

Dose–response associations between musculoskeletal disorders and physical and psychosocial factors among construction workers

by Göran Engholm, MSc,¹ Eva Holmström, PhD²

Engholm G, Holmström E. Dose–response associations between musculoskeletal disorders and physical and psychosocial factors among construction workers. *Scand J Work Environ Health* 2004;31 suppl 2:57–67.

Background As musculoskeletal disorders are common in general populations and they therefore constitute a heavy burden to society, the identification of their determinants is important. The aim of this study was to identify dose-response associations for location-specific prevalences of musculoskeletal disorders with various physical exposures and psychosocial factors in a large group of workers.

Methods The study was based on cross-sectional data from self-administered questionnaires filled out by 85 191 male employees in the Swedish construction industry. In addition to symptoms from nine musculoskeletal locations, the questionnaire addresses physical exposures and psychosocial factors. Logistic regression methods were used to study disorder prevalence in relation to scales of these exposures and factors.

Results Compared with working rarely in a stooping or twisted posture, the odds ratio (OR) for lower back disorder with respect to often working in this posture was 3.05 [95% confidence interval (95% CI) 2.73–3.42]. The OR values for work with hands above the shoulders and for neck and shoulder disorders were 2.93 (95% CI 2.65–3.24) and 3.66 (95% CI 3.32–4.04), respectively. Among the psychosocial factors, sleeping problems and hurrying without reason were associated with symptoms in all of the body locations, the highest OR being found for neck symptoms and sleeping problems, 2.44 (95% CI 2.15–2.78).

Conclusions Work in awkward postures has strong location-specific dose-response associations. In contrast, some psychosocial factors, primarily those reflecting characteristics of individual persons, are strongly associated with symptoms in all body locations. Symptoms seem not to be associated with factors like support from workmates or supervisors or control of the work situation. All location-specific prevalence rates seem to increase strongly with age.

Key terms cross-sectional; foremen; odds ratio; white-collar worker; work postures.

Musculoskeletal disorders, especially lower-back and upper-extremity disorders, are common in the general population and, therefore, also constitute a heavy economic burden to people and society (1–3). Musculoskeletal disorders have been found by many investigators to be associated with various factors, both physical and psychosocial ones (1, 4, 5). A high prevalence of musculoskeletal disorders has been reported for construction workers (6–8). In this group, the prevalence is strongly associated with age, in particular for neck, shoulder, and hip disorders (8). Data concerning employees in the construction industry show that an increase in the prevalence of musculoskeletal disorders occurs among construction workers with lower back disorders when they are compared with foremen and white-collar workers. The increase with age shows a similar pattern for the three categories, but at different levels (8).

Efforts to prevent musculoskeletal disorders should be based on studies showing dose-response relationships between the prevalence of musculoskeletal disorders and relevant exposures. Results from such studies may constitute the basis for setting priorities between prevention options. The aim of this study was to determine to what extent the prevalence of location-specific musculoskeletal disorders shows dose-response associations with various physical and psychosocial exposures in a large group of persons employed in the construction industry.

Study population and methods

The basis for this study was questionnaire data gathered during the period August 1989 through December 1992

¹ Department of East European Studies, Uppsala University, Uppsala, Sweden.

² Department of Health Sciences, Division of Physiotherapy, Lund University, Lund, Sweden.

Reprint requests to: Dr Eva Holmström, Department of Health Sciences, Division of Physiotherapy, Lund University, University Hospital, SE-221 85 Lund, Sweden. Sweden. [E-mail: Eva_B.Holmstrom@med.lu.se]

at regular health check-ups of Swedish workers, foremen, and white-collar workers employed in the construction industry. The check-ups, to which invitations were sent out every 2 to 3 years, were carried out by Bygghälsan, the construction industry's organization of the work environment, safety, and health, which was set up in the late 1960s to provide nationwide occupational health services. The data were recorded from a self-administered questionnaire filled out by all examinees prior to their coming for check-ups.

Participants

A total of 85 191 men (73 631 construction workers, 8603 foremen, and 2957 white-collar workers) attended the voluntary check-ups, and all of them filled out the questionnaire during the period concerned. Although some 7500 men were examined more than once during the period, this study was only based on their questionnaire replies with respect to the first check-up. It was estimated that they constituted some 78% of the total workforce in the industry in the parts of Sweden in which the questionnaire was used. Areas not covered by these check-ups were the Stockholm and the Dalecarlia regions.

The questionnaire

The self-administered questionnaire contained questions addressing symptoms and exposures. Out of the 15 symptom questions, nine addressed disorders of the musculoskeletal system. There was a total of 29 questions

concerning exposure conditions, 18 of which were considered relevant in this study. Altogether 5 of the 18 addressed physical exposures (vibration, lifting heavy loads, and work in three special postures). In addition, there were 8 questions addressing the examinee's general perception of the psychosocial environment, and finally there were 5 questions concerning the perception of the environment during the 12 months preceding the check-up.

The question concerning vibration exposure was phrased as follows: how do you judge your work environment with respect to vibration exposure? Replies to this question were missing for 4765 of the 85 191 examinees (5.6%). Table 1 shows that some 14% of the remaining 80 426 persons considered their conditions to be rather bad or bad.

The questions concerning other physical exposures were phrased as follows: (i) how often do you lift heavy burdens, (ii) how often do you work in a stooping or twisted posture, (iii) how often do you work with your hands above your shoulders, and (iv) how often do you work in a kneeling posture? Table 2 shows that the replies to these questions were only missing for some 2% of the examinees.

The questionnaire contained eight questions addressing the examinee's general perception of the psychosocial environment. They were phrased as follows: (i) do you find your work congenial and does it give you personal satisfaction (job satisfaction), (ii) can you decide yourself how to organize your work (control of work situation), (iii) are you informed well in advance of plans for future work (information about future plans), (iv) are your worktasks alternating (worktasks alternating), (v) can you get support from your supervisors when facing difficulties (supervisory support), (vi) can you get support from your workmates when facing difficulties (support from workmates), (vii) does your work impose responsibility that is too heavy (responsibility that is too heavy), and (viii) do you worry about health hazards in your work (work health hazard anxiety)? In addition there were the following five questions concerning conditions during the past 12 months: (i) have you found your work psychologically demanding (work psychologically demanding), (ii) have you found it difficult to relax during leisure time (difficulties to relax

Table 1. Distribution of replies to the question concerning vibration exposure.

Reply alternative	Number	Percentage
Reply missing	4 765	5.6
Good ^a	27 466	34.2
Rather good	16 543	20.6
Acceptable	24 798	30.8
Rather bad	7 492	9.3
Bad	4 127	5.1
All replies	80 426	100.0
Total	85 191	100.0

^a Reference level in the analyses.

Table 2. Distribution of the replies to questions concerning certain physical exposures.

