain sites. Among those with 'non-poor' work ability at baseline, one-tenth reported their work ability to be poor after 4 years. The number of pain sites predicted poor work ability after 4 years of follow-up with a dose–response manner. Those with widespread pain had almost a 3-fold risk of developing poor work ability at follow-up. The associations were stronger for younger and white-collar workers.

Conclusions The results of the present study indicate that multi-site musculoskeletal pain at baseline strongly predicts poor work ability after 4 years among industrial workers. Counting the number of concurrent pain sites may be a simple method of identifying workers with high risk of work disability in occupational health practice.

Key words Follow-up study; food industry; multiple-site pain; musculoskeletal pain; work ability.

Introduction

Musculoskeletal pain is a common work-related health problem among the working population. Many epidemiological studies concentrating on the occurrence of musculoskeletal pain have focused on a specific anatomical site. However, musculoskeletal symptoms often occur in several anatomical locations [1–4] and pain at one site is associated with an increased occurrence of pain at another site [1]. Musculoskeletal pain at a specific anatomical site is also associated with increased risk of impaired work ability and increased sickness absenteeism [2,5].

Work ability is a useful concept in analysing work life, in particular in responding to the challenge of prolonging the job tenures of aging workers. The concept is built on the balance between a person's resources and work demands [6]. High physical work demands such as heavy muscular work, poor work postures and environmental conditions impair work ability [7–11]. The few earlier studies concerning the relationship of multiple-site pain with work ability have mostly measured work ability in terms of self-reported sickness absence and work disability pension [12–15].

Musculoskeletal pain has direct and immediate effects on work disability [16]. A recent study among a representative sample of actively working Finnish adults [17] found that pain at multiple sites imparts considerable risk for reduced self-perceived work ability. This study had, however, a cross-sectional design and could not establish causality between multi-site pain and reduced work ability. Therefore, longitudinal studies are needed to verify that the total number of pain sites truly is an important prognostic factor of poor work ability. This knowledge has substantial public health importance since counting pain sites can then act as a simple method in clinical work for screening workers at high risk of work disability.

The aim of this study was to investigate in an industrial population whether the number of pain sites predicts future poor work ability after 4 years and whether the predictive effect differs by gender, age group or occupational status.

Methods

A follow-up study in a Finnish food industry company of about 2000 employees was started in 2003 [18]. Questionnaire surveys were conducted among all employees of the company in spring 2005 ($N = 1201$) and spring 2009 ($N = 1398$). The questionnaires were distributed in the workplaces, filled in during the working hours, and the closed reply envelopes were collected and sent to the researchers. The forms were not addressed to individual employees; thus, no reminders could be sent. The respondents provided written consent for linking the survey data with data on age, gender and occupational status obtained from the personnel registers of the company. This study was approved by the ethical committee of Pirkanmaa Hospital District.

The questions in the survey covered working environment, work ability and musculoskeletal problems. The outcome variable or work ability was assessed as a subjective assessment of current work ability compared with a person's self-identified lifetime best (i.e. with the question 'Assume that your work ability at its best has a value of 10 points. What score would you give your current work ability?'). This question is part of the seven-item Work Ability Index (WAI) and contains most of the individual differences of the index [8]. The WAI was developed at the Finnish Institute of Occupational Health in the 1980s and has been validated against clinical data [19]. The WAI is an instrument used in both clinical occupational health care and in research in several countries (translated in 26 languages) nowadays. The index is determined on the basis of the answers to a series of questions regarding demands of work, workers' health status and resources [20]. Scores range from 0 (unable to work) to 10 (work ability at its best) and are categorized into excellent (score 10), good (score 9), moderate (score 8) and poor (scores 0–7) work ability [21]. In this study, work ability is dichotomized into good (8–10) and poor (0–7).

