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RISK FACTORS FOR NEW ONSET AND PERSISTENCE OF MULTI-SITE MUSCULOSKELETAL PAIN IN A LONGITUDINAL STUDY OF WORKERS IN CRETE

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Abstract

Objectives—To explore occupational and psychological risk factors for the incidence and persistence of multi-site musculoskeletal pain.

Methods—We conducted a longitudinal investigation of three occupational groups in Crete, Greece. Baseline information was obtained at interview about pain in the past year at each of six anatomical sites, and about possible risk factors for subsequent symptoms. Twelve months later, subjects were re-interviewed about pain at the same anatomical sites in the past month. Pain at two or more sites was classed as multi-site. Associations with new development and persistence of multi-site pain at follow-up were assessed by logistic regression.

Results—Analysis was based on 518 subjects (87% of those originally selected for study). At follow-up, multi-site pain persisted in 217 (62%) of those who had experienced it in the year before baseline, and was newly developed in 27 (17%) of those who had not. Persistence of multi-site pain was significantly related to physical loading at work, somatising tendency and beliefs about work as a cause of musculoskeletal pain, with ORs (95%CIs) for the highest relative to the lowest exposure categories of 2.3 (1.0-5.6), 2.6 (1.5-4.6) and 1.9 (1.1-3.3) respectively.

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Competing Interests No

Contributor Statement ES designed and analysed the study, did interviews and drafted the paper. LC and MK participated in the design and analysis of the study and in drafting the paper. PB participated in the design of the part on psychological factors of the study and contributed in drafting the paper. DC and KTP are the PIs of the international CUPID study, participated in the design of the study in Greece and in drafting the paper.

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Development of new multi-site pain was most strongly associated with working for ≥ 40 hours per week (OR 5.0, 95%CI 1.1-24.0).

Conclusions—Our findings confirm the importance of both physical loading at work and somatising tendency as risk factors for multi-site pain, and suggest that persistence of pain is also influenced by adverse beliefs about work-causation.

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Introduction

Widespread pain is common in the general population of western countries [1,2], and frequently persistent [3-5]. It impacts adversely on physical fitness and activities of daily living [6,7], is associated with poor general health status and psychological distress [8-10], predicts future mortality [11-13], and in working populations carries an increased risk of long-term sickness absence [14,15], and of poor self-reported work ability [16,17].

The overall economic impact of musculoskeletal disorders is substantial. In one Norwegian study from 2003, 45% of all lost working days in one year were attributed to musculoskeletal illness.[14] However, studies of occupational risk factors for musculoskeletal complaints have generally focused on pain at single anatomical sites, and only occasionally considered multi-site pain as a primary outcome. More often, pain at one site is treated as a risk factor when looking at associations with, or prognosis of, pain at another site. A few studies have suggested that physical exposures and psychosocial factors, such as low social support and work monotony, play a role in the occurrence of regional and/or widespread pain [12,18,19] (sometimes defined by the criteria of the American College of Rheumatology as a specific combination of multi-site pain [20]). And in a cross-sectional survey carried out in Crete, Greece, we found that disabling multi-site pain was strongly associated with physical load at work as well as with tendency to somatise [21]. However, it was unclear whether, and to what extent, experience of pain increased subjects' awareness of occupational physical activities, causing them to report the activities more frequently, and also whether the observed association related to the incidence of multi-site pain or to its persistence once it had developed.

To address this uncertainty, we here present findings from a longitudinal analysis based on follow-up of the same study sample after an interval of one year. Our aim was to explore whether the previously reported cross-sectional association of multi-site pain with physical workload was causal, and whether risk factors influenced the incidence or persistence of multi-site pain.

Methods

This study was the Greek component of the CUPID (Cultural and Psychosocial Influences on Disability) study, which is a multinational investigation conducted in 18 countries [22] . The initial study sample enrolled in 2006 comprised: a random subset of nurses from Heraklion University Hospital (N=240); all office workers employed at Heraklion University who were registered as computer users (N=202); and all postal clerks who sorted mail by hand at the central mail-sorting postal offices of the four prefectures of Crete (N=154). The study size was defined by the protocol of the international CUPID study and was increased to reach adequate power for the evaluation of estimated prevalences of individual musculoskeletal pain in relation to specific risk factors. To be included, subjects had to be aged 21-60 years, and to have worked for at least one year in their current job.