	Missing replies (%)	Reply alternative					Total (%)
		Rarely ^a (%)	Rather rarely (%)	Sometimes (%)	Rather often (%)	Often (%)	
Lifting heavy burdens	2.1	13.0	7.8	33.1	26.8	17.2	100.0
Stooping or twisted posture	2.1	11.8	7.6	25.5	28.2	24.7	100.0
Hands above shoulders	2.1	16.3	8.5	23.1	25.6	24.4	100.0
Kneeling	2.0	14.5	6.2	21.8	27.7	27.8	100.0

^a Reference level in analyses.

during leisure time), (iii) have you yourself been rushing without there being any reasons for it (hurrying without reason), (iv) have you suffered from sleeplessness (sleeping problems), and (v) have you felt sad or depressed (depression)? Table 3 shows that the proportion of missing replies to these questions ranged from 1.7% to 5.1%.

Analysis

The questions addressing musculoskeletal disorders had the same phrasing as the corresponding questions in the general standardized Nordic questionnaire (9): "Have you during the last 12 months had pain, ache from your neck/shoulder, etc?" The locations were the neck, shoulder, elbow, wrist or hand, upper back, lower back, hip, knee, and ankle or foot, and the reply alternatives were never, rarely, sometimes, often, and very often.

The prevalence of location-specific symptoms was been studied in relation to various factors by means of stepwise logistic regression analyses. As shown in

table 4, the proportion of missing replies to the disorder questions ranged from 2.6% to 5.1%. The number of replies to the question concerning neck disorders was 82 185. The table shows their distribution according to the reply alternatives and the proportion of cases for each location among persons in the analysis. In the logistic regression analysis the persons answering "sometimes" to a disorder question were disregarded. Accordingly, as shown in the table, 26.0% of the neck replies were disregarded. The 11.0.1 version of the SPSS package (SPSS Inc, Chicago, IL, USA) was used to relate caseness (ie, case versus noncase) to age and replies to questions concerning physical exposures and psychosocial factors. With respect to age, the participants were classified into 5-year age groups with the youngest group, below 25 years of age, as reference.

As for physical exposures and psychosocial factors, the lowest exposure level and the best condition was taken as the reference level. For each factor then, odds ratios were calculated for five levels other than the reference level. In the stepwise analysis, factors with an overall

Table 3. Distribution of the replies to questions concerning psychosocial factors.

Factor	Missing replies (%)	Reply alternative					Total (%)
		Rarely ^a (%)	Rather rarely (%)	Sometimes (%)	Rather often (%)	Often (%)	
Job satisfaction	2.3	1.7	3.2	25.9	40.2	26.6 ^a	100.0
Control of work situation	1.7	2.4	3.3	19.9	36.0	36.7 ^a	100.0
Information about future plans	2.7	17.3	19.0	29.2	20.3	11.5 ^a	100.0
Alternating worktasks	1.8	2.8	4.6	20.2	35.7	34.9 ^a	100.0
Support from supervisors	5.1	3.1	3.2	18.3	25.9	44.3 ^a	100.0
Support from workmates	4.0	3.7	3.4	22.9	25.7	40.3 ^a	100.0
Job responsibility too heavy	3.5	26.3 ^a	28.1	28.6	7.6	5.9	100.0
Work health hazard anxiety	2.3	21.9 ^a	17.1	40.2	10.1	8.5	100.0
Work psychologically demanding	2.0	47.4 ^a	19.8	23.4	4.9	2.5	100.0
Difficulties to relax during leisure time	1.9	54.7 ^a	16.8	18.3	5.2	3.0	100.0
Hurrying without reason	2.1	25.8 ^a	17.0	37.8	11.7	5.7	100.0
Sleeping problems	1.7	65.0 ^a	15.3	12.4	3.2	2.3	100.0
Depression	1.9	61.1 ^a	20.5	13.8	1.7	0.9	100.0

^a Reference level in the analyses.

Table 4. Missing replies and the distribution according to alternatives of replies to the questions concerning musculoskeletal disorders and the proportion of cases in the logistic regression analysis.^a

Location	Proportion of missing replies (%)	Number of replies	Distribution of replies (%)						Proportion of cases in logistic regression analysis (%)
			Never	Rarely	Sometimes	Often	Very often	Total	
Neck	3.5	82 185	38.1	18.5	26.0	10.2	7.2	100.0	23.5
Shoulder	3.2	82 451	35.7	16.2	26.0	12.5	9.5	100.0	29.8
Elbow	4.1	81 665	60.1	15.5	14.0	5.8	4.7	100.0	12.1
Wrist or hand	4.2	81 616	51.5	18.5	19.0	6.6	4.4	100.0	13.5
Upper back	5.1	80 836	50.5	23.9	17.6	5.2	2.8	100.0	9.7
Lower back	2.6	82 985	23.8	14.9	35.7	15.7	10.0	100.0	39.9
Hip	4.5	81 372	65.9	15.4	11.3	4.2	3.1	100.0	8.3
Knee	2.9	82 682	36.5	15.3	27.9	12.1	8.2	100.0	28.2
Ankle or foot	4.0	81 766	62.5	17.2	12.2	4.5	3.6	100.0	9.2

^a For the logistic regression analyses relating disorders to exposures and age, the participants responding with "sometimes" were excluded. The cases were the participants responding with "often" or "very often", who were contrasted to the noncases (ie, participants responding with "never" or "rarely").

P-value exceeding 0.001 were excluded. Result tables report odds ratios (OR) with 95% confidence intervals (95% CI). To reduce the size of the result tables, however, the results are not shown for the “missing reply level” or for the reference level.

Results

The results of the analyses for all of the locations but the ankle or foot are summarized in table 5.

Vibration exposure showed a positive dose–response association with symptoms from all of the locations but

the lower back, lifting heavy burdens corresponded with all but the neck, stooping or twisted posture was related to all but the knee, and hands above the shoulders to all but the lower back and knee. Kneeling only turned out to have a positive dose–response association with symptoms of the knee and wrist or hand.

Out of the 13 questions addressing the perception of the psychosocial environment, four did not show a significant dose–response association with symptoms from any of the eight locations. They were the questions concerning job satisfaction, control of the work situation, and support from supervisors and workmates. On the other hand, positive dose–response associations with all

Table 5. Odds ratios (OR) with 95% confidence intervals (95% CI) for each combination of body location and the highest level of the physical exposure or the psychosocial factor.