The main determinant, multi-site musculoskeletal pain, was assessed by modified questions from the validated Nordic Musculoskeletal questionnaire [22] with a question on pain or numbness in four anatomical areas (hands or upper extremities, neck or shoulders, low back and feet or lower extremities) during the preceding week with the reply scale from 0 (not at all) to 10 (very much). Each reply scale was dichotomized from the median (less than median: 0 = no and more than median: 1 = yes). All four dichotomized variables were summed and the sum variable was expressed in the number of areas with pain (from 0 = no pain to 4 = 4 pain sites).

Age, gender and occupational status (blue-collar and white-collar), environmental exposure, biomechanical and psychosocial factors and body mass index (BMI) and the level of physical activity were included in the analysis as covariates that may confound the relationship of musculoskeletal pain with work ability. BMI was calculated by using self-reported weight and height of the workers. The level of physical activity during the last month was asked on a scale from 0 (not at all) to 7 (high physical activity for more than 3 h a week). Environmental exposure was constructed from the questions concerning draught, noise, poor indoor climate, heat, cold, poor lighting and restless work environment [23] by summing the replies (scaled from 1 = not at all to 5 = very much) into a sum score variable ranging from 7 to 35. Biomechanical factors were addressed with questions about repetitive work and awkward work postures [23], giving the choice on a 5-point Likert scale. Other potential confounders were psychosocial factors at the workplace, for example job satisfaction was assessed with a question 'how satisfied are you with your work?' with a reply scale 0 (absolutely unsatisfied) to 10 (very satisfied) [23]. Variables 'incentive and participative leadership' (six items, e.g. 'My manager pays attention to my suggestion and wishes'), 'team spirit' (six items, e.g. 'My colleagues discuss improvements to work and/or the work environment') and 'possibilities to exert influence at work' (five items, e.g. 'The organization allows its employees an opportunity to set their own goals') were created by summing of the response scores measured on the 5-point Likert scale from 1 (totally disagree/very probably not) to 5 (totally agree/very probably) [24].

Logistic regression analysis was performed to examine whether baseline multi-site pain predicted the risk of poor work ability after 4 years of follow-up. Risks are presented as odds ratios (ORs) and their 95% confidence intervals (95% CIs). The results of logistic regression analysis were calculated and presented for all employees and separately for those who did not have poor work ability in the baseline. The models were built up in five steps: Model I: crude ORs; Model II: adjusted for age, gender and occupational status, biomechanical factors and environmental exposures; Model III: adjusted for physical exercise and BMI; Model IV: adjusted for job satisfaction, leadership, team spirit and possibilities to exert influence and Model V included all the covariates from Model II, Model III and Model IV. These analyses were also performed stratified by gender, age group and occupational status (cut-off value median age, i.e. 42 years). All analyses were performed using SPSS (version 15.0) software.

Results

A total of 734 employees participated in both surveys with response rates of 60% at baseline and 72% at follow-up.

Of these, 518 were blue-collar employees, the majority worked in food processing and maintenance, whereas 216 were white-collar employees, mainly working in management. The mean age of the employees was 41 years (SD = 9.9) ranging from 20 to 62 years at baseline and two-thirds were women. Those lost to follow-up (i.e. who replied to the baseline questionnaire but did not reply at follow-up) were younger and more often men, compared to those who replied to both questionnaires. They had more often multi-site pain and poor work ability at baseline.

Among the 734 subjects, poor work ability was reported by 106 subjects (15%) at baseline and 161 subjects (22%) at follow-up. Women and men differed only a little regarding their work ability; 15% of women and 13% of men reported poor work ability at baseline, while 20% of women and 25% of men reported poor work ability at follow-up. The distributions of poor, moderate, good and excellent work ability are presented in Table 1.

Table 2 presents the graded association between number of pain sites at baseline and poor work ability at follow-up (*P* value for trend <0.01). After mutual adjustment for various covariates, the risks remained elevated being 3-fold for three to four pain sites (Model II–IV). After additional adjustment for work ability at baseline together with all other covariates in the model, the ORs for three and four pain sites remained significantly increased by more than 2-fold for three to four pain sites (OR for four-site pain 2.1; 95% CI 1.0–4.3).