At baseline, subjects who provided written informed consent were interviewed using a structured questionnaire. This was mainly a Greek translation of the questionnaire used in the international CUPID study, which had originally been developed in English. Among

other things, it asked about demographic characteristics, musculoskeletal pain during the past year, physical activities at work, psychosocial aspects of work, mental health, distress from common somatic symptoms, and health beliefs.

Pain was assessed with the help of pictures illustrating the six body regions of interest (low back, neck, shoulder, elbow, wrist/hand and knee). For each site, the questionnaire asked about pain that had lasted for at least one day in the past year before baseline and in the past month before follow-up. Pain was classed as multi-site if it had occurred in two or more of the six anatomical sites.

The questions about occupational activities were used to classify subjects according to the number of strenuous physical activities (from 0 to 7) that were performed in an average working day . Specifically we inquired about: lifting weights of 25 Kg or more by hand ; working with the hands above shoulder height for >1 hour in total ; repeated bending and straightening of the elbow for >1 hour in total ; using a keyboard or typewriter for >4 hours in total , carrying out other repetitive tasks involving the wrist or fingers for >4 hours in total ; kneeling or squatting for >1 hour in total and climbing up and down >30 flights of stairs .

The questions on psychosocial aspects of work covered hours worked per week (classified as $< \text{or} \geq 40$), job satisfaction (high if the subject was “satisfied” or “very satisfied” with their job), job demands (classed as high if the work entailed piecework, targets or time pressure), job control (classed as high if there was “sometimes” or “often” discretion over what work was done, how work was done or timetables and breaks); job support (high if the subject reported that support was available sometimes or often from colleagues, supervisor or manager), and job security (high if the subject felt their employment would be “very safe” or “safe” if they were off work sick for three months).

Mental health was assessed using elements from the SF-36 questionnaire [23], and classified to three levels (good, intermediate and poor) corresponding to approximate thirds of the observed distribution of scores in the study sample. Questions about somatising tendency were taken from the Brief Symptom Inventory (BSI) [24], and subjects were classified according to the number of symptoms out of a total of seven (faintness or dizziness, pains in the heart or chest, nausea or upset stomach, trouble getting breath, numbness or tingling, weakness and hot or cold spells) that had been at least moderately distressing during the past week.

Questions on health beliefs covered fear-avoidance (modified from the Fear Avoidance Beliefs Questionnaire [25], and classed as positive if the participant completely agreed both that people with upper limb or low back pain should avoid activity and that rest was needed for recovery) and work causation (strong if the subject completely agreed that pain, both in the upper limb and low back, was most commonly caused by work, weak when the perception was limited to only one of these anatomical sites, and otherwise classed as “none”.

In addition to questions from the CUPID study, the baseline questionnaire also included validated translations of the 20-item Toronto Alexithymia Scale (TAS-20) [26] and the Beck Depression Inventory-II (BDI-II) [27]. Standard cut-points were used to classify subjects with regard to alexithymia (difficulty identifying and expressing one’s feelings – classed as normal, “grey zone” or alexithymic) and depression (normal, mild or moderate/severe) [28,29].

One year after entry to the study, subjects were contacted by mail or phone and were asked to answer a further, shorter questionnaire at interview. This included questions about

musculoskeletal pain similar to those asked at baseline, but focusing mainly on symptoms in the past month. Subjects were considered to have multisite pain at follow-up if they reported pain during the past month at more than one of the six anatomical sites covered in the questionnaire.

STATA/SE 10 software was used for the statistical analysis. We constructed logistic regression models to explore associations of multi-site pain at 12 months with risk factors assessed at baseline, and applied the Wald test [30] to assess the significance of differences between the associations of risk factors with new development of multi-site pain in people who did not have it in the year before baseline and their associations with persistence of multi-site pain in those who did. Each potential risk factor was examined in a separate regression model with adjustment for age, sex and main occupation. Risk factors that were significantly associated with the outcome of interest in these analyses were then entered into a single multivariable model, together with age, sex and main occupation. Statistical significance was set at $P<0.05$.