Exposure	Body location															
	Neck		Shoulder		Elbow		Wrist or hand		Upper back		Lower back		Hip		Knee	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Vibration	1.34	1.21–1.47 ^a	1.44	1.31–1.59 ^a	1.55	1.40–1.72 ^a	2.21	2.00–2.44 ^a	1.30	1.16–1.46 ^a	1.08	0.98–1.19	1.35	1.20–1.53 ^a	1.09	0.99–1.20
Lifting heavy burdens	1.03	0.92–1.15	1.27	1.14–1.42 ^a	1.62	1.42–1.85 ^a	1.60	1.40–1.84 ^a	1.23	1.06–1.42 ^a	1.90	1.72–2.11 ^a	1.35	1.16–1.57 ^a	1.26	1.13–1.40 ^a
Stooping or twisted posture	1.87	1.67–2.08 ^a	1.77	1.57–1.99 ^a	1.55	1.34–1.80 ^a	1.60	1.38–1.87 ^a	2.23	1.89–2.63 ^a	3.05	2.73–3.42 ^a	1.79	1.53–2.10 ^a	1.19	1.06–1.34 ^a
Hands above shoulders	2.93	2.65–3.24 ^a	3.66	3.32–4.04 ^a	1.77	1.59–1.97 ^a	1.44	1.28–1.62 ^a	1.54	1.35–1.76 ^a	0.77	0.71–0.85 ^b	1.06	0.93–1.19	0.90	0.82–0.99 ^b
Kneeling	0.69	0.62–0.77 ^b	0.70	0.63–0.77 ^b	1.07	0.94–1.22	1.25	1.10–1.42 ^a	0.79	0.69–0.91 ^b	1.12	1.02–1.24	1.19	1.03–1.38 ^a	3.94	3.55–4.37 ^a
Low job satisfaction	0.88	0.75–1.03	0.92	0.79–1.08	0.90	0.75–1.08	0.84	0.71–1.00	0.91	0.76–1.10	1.10	0.94–1.29	0.78	0.63–0.95 ^b	0.96	0.82–1.12
Lack of control	1.01	0.88–1.16	1.16	1.01–1.33 ^a	1.21	1.03–1.41	1.18	1.02–1.37	1.17	0.99–1.37	1.13	0.99–1.29	1.17	0.98–1.40	1.02	0.90–1.16
Poor information	1.30	1.19–1.42 ^a	1.33	1.22–1.44 ^a	1.14	1.04–1.26 ^a	1.28	1.16–1.42 ^a	1.14	1.02–1.27 ^a	1.24	1.14–1.34 ^a	1.17	1.04–1.31 ^a	1.22	1.13–1.32 ^a
Lack of task variation	1.57	1.39–1.78 ^a	1.62	1.43–1.83 ^a	1.29	1.13–1.47 ^a	1.42	1.25–1.61 ^a	1.38	1.20–1.59 ^a	1.51	1.34–1.70 ^a	1.25	1.07–1.46 ^a	1.13	1.00–1.26 ^a
Poor supervisory support	1.03	0.91–1.16	0.94	0.84–1.05	0.99	0.86–1.13	0.95	0.83–1.08	0.97	0.84–1.13	0.91	0.81–1.02	0.97	0.84–1.14	0.92	0.82–1.03
Poor workmate support	1.14	1.03–1.28	1.10	0.99–1.23	0.96	0.84–1.09	1.06	0.93–1.20	1.12	0.98–1.28	1.04	0.93–1.16	1.23	1.07–1.41 ^a	1.08	0.97–1.20
Job responsibility too heavy	0.91	0.83–1.00	0.91	0.83–1.00	0.96	0.86–1.06	1.00	0.90–1.11	1.03	0.92–1.16	1.00	0.91–1.09	1.05	0.94–1.18	1.12	1.03–1.22 ^a
Work health hazard anxiety	2.15	1.97–2.35 ^a	2.37	2.18–2.59 ^a	1.71	1.55–1.89 ^a	1.78	1.62–1.96 ^a	1.91	1.71–2.13 ^a	2.36	2.17–2.57 ^a	1.77	1.58–1.99 ^a	1.87	1.72–2.03 ^a
Work psychologically demanding	1.14	0.99–1.30	1.06	0.92–1.21	1.20	1.03–1.40 ^a	1.16	1.00–1.35 ^a	1.24	1.05–1.45 ^a	1.05	0.92–1.21	0.98	0.82–1.16	1.08	0.94–1.24
Difficult to relax during leisure time	1.12	0.99–1.27	1.06	0.93–1.20	0.92	0.80–1.06	1.16	1.02–1.33 ^a	1.28	1.11–1.49 ^a	1.13	1.00–1.29	1.06	0.91–1.24	1.18	1.04–1.33 ^a
Hurrying without reason	1.78	1.62–1.96 ^a	1.76	1.60–1.93 ^a	1.38	1.24–1.53 ^a	1.35	1.22–1.51 ^a	1.31	1.16–1.47 ^a	1.74	1.59–1.91 ^a	1.34	1.18–1.52 ^a	1.27	1.16–1.40 ^a
Sleeping problems	2.44	2.15–2.78 ^a	2.41	2.11–2.74 ^a	2.21	1.95–2.51 ^a	2.03	1.77–2.32 ^a	2.56	2.23–2.95 ^a	1.99	1.74–2.27 ^a	2.24	1.94–2.60 ^a	1.84	1.63–2.09 ^a
Depression	1.06	0.87–1.30 ^a	1.04	0.85–1.27	1.09	0.87–1.36	1.34	1.09–1.64 ^a	1.19	0.95–1.49 ^a	1.24	1.00–1.53 ^a	1.19	0.95–1.51	1.12	0.93–1.36

^a Combinations for which there was a positive dose–response association between the exposure or factor and symptoms of the musculoskeletal location (ie, for which the OR is monotonously and significantly increasing) as the exposure or factor level increases.

^b Combinations for which there was a corresponding decrease in the OR.

locations were found for the three questions addressing work health hazard anxiety, hurrying without reason, and sleeping problems.

For four combinations, hands above the shoulders–lower back, kneeling–neck, kneeling–upper back, and kneeling–shoulders, a negative dose-response association was found.

Work in awkward postures showed stronger associations with musculoskeletal disorders than with psychosocial factors. Age, as defined in this study, showed a stronger association with musculoskeletal disorders than any other factor analyzed in the study (tables 6 and 7).

The strength of the association between physical exposures and musculoskeletal disorders varied between body locations. Psychosocial factors, on the other hand,

showed a more general and consistent association with musculoskeletal disorders from all locations (table 5).

For exposure to work in a stooping or twisted posture the highest OR values were found for the lower and upper-back disorders with OR values of 3.66 (95% CI 3.32–4.04) and 2.93 (95% CI 2.65–3.24), respectively (table 7). The highest OR values for exposure to work with hands above shoulder level were found for shoulder and neck disorders with OR values of 3.66 (95% CI 3.32–4.04) and 2.93 (95% CI 2.65–3.24), respectively (table 6). The highest OR value for exposure to kneeling was found for knee disorders with an OR value of 3.94 (95% CI 3.55–4.37) (table 7).