The association between the number of pain sites and work ability did not differ by gender. Moreover, the risk of poor work ability due to three to four-site pain was 4- to 5-fold for both male and female employees. In the occupational status-stratified analyses (Table 3), most notable findings were the high risk of poor work ability in white-collar employees with four-site pain and the low, albeit non-significant, risk of white-collar employees with one-site pain. Two- and three-site pain incurred similar risks (point estimates 1.9 and 3.3 for the blue-collar and 2.1 and 3.3 for the white-collar employees in Model IV) with statistical significance in the case of three-site pain in blue-collar employees. However, when work ability at baseline was introduced into the model together with other covariates, pain lost the significant association for white-collar workers (Model V; Table 3). Consequently, in the age-stratified analyses (Table 4), the risks of poor work ability at follow-up differed considerably among younger and older workers: the younger workers were at greater risk due to multi-site pain compared to the older workers. Older workers lost the significant association with multi-site pain when baseline work ability was introduced into the model (Model V).

Table 5 presents the association between number of pain sites at baseline and poor work ability at follow-up for those who did not have poor work ability at baseline. Again, a strong dose–response association was found (*P* value for trend < 0.01), with unadjusted ORs for three-site pain of 2.7 (95% CI: 1.3–5.4) and for four-site pain of 3.1 (95% CI: 1.6–5.8).

Table 1. Basic characteristics of the study subjects at baseline

Variables	All employees	
Age (mean, SD)	41 (10.0)	
Gender (*N*, %)		
Female	479	65
Male	255	35
Occupational status (*N*, %)		
Blue collar	518	71
White collar	216	29
Physical working conditions (mean, SD)		
Environment[a] (7–35)	18 (5.5)	
Biomechanics[b] (2–10)	6 (2.5)	
Pain sites (*N*, %)		
None	194	27
One	108	15
Two	147	21
Three	107	15
Four	159	22
Work ability (*N*, %)		
Poor	106	15
Moderate	235	32
Good	274	37
Excellent	116	16
BMI (*N*, %)		
<23	180	26
23.0–25.9	221	32
26.0–28.9	150	22
>29.0	138	20
Physical exercise (*N*, %)		
Not at all or only little	160	22
Moderate	324	45
Much	246	33
Psychosocial factors (mean, SD)		
Job satisfaction (0–10)	7.4 (1.8)	
Leadership (1–5)	3.5 (0.7)	
Team spirit (1–5)	3.5 (0.7)	
Possibilities to exert influence (1–5)	3.4 (0.7)	

[a]Environmental exposure includes draught, noise, bad indoor climate, heat, cold, poor lighting and restless environment.

[b]Biomechanical factors include repetitive work and awkward postures.

Discussion

The results of this prospective study showed that poor self-perceived work ability became considerably more common among industrial worker over the 4 years of follow-up (about 50% increase in the prevalence) and that the number of concurrent painful body sites was a strong predictor of future self-perceived poor work ability. multi-site pain at baseline increased the risk of poor work ability even after controlling for baseline work ability and after exclusion of those with poor work ability at baseline. Moreover, the relatively minor confounding effect of the various covariates (including several work-related confounders), as well as the dose–response increase in

Table 2. The risk of poor work ability at follow-up by the number of musculoskeletal pain sites at baseline among all employees