The study protocol was approved by the Scientific Board Committee of the University Hospital of Heraklion.

Results

Among the 596 subjects selected for study, 564 completed the baseline assessment, and 539 also answered the follow-up questionnaire. These included 518 (87% of the original sample) who provided complete information on pain history, and were included in our analysis. Participants were similar to non-participants in terms of age, sex and mean number of anatomical sites with pain in the past year at baseline.

Table 1 shows the prevalence of multi-site pain in the past month at follow-up, according to sex, age (at baseline), occupation, and whether or not pain had been present at multiple sites during the year before entry to the study. Multi-site pain at follow-up was reported by almost half of all participants, being more common in women (49%) than men (44%). It occurred in 217 (62%) of those who had pain at multiple sites in the year prior to baseline (“persistent multi-site pain”) and 27 (17%) of those who did not (“new-onset multi-site pain”).The mean number of painful sites at follow-up was 2.9 for those with persistent multi-site pain and 2.3 for the new-onset group. Among the participants with new-onset multi-site pain, approximately half reported no pain at baseline, and the remainder had experienced pain in the past year at a single site.

Table 2 displays the associations of new-onset and multi-site pain with sex, age and occupational risk factors. Although age and sex were not significantly associated with either new-onset or persistent multi-site pain, the risk that multi-site pain was persistent varied by occupation, being higher in postal clerks and nurses than in office workers (ORs 2.0, 95%CI 1.0-4.1 and 1.9, 95%CI 1.1-3.1 respectively). A similar pattern was observed for new-onset multi-site pain although the differences between occupations were not significant at the 5% level. Among subjects who were initially free from multi-site pain, after allowance for sex, age and occupation, new-onset multi-site pain was significantly associated with working ≥40 hours per week (OR 5.0, 95%CI 1.1-24.0) ,whereas persistence of multi-site pain among those who had suffered from it in the year before baseline was unrelated to working hours. This difference in prediction of new-onset as compared with persistence of multi-site pain was statistically significant ($p<0.05$). Additionally, persistence was strongly predicted by exposure to physical loading at work (OR 3.2, 95%CI 1.4-7.4, for 4-7 vs. 0–1 strenuous activities). None of the other occupational risk factors examined was significantly associated with either onset or persistence of multi-site pain.

Table 3 shows the relation of new-onset and persistent multi-site pain to psychological risk factors assessed at baseline. New-onset multi-site pain was less frequent in subjects who initially were depressed according the BDI-II (p for trend across levels of depression = 0.05). Paradoxically, however, it tended to be more common in those with worse mood as assessed by questions from SF-36. Persistence of multisite pain was significantly predicted by low mood (p for trend = 0.05), somatising tendency (p for trend < 0.001) and adverse beliefs about work as a cause of musculoskeletal complaints (p for trend = 0.03).

When the significant predictors of persistent multi-site pain from the analyses presented in Tables 2 and 3 (occupation, physical loading, mental health, somatizing tendency and beliefs about work causation) were incorporated into a single multivariate regression model, together with sex and age, only physical loading at work, somatising tendency and work causation beliefs remained statistically significant (Table 4). In particular, the OR for report of two or more as compared with no distressing somatic symptoms was 2.6 (95%CI 1.5-4.6), and the OR for loading of 4-7 anatomical sites as compared with 0-1 was 2.3 (95% CI 1.0-5.6). As only weekly working hours was significantly associated with new-onset multi-site pain, no multivariable model was constructed for this outcome.

Finally, to explore the potential for residual confounding arising from pain status at baseline, we carried out sensitivity analyses, including all participants (with and without multisite pain at baseline), taking multi-site pain at follow-up as the outcome , and adjusting for the number of sites that had been painful in the past year at baseline . This affected the results of the univariate analyses only slightly, whereas in multivariate analysis, the statistical significance of the findings became marginal, although the point estimates of risk were similar (data available on request).

Discussion

This extension to our earlier cross-sectional study confirmed the high prevalence and frequent persistence of multi-site pain in the working population studied. It suggests that physical loading at work is related more to the persistence of multi-site pain than its new development, and that pain persistence is also strongly related to somatising tendency and beliefs about work as a cause of musculoskeletal pain.