Lifting heavy burdens showed more modest associations with lower-back disorders with an OR value of

Table 6. Odds ratios (OR) with 95% confidence intervals (95% CI) for the neck, shoulder, elbow, and wrist or hand and factor-specific levels of exposure.^a

Factor	Neck		Shoulder		Elbow		Wrist or hand	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Vibration conditions								
Rather good	0.96	0.90–1.02	0.99	0.93–1.05	1.03	0.95–1.11	1.16	1.08–1.25
Acceptable	1.01	0.95–1.07	1.11	1.05–1.17	1.13	1.06–1.21	1.25	1.16–1.33
Rather bad	1.23	1.14–1.33	1.27	1.18–1.38	1.42	1.30–1.55	1.63	1.49–1.78
Bad	1.34	1.21–1.47	1.44	1.31–1.59	1.55	1.40–1.72	2.21	2.00–2.44
Lifting heavy burdens								
Rather rarely	.	.	1.02	0.91–1.14	1.09	0.94–1.25	1.05	0.91–1.22
Sometimes	.	.	1.12	1.02–1.24	1.17	1.03–1.32	1.23	1.08–1.39
Rather often	.	.	1.29	1.17–1.43	1.41	1.24–1.60	1.43	1.25–1.62
Often	.	.	1.27	1.14–1.42	1.62	1.42–1.85	1.60	1.40–1.84
Stooping or twisted posture								
Rather rarely	1.15	1.02–1.31	1.19	1.05–1.35	1.15	0.98–1.35	0.99	0.83–1.17
Sometimes	1.41	1.26–1.56	1.31	1.18–1.47	1.23	1.07–1.42	1.20	1.04–1.39
Rather often	1.69	1.52–1.88	1.57	1.41–1.76	1.44	1.25–1.65	1.28	1.10–1.48
Often	1.87	1.67–2.08	1.77	1.57–1.99	1.55	1.34–1.80	1.60	1.38–1.87
Hands above shoulders								
Rather rarely	1.14	1.02–1.28	1.16	1.04–1.29	1.12	0.98–1.27	1.12	0.98–1.28
Sometimes	1.21	1.10–1.34	1.38	1.26–1.52	1.27	1.14–1.42	1.18	1.05–1.33
Rather often	1.64	1.48–1.82	1.98	1.80–2.18	1.49	1.34–1.66	1.36	1.21–1.53
Often	2.93	2.65–3.24	3.66	3.32–4.04	1.77	1.59–1.97	1.44	1.28–1.62
Kneeling								
Rather rarely	0.90	0.80–1.02	.	.	.	.	1.04	0.90–1.21
Sometimes	0.74	0.67–0.82	.	.	.	.	1.06	0.93–1.20
Rather often	0.74	0.67–0.82	.	.	.	.	1.13	0.99–1.28
Often	0.69	0.62–0.77	.	.	.	.	1.25	1.10–1.42
Poor information about future plans								
Rather often	1.04	0.96–1.13	1.03	0.95–1.11	0.99	0.90–1.09	1.07	0.97–1.18
Sometimes	1.12	1.04–1.22	1.12	1.04–1.21	1.05	0.96–1.15	1.17	1.07–1.29
Rather seldom	1.10	1.01–1.20	1.19	1.09–1.29	1.05	0.95–1.16	1.22	1.10–1.35
Seldom	1.30	1.19–1.42	1.33	1.22–1.44	1.14	1.04–1.26	1.28	1.16–1.42
Lack of worktask variation								
Rather often	1.05	1.00–1.11	1.11	1.06–1.17	1.04	0.98–1.10	0.95	0.89–1.01
Sometimes	1.20	1.12–1.28	1.24	1.16–1.32	1.13	1.05–1.21	1.00	0.93–1.07
Rather seldom	1.48	1.33–1.63	1.46	1.33–1.62	1.26	1.12–1.41	1.10	0.99–1.23
Seldom	1.57	1.39–1.78	1.62	1.43–1.83	1.29	1.13–1.47	1.42	1.25–1.61
Job responsibility too heavy								
Rather seldom	.	.	0.89	0.84–0.95	.	.	.	.
Sometimes	.	.	0.90	0.85–0.95	.	.	.	.
Rather often	.	.	0.86	0.79–0.93	.	.	.	.
Often	.	.	0.91	0.83–1.00	.	.	.	.

(continued)

Table 6. Continued.

Factor	Neck		Shoulder		Elbow		Wrist or hand	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Work health hazard anxiety								
Rather seldom	1.06	0.98–1.15	1.04	0.97–1.12	0.98	0.89–1.07	0.94	0.85–1.03
Sometimes	1.43	1.34–1.53	1.44	1.36–1.54	1.21	1.12–1.30	1.19	1.10–1.28
Rather often	1.93	1.77–2.10	2.14	1.97–2.32	1.64	1.49–1.80	1.53	1.39–1.68
Often	2.15	1.97–2.35	2.37	2.18–2.59	1.71	1.55–1.89	1.78	1.62–1.96
Work psychologically demanding								
Rather seldom	1.04	0.98–1.10	1.02	0.96–1.08	.	.	.	.
Sometimes	1.21	1.14–1.28	1.13	1.07–1.20	.	.	.	.
Rather often	1.26	1.14–1.39	1.12	1.02–1.24	.	.	.	.
Often	1.14	0.99–1.30	1.06	0.92–1.21	.	.	.	.
Difficult to relax during leisure time								
Rather seldom	.	.	.	.	.	.	1.00	0.93–1.08
Sometimes	.	.	.	.	.	.	1.13	1.06–1.21
Rather often	.	.	.	.	.	.	1.22	1.09–1.35
Often	.	.	.	.	.	.	1.16	1.02–1.33
Hurrying without reason								
Rather seldom	1.08	1.00–1.16	1.08	1.01–1.16	0.91	0.84–0.99	0.90	0.83–0.98
Sometimes	1.32	1.25–1.41	1.30	1.22–1.37	1.04	0.97–1.11	1.12	1.04–1.20
Rather often	1.69	1.56–1.82	1.57	1.45–1.69	1.24	1.14–1.35	1.21	1.10–1.32
Often	1.78	1.62–1.96	1.76	1.60–1.93	1.38	1.24–1.53	1.35	1.22–1.51
Sleeping problems								
Rather seldom	1.24	1.16–1.32	1.21	1.14–1.29	1.15	1.08–1.24	1.20	1.12–1.29
Sometimes	1.63	1.53–1.73	1.60	1.51–1.71	1.40	1.30–1.50	1.41	1.31–1.52
Rather often	2.08	1.87–2.32	2.13	1.91–2.36	1.74	1.55–1.95	1.86	1.66–2.09
Often	2.44	2.15–2.78	2.41	2.11–2.74	2.21	1.95–2.51	2.03	1.77–2.32
Depression								
Rather seldom	1.06	1.00–1.13	1.02	0.96–1.08	.	.	1.12	1.05–1.20
Sometimes	1.26	1.18–1.35	1.15	1.08–1.23	.	.	1.23	1.14–1.32
Rather often	1.36	1.17–1.58	1.16	1.00–1.35	.	.	1.29	1.10–1.50
Often	1.06	0.87–1.30	1.04	0.85–1.27	.	.	1.34	1.09–1.64
Age								
25–29 years	1.76	1.61–1.92	1.94	1.78–2.10	1.48	1.30–1.68	1.12	1.03–1.22
30–34 years	2.68	2.45–2.93	2.80	2.57–3.04	2.73	2.41–3.08	1.19	1.08–1.31
35–39 years	3.68	3.37–4.02	3.77	3.47–4.09	4.51	4.02–5.06	1.36	1.24–1.49
40–44 years	4.09	3.76–4.46	4.90	4.52–5.31	6.72	6.02–7.51	1.34	1.22–1.46
45–49 years	4.44	4.07–4.84	6.16	5.67–6.69	8.26	7.39–9.23	1.52	1.39–1.66
50–54 years	5.93	5.41–6.51	8.48	7.76–9.27	8.21	7.29–9.24	1.79	1.63–1.97
55–59 years	7.10	6.43–7.85	10.64	9.66–11.73	8.59	7.58–9.75	1.95	1.75–2.17
60+ years	7.01	6.25–7.86	10.85	9.71–12.12	8.41	7.30–9.70	1.99	1.75–2.26

^a The OR was not reported for the reference level of a factor—by definition 1—or for the “reply missing” category.