Pain sites	All subjects (n = 734)	No. of subjects with poor work ability (%)	The risk of poor work ability at follow-up				
			Model I, OR (95% CI)	Model II, OR (95% CI)	Model III, OR (95% CI)	Model IV, OR (95% CI)	Model V, OR (95% CI)
None	194	21 (11)	1.0	1.0	1.0	1.0	1.0
One	108	14 (13)	1.2 (0.6–2.5)	1.1 (0.5–2.4)	1.1 (0.5–2.4)	1.3 (0.6–2.7)	0.9 (0.4–2.1)
Two	147	30 (20)	2.1 (1.2–3.9)	1.8 (1.0–3.4)	2.1 (1.1–3.9)	2.2 (1.1–4.1)	1.5 (0.7–3.1)
Three	107	33 (31)	3.7 (2.0–6.8)	3.2 (1.7–6.0)	3.5 (1.9–6.4)	3.5 (1.8–6.7)	2.5 (1.2–5.3)
Four	159	55 (35)	4.4 (2.5–7.6)	3.3 (1.8–6.0)	3.9 (2.2–7.0)	4.2 (2.3–7.6)	2.1 (1.0–4.3)

Model I: crude ORs; Model II: age, gender, occupational status, biomechanical factors and environmental exposure at baseline; Model III: BMI and physical exercise; Model IV: job satisfaction, leadership, team spirit and possibilities to exert influence and Model V: Model II +Model III + Model IV + baseline work ability.

Table 3. The risk of poor work ability at follow-up by the number of musculoskeletal pain sites at baseline among blue- and white-collar employees

	All subjects (n = 734)	No. of subjects with poor work ability (%)	The risk of poor work ability at follow-up				
			Model I, OR (95% CI)	Model II, OR (95% CI)	Model III, OR (95% CI)	Model IV, OR (95% CI)	Model V, OR (95% CI)
Blue collar (n = 518)							
Pain sites							
None	122	16 (13)	1.0	1.0	1.0	1.0	1.0
One	67	13 (19)	1.6 (0.7–3.6)	1.5 (0.7–3.4)	1.5 (0.7–3.4)	1.6 (0.7–3.8)	1.2 (0.5–3.2)
Two	101	22 (22)	1.8 (0.9–3.7)	1.7 (0.8–3.4)	1.9 (0.9–3.9)	2.0 (0.9–4.2)	1.4 (0.6–3.3)
Three	78	27 (35)	3.5 (1.7–7.1)	3.3 (1.6–6.9)	3.4 (1.7–7.0)	3.4 (1.6–7.3)	2.6 (1.1–6.1)
Four	133	45 (34)	3.4 (1.8–6.4)	3.0 (1.5–5.9)	3.1 (1.6–5.9)	3.6 (1.8–7.2)	2.3 (1.0–5.1)
White collar (n = 216)							
Pain sites							
None	72	5 (7)	1.0	1.0	1.0	1.0	1.0
One	41	1 (2)	0.3 (0.1–3.0)	0.3 (0.1–2.8)	0.4 (0.1–3.4)	0.3 (0.1–2.9)	0.2 (0.0–3.2)
Two	46	8 (17)	2.8 (0.9–9.2)	2.3 (0.6–7.9)	2.7 (0.8–9.1)	2.4 (0.7–8.2)	2.2 (0.4–10.6)
Three	29	6 (21)	3.5 (1.0–12.5)	3.0 (0.8–12.0)	3.2 (0.8–11.9)	3.6 (0.9–13.5)	3.6 (0.6–20.8)
Four	26	10 (39)	8.4 (2.5–27.9)	6.3 (1.5–26.0)	7.2 (2.1–24.8)	6.8 (1.9–24.3)	1.9 (0.3–1.1)

Model I: crude ORs; Model II: age, gender, biomechanical factors and environmental exposure at baseline; Model III: BMI and physical exercise; Model IV: job satisfaction, leadership, team spirit and possibilities to exert influence and Model V: Model II + Model III + Model IV + baseline work ability.

the risks further strengthen the evidence that multiple-site pain was a strong predictor of poor work ability. To our knowledge, this study is the first to prospectively establish this association.

The findings of this study support the results from an earlier cross-sectional study among a sample of the general population in Finland in which multi-site pain was strongly associated with reduced self-perceived work ability. Work ability was assessed with respect to the physical and mental demands of work [17]. In our study, the outcome variable was based on a single-item question on work ability compared with the lifetime best with the scale from 0 to 10. This simple question has been shown to strongly predict the status and progress of work ability and has therefore been suggested to be used as a useful indicator of work ability. It can also be used as a less time-consuming alternative for the WAI [25].