The method by which subjects were selected, and the high response rates achieved, ensured that participants were representative of the occupational groups studied. Moreover, the longitudinal design, with separate analyses for subjects with and without multi-site pain at baseline, meant that reporting of exposures was not influenced by the outcomes under investigation (development and persistence of multi-site pain), and that observed associations could not be a consequence of reverse causation.

It is possible that subjects' recall of exposures at baseline was not always accurate, but if errors occurred, they would be expected to obscure rather than spuriously exaggerate associations with the subsequent occurrence of symptoms. Another concern is that exposure to physical loading at work could have increased subjects' awareness of pain, leading to a higher reported prevalence of symptoms at follow-up. However, this would apply to reporting of pain at baseline as well as at follow-up, and might be expected to have less impact in analyses that were stratified according to report of multi-site pain at baseline. Moreover, it would not explain why physical loading was unrelated to new onset of multi-site pain.

It remains possible that the number of sites with pain at baseline could confound longitudinal associations with multi-site pain at follow-up. This might occur, for example, if a higher number of painful sites at baseline caused lower mood at or adversely affected other

baseline psychosocial risk factors, and independently made it more likely that multi-site pain was present at follow-up. However, a baseline association between number of sites affected and psychosocial risk factors could also arise because the psychosocial factor made pain more likely to occur. In this circumstance, the number of sites affected at baseline would not be confounding, but instead an intermediary in the causal chain. In practice, a baseline association between psychosocial factors and number of sites affected could result from a combination of causation in both directions. To address the possibility of a confounding effect we performed alternative analyses, including the number of painful sites at baseline as a factor of adjustment. However, this left the associations with psychological risk factors largely unchanged.

Our finding that physical loading was associated with persistence of multi-site pain accords with observations from cross-sectional studies linking prevalent pain with physical stresses [20,23]. However, other longitudinal studies have suggested that occupational activities such as heavy lifting [19], prolonged work with the hands above shoulder height [19], and working in bent positions [12], are also associated with new onset of widespread pain. It is possible that our failure to detect an effect on incidence of new pain was attributable in part to small numbers and lack of statistical power.

We found that new onset of multi-site pain was significantly predicted by prolonged working hours, but there was no corresponding association with persistence of multi-site pain. Several other studies have linked musculoskeletal disorders with long working hours, but findings have not been entirely consistent, and require further research [31].

The strong association that we observed between somatising tendency and persistence of multi-site pain is consistent with findings from cross-sectional studies [20,23,32], and from longitudinal studies of musculoskeletal pain, both at single [33,34] and multiple anatomical sites [3]. As in other studies [1], somatising tendency was also associated with new onset of multi-site pain, although the relation was not as strong as that with pain persistence.

Like somatising tendency, poor mental health has previously been found to predict both the incidence and persistence of widespread pain [8]. In our study associations were weaker than for somatising tendency, and after adjustment for other risk factors, were not statistically significant. Our finding that depression, as assessed by the BDI-II, was associated with a reduced incidence of multi-site pain was unexpected, and inconsistent with the findings for mental health assessed by questions from SF-36. Further analysis revealed that 19 of the 61 subjects classed as having moderate/severe depression by the BDI-II were assigned to the best third of the distribution of mental health scores, suggesting that there may have been problems with the way in which the BDI-II was understood or answered.

We found that persistence of multi-site pain was also predicted by strong beliefs that work is a cause of musculoskeletal pain. The relation of multi-site pain to health beliefs has been little studied previously, but earlier investigations have found that fear-avoidance beliefs were associated with poorer outcomes in patients with low back pain [35,36], and that arm pain was more likely to persist in people who attributed the symptom to work or stress [34]. One possibility is that pain is more likely to persist if a person is exposed to an activity at work which they believe causes the pain (a nocebo effect).

Our study confirms the importance of both physical loading at work and somatising tendency as risk factors for multi-site pain, and suggests that their main impact is on the persistence of pain rather than the onset of new symptoms. It also suggests that beliefs about work as a cause of musculoskeletal disorders have an important influence on the persistence of multi-site pain. This finding is novel and needs to be independently replicated in other populations. However, it suggests that interventions to reduce the persistence of multi-site

pain should focus on modifying beliefs about the causal role of work on symptoms, with care not to over-emphasize the musculoskeletal risk from occupational activities.