Table 7. Odds ratios (OR) with 95% confidence intervals (95% CI) for the upper back, lower back, hip, and knee and factor-specific levels of exposure.^a

Factor	Upper back		Lower back		Hip		Knee	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Vibration conditions								
Rather good	1.03	0.95–1.12	.	.	1.09	1.00–1.19	1.06	1.00–1.13
Acceptable	1.00	0.93–1.08	.	.	1.19	1.10–1.29	1.10	1.04–1.16
Rather bad	1.10	0.99–1.21	.	.	1.19	1.07–1.33	1.16	1.08–1.25
Bad	1.30	1.16–1.46	.	.	1.35	1.20–1.53	1.09	0.99–1.20
Lifting heavy burdens								
Rather rarely	0.82	0.70–0.97	0.94	0.85–1.05	1.04	0.89–1.21	0.99	0.89–1.11
Sometimes	0.95	0.83–1.09	1.16	1.06–1.28	1.03	0.90–1.18	1.09	0.99–1.20
Rather often	1.10	0.96–1.27	1.70	1.55–1.87	1.23	1.07–1.41	1.30	1.18–1.44
Often	1.23	1.06–1.42	1.90	1.72–2.11	1.35	1.16–1.57	1.26	1.13–1.40
Stooping or twisted posture								
Rather rarely	1.06	0.88–1.28	1.15	1.02–1.29	0.97	0.81–1.17	.	.
Sometimes	1.31	1.11–1.53	1.50	1.35–1.67	1.11	0.95–1.29	.	.
Rather often	1.82	1.54–2.14	2.10	1.89–2.34	1.39	1.19–1.63	.	.
Often	2.23	1.89–2.63	3.05	2.73–3.42	1.79	1.53–2.10	.	.

(continued)

Table 7. Continued.

Factor	Upper back		Lower back		Hip		Knee	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Hands above shoulders								
Rather rarely	1.25	1.08–1.46	1.04	0.94–1.15	1.27	1.11–1.47	1.02	0.92–1.14
Sometimes	1.18	1.03–1.35	0.95	0.87–1.04	1.21	1.07–1.37	1.13	1.03–1.24
Rather often	1.25	1.09–1.43	0.86	0.78–0.94	1.10	0.97–1.24	1.09	0.99–1.19
Often	1.54	1.35–1.76	0.77	0.71–0.85	1.06	0.93–1.19	0.90	0.82–0.99
Kneeling								
Rather rarely	0.87	0.74–1.03	.	.	.	.	1.18	1.05–1.34
Sometimes	0.80	0.70–0.92	.	.	.	.	1.22	1.10–1.35
Rather often	0.73	0.64–0.84	.	.	.	.	2.11	1.90–2.34
Often	0.79	0.69–0.91	.	.	.	.	3.94	3.55–4.37
Poor information about future plans								
Rather often	.	.	1.00	0.93–1.08	.	.	0.97	0.90–1.05
Sometimes	.	.	1.08	1.00–1.16	.	.	1.05	0.97–1.12
Rather seldom	.	.	1.12	1.03–1.21	.	.	1.14	1.05–1.23
Seldom	.	.	1.24	1.14–1.34	.	.	1.22	1.13–1.32
Lack of worktask variation								
Rather often	1.04	0.97–1.11	1.07	1.02–1.13	.	.	.	.
Sometimes	1.08	1.00–1.17	1.18	1.11–1.25	.	.	.	.
Rather seldom	1.33	1.18–1.50	1.32	1.20–1.46	.	.	.	.
Seldom	1.38	1.20–1.59	1.51	1.34–1.70	.	.	.	.
Job responsibility too heavy								
Rather seldom	.	.	.	.	.	.	1.00	0.94–1.05
Sometimes	.	.	.	.	.	.	1.09	1.03–1.15
Rather often	.	.	.	.	.	.	1.19	1.10–1.29
Often	.	.	.	.	.	.	1.12	1.03–1.22
Work health hazard anxiety								
Rather seldom	0.93	0.83–1.04	1.05	0.98–1.12	1.03	0.93–1.15	1.00	0.93–1.07
Sometimes	1.25	1.14–1.36	1.46	1.38–1.55	1.22	1.11–1.33	1.26	1.18–1.33
Rather often	1.60	1.44–1.79	2.11	1.95–2.28	1.54	1.38–1.73	1.66	1.54–1.80
Often	1.91	1.71–2.13	2.36	2.17–2.57	1.77	1.58–1.99	1.87	1.72–2.03
Work psychologically demanding								
Rather seldom	1.05	0.97–1.14	.	.	.	.	.	.
Sometimes	1.18	1.09–1.28	.	.	.	.	.	.
Rather often	1.21	1.07–1.38	.	.	.	.	.	.
Often	1.24	1.05–1.45	.	.	.	.	.	.
Difficult to relax during leisure time								
Rather seldom	1.17	1.07–1.27	.	.	.	.	.	.
Sometimes	1.18	1.09–1.28	.	.	.	.	.	.
Rather often	1.26	1.12–1.43	.	.	.	.	.	.
Often	1.28	1.11–1.49	.	.	.	.	.	.
Hurrying without reason								
Rather seldom	0.97	0.88–1.07	1.00	0.94–1.07	0.99	0.89–1.10	0.97	0.91–1.03
Sometimes	1.15	1.06–1.25	1.33	1.26–1.40	1.15	1.05–1.25	1.12	1.06–1.18
Rather often	1.34	1.21–1.48	1.64	1.52–1.76	1.26	1.13–1.40	1.25	1.16–1.34
Often	1.31	1.16–1.47	1.74	1.59–1.91	1.34	1.18–1.52	1.27	1.16–1.40
Sleeping problems								
Rather seldom	1.18	1.09–1.28	1.26	1.19–1.33	1.23	1.13–1.34	1.18	1.11–1.25
Sometimes	1.55	1.43–1.69	1.55	1.46–1.65	1.60	1.47–1.74	1.38	1.30–1.47
Rather often	1.90	1.67–2.15	1.87	1.67–2.08	2.04	1.79–2.32	1.62	1.46–1.79
Often	2.56	2.23–2.95	1.99	1.74–2.27	2.24	1.94–2.60	1.84	1.63–2.09
Depression								
Rather seldom	1.06	0.98–1.15	1.19	1.13–1.26	.	.	.	.
Sometimes	1.28	1.18–1.39	1.38	1.29–1.47	.	.	.	.
Rather often	1.55	1.32–1.83	1.55	1.34–1.80	.	.	.	.
Often	1.19	0.95–1.49	1.24	1.00–1.53	.	.	.	.
Age								
25–29 years	1.05	0.95–1.16	1.38	1.28–1.47	1.36	1.17–1.58	1.14	1.07–1.22
30–34 years	1.14	1.03–1.27	1.52	1.41–1.63	2.02	1.74–2.35	1.26	1.17–1.36
35–39 years	1.18	1.06–1.31	1.97	1.83–2.12	2.76	2.40–3.19	1.37	1.27–1.48
40–44 years	1.13	1.02–1.26	2.18	2.03–2.34	4.07	3.56–4.66	1.55	1.44–1.66
45–49 years	1.15	1.04–1.28	2.22	2.06–2.39	5.77	5.06–6.59	1.77	1.65–1.91
50–54 years	1.53	1.37–1.72	2.93	2.70–3.18	8.68	7.59–9.92	2.18	2.01–2.36
55–59 years	1.61	1.43–1.83	3.14	2.87–3.45	11.84	10.31–13.60	2.50	2.29–2.73
60+ years	1.58	1.36–1.84	3.01	2.70–3.36	13.43	11.54–15.62	2.70	2.43–3.00