This study showed that although work ability decreased with age and poor work ability was more common among blue-collar workers, the relationship between multi-site pain and poor work ability was stronger among younger and white-collar workers. This is likely to be caused by a selection bias called the healthy worker effect, which may cause underestimations in the detected associations. Those workers with pain at various body areas may have left the workforce entirely or sought lighter jobs, whereas those workers, especially the older manual workers, who remain in the workforce, are healthier and more resistant to the effect of widespread pain symptoms. The presence of a healthy worker

Table 4. The risk of poor work ability at follow-up by the number of musculoskeletal pain sites at baseline among younger (<42 years) and older (≥42 years) employees

	All subjects (n = 734)	No. of subjects with poor work ability (%)	The risk of poor work ability at follow-up				
			Model I, OR (95% CI)	Model II, OR (95% CI)	Model III, OR (95% CI)	Model IV, OR (95% CI)	Model V, OR (95% CI)
Younger (n = 393)							
Pain sites							
None	115	9 (8)	1.0	1.0	1.0	1.0	1.0
One	54	8 (15)	2.0 (0.7–5.6)	2.1 (0.8–5.8)	2.2 (0.8–6.1)	1.9 (0.6–5.6)	1.7 (0.5–5.2)
Two	77	14 (18)	2.6 (1.1–6.4)	2.6 (1.0–6.6)	2.6 (1.1–6.5)	2.7 (1.0–6.8)	2.1 (0.8–5.9)
Three	60	18 (30)	5.0 (2.1–12.1)	4.8 (1.9–12.2)	4.4 (1.8–10.8)	4.9 (1.9–12.6)	3.2 (1.1–9.4)
Four	87	25 (29)	4.8 (2.1–10.8)	4.2 (1.7–10.3)	4.3 (1.9–10.0)	4.9 (2.0–11.9)	2.9 (1.0–8.0)
Older (n = 322)							
Pain sites							
None	79	12 (15)	1.0	1.0	1.0	1.0	1.0
One	54	6 (11)	0.7 (0.2–2.0)	0.6 (0.2–1.9)	0.6 (0.2–1.7)	0.8 (0.3–2.3)	0.4 (0.1–1.6)
Two	70	16 (23)	1.7 (0.7–3.8)	1.3 (0.6–3.2)	1.6 (0.7–3.7)	1.6 (0.7–3.9)	1.0 (0.4–2.7)
Three	47	15 (32)	2.6 (1.1–6.2)	2.3 (0.9–5.6)	2.7 (1.1–6.4)	2.6 (1.0–6.6)	2.0 (0.7–5.8)
Four	72	30 (42)	4.0 (1.8–8.6)	2.9 (1.2–6.7)	3.6 (1.6–8.0)	3.4 (1.5–8.0)	1.3 (0.4–3.6)

Model I: crude ORs; Model II: Occupational status, biomechanical factors and environmental exposure at baseline; Model III: BMI and physical exercise; Model IV: Job satisfaction, leadership, team spirit and possibilities to exert influence and Model V: Model II + Model III + Model IV + baseline work ability.

Table 5. The risk of poor work ability at follow-up by the number of musculoskeletal pain sites at baseline among those who had 'non-poor' work ability at baseline