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What this paper adds

What is known

- Studies of occupational risk factors for musculoskeletal complaints have focused on pain at single anatomical sites, and have rarely considered multi-site pain as a primary outcome.
- It is unclear whether observed associations on occupational physical activities, psychosocial and other factors are related to the incidence of multi-site pain or to its persistence once it had developed

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What this study adds

- Findings from this study confirm the importance of both physical loading at work and somatising tendency as risk factors for multi-site pain
- The main impact of physical loading at work and somatizing tendency is on the persistence of pain rather than the onset of new symptoms

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Table 1

One-month prevalence of multi-site pain at follow-up according to sex, age, occupation and pain history at baseline

Baseline characteristics	Number of Subjects	Number (%) of subjects with multi-site pain in past month at follow-up
Sex		
Male	171	75 (44%)
Female	347	169(49%)
Age (years)		
20-29	27	7 (26%)
30-39	240	123 (51%)
40-49	195	92 (47%)
≥50	53	22 (42%)
Occupation		
Nurse	212	112 (53%)
Office worker	189	75 (40%)
Postal clerk	117	57 (49%)
Multi-site pain in past year		
No	168	27 (16%)
Yes	350	217 (62%)

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Table 2

Associations of sex, age and occupational risk factors with new development and persistence of multi-site pain

Risk Factor[a]	New onset of multi-site pain				Persistence of multi-site pain				Wald test[d] p-value
	No. at risk[b]	No. of cases	OR	(95% CI)	No. at risk[c]	No. of cases	OR	(95% CI)	
Age (yrs)	165	27	1.0	0.9-1.0	350	217	1.0	1.0-1.1	0.12
Sex									0.91
Male	67	11	1		104	64	1		
Female	101	16	0.8	0.3-2.5	246	153	1.3	0.7-2.3	
Main occupation									0.80
Office worker	59	6	1		130	69	1		
Postal clerk	46	8	2.3	0.6-9.0	71	49	2.0	1.0-4.1	
Nurse	63	13	2.3	0.8-6.7	149	99	1.9	1.1-3.1	
Hours worked per week									
<40	45	2	1		83	49	1		0.04
≥40	123	25	5.0	(1.1-24.0)	266	167	1.0	(0.6-1.7)	
Number of strenuous physical activities									
0-1	35	7	1		35	15	1		0.29
2	35	4	0.5	(0.1-2.0)	67	34	1.2	(0.5-2.9)	
3	47	6	0.5	(0.2-1.8)	127	78	2.0	(0.9-4.3)	
4-7	51	10	0.9	(0.3-2.7)	121	90	3.2	(1.4-7.4)	
Job satisfaction									
High	150	23	1		266	161	1		0.88
Low	17	3	1	(0.3-4.0)	83	56	1.1	(0.6-1.9)	
Job demands									
Low	36	4	1		64	33	1		0.98
High	130	22	1.4	(0.4-4.8)	286	184	1.3	(0.8-2.5)	
Job control									
High	69	11	1		148	84	1		
Low	99	16	0.7	(0.3-1.8)	202	133	1.2	(0.7-2.0)	0.54

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Risk Factor[a]	New onset of multi-site pain				Persistence of multi-site pain				Wald test[d] p-value
	No. at risk[b]	No. of cases	OR	(95% CI)	No. at risk[c]	No. of cases	OR	(95% CI)	
Job support									
High	139	20	1		286	176	1		
Low	25	7	2.6	(0.8-8.3)	61	40	1	(0.5-1.8)	0.25
Job security									
High	135	20	1		281	174	1		
Low	31	7	1.4	(0.5-3.9)	69	43	1	(0.6-1.7)	0.49

[a] Each risk factor was analysed in a separate logistic regression model, which also included sex, age (as a continuous variable) and occupation

[b] Subjects who did not report pain at multiple sites in the year before baseline (information on some risk factors was missing for some participants)

[c] Subjects who reported pain at multiple sites in the year before baseline (information on some risk factors was missing from some participants)

[d] Wald test for significance of differences between associations with new onset and persistence of multi-site pain