^a The OR was not reported for the reference level of a factor—by definition 1—or for the “reply missing” category.

1.90 (95% CI 1.72–2.11), followed by elbow and wrist or hand disorders with OR values of 1.62 (95% CI 1.42–1.85) and 1.60 (95% CI 1.40–1.84), respectively (tables 6 and 7).

Exposure to vibration was more strongly associated with neck and upper-extremity disorders than with back and lower-extremity disorders. The strongest relationship was found for the wrists or hands, the most peripheral part of the extremity, with an OR value of 2.21 (95% CI 2.00–2.44), followed by a gradual decrease in the OR values for elbows, shoulders, and the neck (table 6).

Of the psychosocial items, sleeping problems, work health hazard anxiety, and hurrying without reason showed the strongest associations with musculoskeletal disorders of the nine body locations, with OR values in the ranges of 1.84–2.44, 1.71–2.27, 1.27–1.78, respectively (tables 6 and 7).

Discussion

What gives this study its strength is the size of the study group, which provides for good possibilities to demonstrate dose–response associations, if there are any, and to obtain stable risk estimates. Its weakness derived from its cross-sectional character, which made it difficult to draw a conclusion from the associations reported.

Dose–response associations with musculoskeletal disorders were found for both physical and psychosocial factors. The results, in general, support overall results presented in comprehensive reviews (1, 3, 10) and may therefore, to some extent, strengthen the evidence.

Most of the studies on associations between musculoskeletal disorders and work-related factors have focused on the lower back, the neck and neck or shoulder, or the upper extremity. In our study, eight body locations were analyzed to make it possible to study patterns of location-specific risk estimates for various physical and psychosocial factors.

Age was the single most important factor associated with musculoskeletal disorders for all body locations. This association has been reported for samples of populations (11) and for construction workers (8, 12). Age seems to be one of the most important characteristics of the individual in contributing to the development of pain and disability (3). This finding may have implications for intervention strategies.

Physical factors

Higher OR values for musculoskeletal disorders were found for exposure to physical factors than for exposure to psychosocial factors. This finding is in agreement with the results concerning work-related upper-extremity

disorders in a population-based study, carried out in 1996 with 3200 respondents (13), and in a study of low-back pain among scaffolders (14). In a prospective study of low-back pain in a cohort of 861 workers, no significant associations between psychosocial job characteristics and low-back pain was found after adjustment for various physical and individual factors (15). A systematic review of psychosocial factors at work and back pain found evidence for an effect of work-related psychosocial factors but could not establish evidence for any single factor (16). Neck pain, however, was significantly associated with high quantitative demands, reflecting “much to do at work” and with low co-worker support (17). The results concerning physical exposures in our study differed from those in earlier studies of lower-back and neck or shoulder disorders among construction workers (18, 19). This finding can be explained by the fact that the larger and more heterogeneous group of persons in our study was comprised of persons representing a wider range of physical exposures.

Predictors for the occurrence of new episodes of low-back pain were poor general health at baseline in a population-based study of construction workers (20), workers’ stress due to personal relations at work, awkward postures during work and unstable body balance like scaffoldings (21), and a history of back pain and low job satisfaction in a study of employees in an industry (22).

The various physical exposures showed different patterns of association with location-specific musculoskeletal disorders. In contrast, the psychosocial factors showed similar patterns of association with location-specific musculoskeletal disorders. The explanation for this finding could be that physical factors like load, frequency, and the duration of physical strain probably have localized effects on the exposed part of the body, while psychosocial factors have a more general influence on the whole system. To understand fully the probable different pathomechanisms behind location-specific musculoskeletal disorders and widespread pain in relation to the workplace, separate analyses of the groups with located and widespread pain disorders have to be performed.

As for lower-back disorders, evidence, but no strong evidence, for an association with work-related awkward postures was reported in a review by the National Institute for Occupational Safety and Health (NIOSH) from 1997 (1) and supported by others (10, 23, 24). Our results only support the finding of an increased risk associated with work in a stooping or twisted posture.

According to the NIOSH review (1) there is strong evidence for an increased risk of neck and neck or shoulder disorders for people with high levels of static contraction, prolonged static loads, or extreme work postures involving the neck or shoulder muscles. Our results are in accordance with the findings of this review.

Hansson & Westerholm (10), however, found the evidence to be insufficient.

The NIOSH report (1) showed evidence for an association between repeated or sustained shoulder postures with greater than 60 degrees of flexion or abduction and shoulder musculoskeletal disorders in agreement with our findings. The evidence for shoulder postures was strongest when combined with exposure to several physical factors. This finding supports the evidence of an increased risk for shoulder disorders among construction workers often working with hands above shoulder level.

Our finding of an association between knee straining work and knee disorders is supported in prospective studies of floor layers, carpenters and compositors (25) and employees in a large forestry company (26). Miranda et al found (26) similar risk factors, including knee straining work, age, and overweight, for knee disorders as for knee osteoarthritis (26). The association between kneeling and wrist or hand disorders may be explained by the fact that when working in a kneeling posture, one has to support oneself with one hand on the floor while using the other hand for handling machines.