Pain sites	All subjects (n = 628)	No. of subjects with poor work ability (%)	The risk of poor work ability at follow-up				
			Model I, OR (95% CI)	Model II, OR (95% CI)	Model III, OR (95% CI)	Model IV, OR (95% CI)	Model V, OR (95% CI)
None	186	18 (10)	1.0	1.0	1.0	1.0	1.0
One	101	10 (10)	1.0 (0.5–2.3)	1.1 (0.5–2.4)	1.0 (0.5–2.3)	1.1 (0.5–2.5)	0.9 (0.4–2.3)
Two	125	20 (16)	1.8 (0.9–3.5)	1.7 (0.8–3.4)	1.8 (0.9–3.6)	2.0 (1.0–4.1)	1.7 (0.8–3.7)
Three	85	19 (22)	2.7 (1.3–5.4)	2.6 (1.2–5.6)	2.5 (1.2–5.1)	2.6 (1.2–5.7)	1.9 (0.8–4.4)
Four	117	29 (25)	3.1 (1.6–5.8)	2.7 (1.3–5.3)	2.7 (1.4–5.3)	3.4 (1.7–6.8)	1.7 (0.8–3.7)

Model I: crude ORs; Model II: age, gender, occupational status, biomechanical factors and environmental exposure at baseline; Model III: BMI and physical exercise; Model IV: job satisfaction, leadership, team spirit and possibilities to exert influence and Model V: Model II + Model III + Model IV + baseline work ability.

effect is also supported by our loss-to-follow-up analyses: non-response at follow-up was related to the greater likelihood of having multi-site pain and poor work ability at baseline.

Women tend to report more musculoskeletal pain and have a higher risk of sickness absence and work disability pensions, especially due to musculoskeletal disorders [26]. However, with respect to self-perceived work ability, some earlier studies among the general population have indicated that males and females perceive their work ability to be approximately the same [21,27]. We also did not find any major gender differences in the perceived poor work ability related to multi-site pain. This is in line with the other Finnish study in which the effect of multi-site pain on perceived work ability did not differ between the women and the men [17].

This study has strengths, of which the most important is the prospective follow-up design. In addition to predicting poor work ability at follow-up, the change in work ability from non-poor to poor was assessed and similar dose–response risk increases were detected. The response rates for both surveys were satisfactory. However, it considerably improved at follow-up to 72%. Musculoskeletal pain reporting concerned the previous 7 days. This time frame increases the likelihood of pain truly occurring at multiple body sites concurrently. It also reduces the effects of recall bias. A variety of work-related factors, including environmental exposures such as cold work environment, was considered as confounders. However, the effects of unmeasured confounding, for example due to chronic illnesses, cannot be ruled out. The role of age, gender and occupational status as effect modifiers was investigated with stratified analyses. The risks varied by age and occupational status, and hence, they should be considered in future studies as well. All information was elicited by questionnaire, i.e. no objective measurements were carried out. However, a self-report method appears to be the best (and practically only) way of assessing pain in epidemiological studies [28, 29]. Moreover, the single-item question on self-perceived work ability is a quick and cost-effective method especially for clinical use and its results are easy to interpret [25].

This study represents food industry employees in which high levels of exposures to physical and psychosocial load can be found. Including white-collar workers in the cohort increased the variation and contrast in the exposures. Although sickness absence and work disability rates are remarkably high in the food industry and musculoskeletal disorders are the major reason for sick leaves and work disability, the occurrence of musculoskeletal disorders and its relation with work ability have rarely been assessed in an epidemiological study. The food processing industry is a significant employer in Finland with about 34 000 workers (1–2% of the workforce).

In conclusion, single-site and multi-site pain have a very different prognosis with respect to work ability. Multi-site musculoskeletal pain increases the risk of future poor self-perceived work ability, especially among younger workers. The study results support the view that simply counting the concurrent pain sites can be used to screen for workers with high risk of work disability in occupational health practice. In general, widespread pain requires special attention and effective preventive measures in order to improve the work ability and prolong the work careers of working-age people.

Key points

- Among working people, multi-site musculoskeletal pain is a common phenomenon.
- Multi-site musculoskeletal pain increases the risk of future poor self-perceived work ability, especially among younger workers.
- Multi-site pain requires special attention and effective preventive measures in order to improve the work ability and prolong the work careers of working-age people.

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Conflicts of interests

None declared.

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