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Table 3

Associations of psychological risk factors with subsequent new development and persistence of multi-site pain

Risk Factor[a]	New onset of multi-site pain				Persistence of multi-site pain				Wald test[d] p-value
	No. at risk[b]	No. of cases	OR	(95% CI)	No. at risk[c]	No. of cases	OR	(95% CI)	
Mental Health									
Good	74	10	1		96	49	1		0.92
Intermediate	62	11	1.5	(0.5-3.8)	122	79	1.9	(1.1-3.3)	
Poor	32	6	1.5	(0.5-4.9)	132	89	1.8	(1.0-3.2)	
	p-value for trend = 0.4				p-value for trend = 0.05				
Number of somatic symptoms at least moderately distressing									
0	119	17	1		117	54	1		0.68
1	25	5	1.4	(0.5-4.5)	54	32	1.6	(0.8-3.2)	
2+	24	5	1.8	(0.5-5.7)	178	131	3.3	(1.9-5.5)	
	p-value for trend = 0.3				p-value for trend <0.001				
Fear-avoidance beliefs									
No	77	12	1		171	110	1		0.67
Yes	91	15	0.9	(0.4-2.0)	179	107	0.7	(0.4-1.1)	
Beliefs about work causation									
None	57	11	1		95	47	1		0.05
Weak	25	3	0.5	(0.1-1.9)	58	31	1.2	(0.6-2.3)	
Strong	86	13	0.5	(0.2-1.4)	197	139	2.2	(1.3-3.8)	
	p-value for trend = 0.2				p-value for trend = 0.03				
Alexithymia									
Normal	117	21	1		255	161	1		0.63

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Risk Factor[a]		New onset of multi-site pain				Persistence of multi-site pain				Wald test[d] p-value
		No. at risk[b]	No. of cases	OR	(95% CI)	No. at risk[c]	No. of cases	OR	(95% CI)	
	Grey zone	27	3	0.5	(0.1-2.0)	40	23	0.8	(0.4-1.6)	
	Alexithymic	14	1	0.4	(0.0-3.0)	33	20	0.8	(0.4-1.8)	
		p-value for trend =0.2				p-value for trend =0.5				
Depression										
	Normal	114	22	1		228	136	1		0.19
	Mild	29	3	0.4	(0.1-1.6)	64	44	1.3	(0.7-2.4)	
	Moderate/severe	19	1	0.2	(0.0-1.6)	39	22	0.8	(0.4-1.6)	
		p-value for trend = 0.05				p-value for trend = 0.9				

[a] Each risk factor was analysed in a separate logistic regression model, which also included sex, age (As a continuous variable) and occupation

[b] Subjects who did not report pain at multiple sites in the year before baseline (information on some risk factors was missing for some participants)

[c] Subjects who reported pain at multiple sites in the year before baseline (information on some risk factors was missing from some participants)

[d] Wald test for significance of differences between associations with new onset and persistence of multi-site pain

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Table 4

Mutually adjusted associations of selected risk factors with persistence of multi-site pain

Risk factor[a]	No. at risk[b]	No. of cases	OR	(95% CI)
Main occupation				
Office worker	129	69	1	
Postal clerk	71	49	1.0	0.4-2.3
Nurse	149	99	1.2	0.7-2.0
Number of strenuous physical activities				
0-1	34	15	1	
2	67	34	1.1	(0.4-2.6)
3	127	78	1.5	(0.6-3,4)
4-7	121	90	2.3	(1.0-5.6)
Mental Health				
Good	95	49	1	
Intermediate	122	79	1.7	(0.9-3.1)
Poor	132	89	1.3	(0.7-2.4)
Number of somatic symptoms at least moderately distressing				
0	117	54	1	
1	54	32	1.5	(0.8-3.1)
2+	178	131	2.6	(1.5-4.6)
Beliefs about work causation				
None	94	47	1	
Weak	58	31	1.1	(0.6-2.3)
Strong	197	139	1.9	(1.1-3.3)

[a] Analysis was restricted to risk factors which showed statistically significant associations when examined individually. All risk factors were analysed in a single logistic regression model, which also included sex and age (as a continuous variable).

[b] Analysis was restricted to subjects with complete information on all variables