Psychosocial factors

The psychosocial items in our study represent factors associated with the job and work environment, as well as with characteristics of the individual worker. Items related to the job and the work environment are lack of worktask variation, lack of control, work responsibility that is too heavy, psychologically demanding work, poor supervisory support, poor workmate support, and poor information. Psychosocial items that were rather related with the individual worker were work health hazard anxiety, low job satisfaction, difficulties to relax during leisure time, hurrying without reason, sleeping problems, and depression.

Out of the two types of psychosocial items, primarily those rather reflecting individual characteristics showed associations with musculoskeletal disorders. Three of these items, work health hazard anxiety, hurrying without reason, and sleeping problems, showed dose-response associations with musculoskeletal disorders in all body locations. It may therefore be reasonable to assume that these factors may trigger a system giving pain in the whole body. It may also be the other way around. The cross-sectional design of our study did not allow any conclusions to be drawn about cause and effect.

Of all the psychosocial items, sleeping problems showed the highest OR values for six of the eight body locations. There are few reports about sleeping problems as a risk factor for musculoskeletal disorders, but these problems have been reported in connection with fibromyalgia (27). An association between fatigue and short-

term, as well as long-term, sickness absence has also been reported (28).

Anxiety is a factor focused on in research about low-back pain (29), but it is obviously a general problem. Work health hazard anxiety, sleeping problems, and depression may simply be consequences of pain and have to be further analyzed in prospective studies.

Hurrying without reason could be a manifestation of a so-called type A-behavior. In an earlier study of low-back and neck or shoulder disorders among construction workers, a stress index, including the items hurrying without reason and difficulties to relax during leisure time, showed a significant association with lower-back and neck or shoulder disorders (18, 19). In the present study, difficulties to relax during leisure time was only significantly associated with upper-back and wrist or hand disorders. Mental stress may induce muscle tension and has been suggested to contribute to the development of work-related upper-extremity disorders (30). It has recently been demonstrated that mental stress and physical demand activate the same motor units. Lack of rest and recovery seems even more important for health than the magnitude of stress and physical demands during work (31). Mental stress and time for recovery have to be considered in the prevention of musculoskeletal disorders.

Low job satisfaction is not significantly associated with musculoskeletal disorders from any body location, at the level of significance decided in our study. This finding is in contrast to results from reviews (3) and from results from prospective studies of low-back pain (19, 22, 24, 32). However, there are reports on shortcomings concerning reported associations between low-back pain and low job satisfaction (16). Low job satisfaction shows an association with neck and shoulder physical findings and symptoms in a study of machine operators, carpenters, and office workers (33).

Of the factors associated with the job and the work environment in this study, the items lack of control, poor workmate support, and poor supervisory support were not significantly associated with symptoms from any location at the level of significance chosen. Earlier studies of lower-back pain and neck-shoulder trouble among construction workers were not significantly associated with the two support items (18, 19). These results are in contrast to those of Ariens et al (17), who, in a prospective study, found that low co-worker support increased the risk for neck pain. However, doubts concerning the relationship between low-back pain and low workplace social support is reported in a review by Hoogendoorn et al (16).

The item lack of worktask variation showed clear dose-response associations with musculoskeletal disorders from all body locations except the hip and knee. This finding is in agreement with those of other studies, and

there is evidence for repetition as a risk factor for neck and shoulder, shoulder, and hand and wrist disorders (1, 3).

Method

According to estimates our study group constituted some 78% of the total number of persons employed in the industry. A dropout frequency of 22% seems reasonable when compared with those of other studies in the construction industry (34). On one hand, the dropout represents employees not having been reached by invitations and, on the other, employees unwilling or unable to attend the health check-ups. According to the general experience gained in the Bygghälsan check-ups, the construction workers and the foremen examined are representative of their respective categories.

The questionnaire used in this study was a modified version of the standardized Nordic questionnaire for the analysis of musculoskeletal symptoms (9) with reply alternatives from "never" to "very often" instead of from "0 day" to "daily". The persons responding with "very often" or "often" were considered cases. As for low-back pain among construction workers, this practice seems to correspond well with reported symptoms of more than 30 days a year in the Nordic questionnaire. This agreement, in turn, corresponds well to positive findings in a clinical examination of workers in this category who report current low-back pain (35). Earlier analyses of self-reported physical exposure have not indicated that exposure is overestimated from the replies to the physical exposure questions used in the study (36). Most of the questions about the psychosocial work environment stemmed from a large survey of white-collar workers in Sweden's Federation of White Collar Unions and has been adapted to the construction industry (37). The type-A behavior questions were modified questions from the JAS Inventory (Jenkins Activity Survey, type A score), which was originally designed to identify a behavior pattern for coronary heart disease (38). It has not been validated in the revised form used in this study.

Concluding remarks

Age was found to be a stronger determinant than any other factor analyzed in this study. Physical factors, especially awkward work postures, showed strong location-specific risk estimates for musculoskeletal disorders increasing with dose. The strongest risk factors were stooping or twisted postures for lower-back disorders, work with hands above the shoulder level for shoulder and neck disorders, and work in kneeling postures for knee disorders. Work health hazard anxiety, sleeping problems, and hurrying without reason showed dose-

response associations with musculoskeletal disorders from all body locations. The strongest psychosocial determinant for musculoskeletal disorders was sleeping problems. Lack of control, poor workmate support, and poor supervisory support were not, at the significance level chosen in this study, significantly associated with musculoskeletal disorders from any location.

Acknowledgments

The study was supported by grants from The Swedish Construction Federation.

References

1. Bernhard BP, editor. Musculoskeletal disorders (MSD) and workplace factors: critical review. Cincinnati (OH): National Institute for Occupational Safety and Health (NIOSH), US Department of Health and Human Services; 1997. Report no 97-141.
2. Bassols A, Bosch F, Campillo M, Canellas M, Banos JE. An epidemiological comparison of complaints in the general population of Catalonia (Spain). *Pain* 1999;83:9-16.
3. National Research Council and Institute of Medicine (US). Musculoskeletal disorders and the workplace: low back and upper extremities [panel on musculoskeletal disorders and the workplace]. Washington (DC): Commission on Behavioral and Social Sciences and Education, National Academy Press; 2001.
4. Bongers PM, de Vinther CR, Kompier MAJ, Hildebrandt VH. Psychosocial factors at work and musculoskeletal disease [review]. *Scand J Work Environment Health* 1993;19:297-312.
5. Kuorinka I, Forcier L, editors. Work related musculoskeletal disorders (WMSDs): a reference book for prevention. London: Taylor & Francis; 1995.
6. Hildebrandt VH. Back pain in the working population: prevalence rates in Dutch trades and professions. *Ergonomics* 1995;38:1283-98.
7. Xu Y, Bach E, Orhede E. Occupation and risk for the occurrence of low-back pain (LBP) in Danish employees. *Occup Med (Lond)* 1996;46(2):131-6.
8. Holmström E, Engholm G. Musculoskeletal disorders in relation to age and occupation in Swedish construction workers. *Am J Ind Med* 2003;44(4):377-84.
9. Kuorinka I, Jonsson B, Kilbom Å, Vinterberg H, Biering-Sorensen F, Andersson G, et al. Standardised Nordic questionnaire for the analysis of musculoskeletal symptoms. *Appl Ergon* 1987;18:233-7.
10. Hansson T, Westerholm P, editors. Arbete och besvär i rörelseorganen: en vetenskaplig värdering av frågor om samband [Work and musculoskeletal disorders: a critical review of work-relatedness]. Stockholm: Arbetslivsinstitutet; 2001. Arbete och Hälsa 12, Arbetslivsinstitutets förlagstjänst.
11. Andersson I, Ejlertsson G, Leden I, Rosenberg C. Chronic pain in a geographically defined general population: studies of differences in age, gender, social class, and pain localization. *Clin J Pain* 1993;9:174-82.
12. Ueno S, Hisanaga N, Jonai H, Shibata E, Kamijima M.

- Association between musculoskeletal pain in Japanese construction workers and job, age, alcohol consumption, and smoking. *Ind Health* 1999;37(4):449–56.
13. Warren N, Dillon C, Morse T, Hall C, Warren A. Biomechanical, psychosocial, and organizational risk factors for WRMSD: population-based estimates from the Connecticut Upper-Extremity Surveillance Project (CUSP). *J Occup Health Psychol* 2000;5(1):164–81.
 14. Elders LA, Burdorf A. Interrelations of risk factors and low back pain in scaffolders. *Occup Environ Med* 2001;58(9):597–603.
 15. Hoogendoorn WE, Bongers P, de Vet HCW, Houtman IL, Ariens GAM, van Mechelen W, et al. Psychological work characteristics and psychological strain in relation to low-back pain. *Scand J Work Environ Health* 2001;27(4):258–67.
 16. Hoogendoorn WE, van Poppel MN, Bongers PM, Koes BW, Bouter LM. Systematic review of psychosocial factors at work and private life as risk factors for back pain. *Spine* 2000;25(16):2114–25.
 17. Ariens GA, Bongers PM, Hoogendoorn WE, Houtman IL, van der Wal G, van Mechelen W. High quantitative job demands and low coworker support as risk factors for neck pain: results of a prospective cohort study. *Spine* 2001;26(17):1896–901.
 18. Holmström EB, Lindell J, Moritz U. Low back and neck/shoulder pain in construction workers: occupational workload and psychosocial risk factors, part 2: relationship to neck and shoulder pain. *Spine* 1992;17(6):672–7.
 19. Holmström E, Lindell J, Moritz U. Low back and neck/shoulder pain in construction workers: occupational workload and psychosocial risk factors. Part 1: Relationship to low back pain. *Spine* 1992;17(6):663–71.
 20. Croft PR, Papageorgiou AC, Thomas E, Macfarlane GJ, Silman AJ. Short-term physical risk factors for new episodes of low back pain: prospective evidence from the South Manchester Back Pain Study. *Spine* 1999;24(15):1556–61.
 21. Kaneda K, Shirai Y, Miyamoto M. An epidemiological study on occupational low back pain among people who work in construction. *J Nippon Med Sch* 2001;68(4):310–7.
 22. van Poppel MN, Koes BW, Deville W, Smid T, Bouter LM. Risk factors for back pain incidence in industry: a prospective study. *Pain* 1998;77(1):81–6.
 23. Hoogendoorn WE, Bongers PM, de Vet HC, Douwes M, Koes BW, Miedema MC, et al. Flexion and rotation of the trunk and lifting at work are risk factors for low back pain: results of a prospective cohort study. *Spine* 2000;25(23):3087–92.
 24. Vingård E, Alfredsson L, Hagberg M, Kilbom Å, Theorell T, Waldenström M, et al. To what extent do current and past physical and psychosocial occupational factors explain care-seeking for low back pain in a working population? results from the Musculoskeletal Intervention Center-Norrtilje Study. *Spine* 2000;15;25(4):493–500.
 25. Jensen LK, Mikkelsen S, Loft IP, Eenberg W. Work-related knee disorders in floor layers and carpenters. *J Occup Environ Med* 2000;42(8):835–42.
 26. Miranda H, Viikari-Juntura E, Martikainen R, Riihimäki H. A prospective study on knee pain and its risk factors. *Osteoarthritis Cartilage* 2002;10(8):623–30.
 27. Schaefer KM. Sleep disturbances and fatigue in women with fibromyalgia and chronic fatigue syndrome. *J Obstet Gynecol Neonatal Nurs* 1995;24(3):229–33.
 28. Janssen N, Kant IJ, Swaen GM, Janssen PP, Schroer CA. Fatigue as a predictor of sickness absence: results from the Maastricht cohort study on fatigue at work. *Occup Environ Med* 2003;60 Suppl 1:i71–6.
 29. Jonsson E, Nachemson A, editors. *Ont i ryggen, ont i nacken, en evidensbaserad kunskapssammanställning, volym 1. 1 ed* [Back pain, neck pain, an evidence based review, vol 1. 1 ed]. Stockholm: Statens beredning för medicinsk utvärdering; 2000. p 19–21.
 30. Lundberg U. Psychophysiology of work: stress, gender, endocrine response, and work-related upper extremity disorders. *Am J Ind Med* 2002;41(5):383–92.
 31. Lundberg U. [Psychosocial stress and musculoskeletal disorders: psychobiological mechanisms] [In Swedish, English summary]. *Läkartidningen* 2003;100(21):1892–5.
 32. Papageorgiou AC, Macfarlane GJ, Thomas E, Croft PR, Jayson MI, Silman AJ. Psychosocial factors in the workplace—do they predict new episodes of low back pain?: evidence from the South Manchester Back Pain Study. *Spine* 1997;15(10):1137–42.
 33. Tola S, Riihimäki H, Videman T, Viikari-Juntura E, Hänninen K. Neck and shoulder symptoms among men in machine operating, dynamic physical work and sedentary work. *Scand J Work Environ Health* 1988;14(5):299–305.
 34. Lindell J. Bortfall vid Bygghälsans hälsoundersökningen [Drop-outs from Bygghälsan's health check-ups]. Stockholm: Bygghälsans Forskningsstiftelse; 1988. Report no 2:1.
 35. Holmström E, Moritz U. Low back pain—correspondence between questionnaire, interview and clinical examination. *Scand J Rehabil Med* 1991;23(3):119–25.
 36. Holmström E. Musculoskeletal disorders in construction workers—related to physical, psychosocial and individual factors. Lund (Sweden): Lund University; 1992.
 37. Karasek R, Gardell B, Lindell J. Work and non-work correlates of illness and behavior in male and female Swedish white-collar workers. Mimeo, Los Angeles (CA): Department of Industrial and Systems Engineering, University of South California; 1985.
 38. Jenkins CD, Rosenman R, Friedman M. Development of an objective psychological test for the determination of the coronary-prone behavior pattern in employed men. *J Chronic Dis* 1967;20:371–9.