Scand J Rehab Med 26: 131–142, 1994

RISK INDICATORS IN THE PSYCHOSOCIAL AND PHYSICAL WORK ENVIRONMENT FOR WORK-RELATED NECK, SHOULDER AND LOW BACK SYMPTOMS: A STUDY AMONG BLUE- AND WHITE-COLLAR WORKERS IN EIGHT COMPANIES

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ABSTRACT. The study was based on a questionnaire and included 209 white-collar workers and 241 blue-collar workers in eight companies. The questionnaire deals with musculoskeletal symptoms, psychosocial and physical load factors. The relationship between job factors and neck, shoulder and low-back symptoms was analysed. The Nordic Musculoskeletal Questionnaire (NMQ) was supplemented with an additional question regarding whether or not the symptoms were believed to be related to work. The associations between the psychosocial factors and musculoskeletal symptoms were substantially higher when solely work-related symptoms were included in the analyses; these associations were of the same magnitude as that between several physical work load factors and work-related musculoskeletal symptoms. This study suggests that calculations of associations based solely on the NMQ, without the inclusion of questions to elicit reports of symptoms that are believed to be work-related, could have a powerful effect-masking consequence.

Key words: musculoskeletal symptoms, psychosocial factors, physical work-load, work-related, white-collar workers, blue-collar workers.

INTRODUCTION

The role of potential risk indicators in the development of neck, shoulder and back symptoms has been discussed in the literature (3, 8, 9, 21, 25, 27, 29, 30, 32, 37, 43). Musculoskeletal symptoms have a multifactorial etiology, probably with a net-formed causality (rather than chains) (10). Risk indicators for neck and shoulder symptoms are supposed to be long exposure to work with the arms raised above shoulder level and the neck bent, a high working pace and an ergonomically unsuitable work-place. Heavy physical work, heavy or frequent manual operations, repeated rotation of the trunk and prolonged sitting are likely to be risk indicators for low-back symptoms.

Scientific documentation of the role of psychological and social work factors is less prolific. However, a significant association between low overall job satisfaction and low-back symptoms has been found in several studies (5, 28, 39). One of the largest and longest prospective studies in the field suggests that job satisfaction plays an important role for reporting of low-back pain (1, 2). Moreover, Johansson & Nonås (18) found that low-back symptoms correlate with low stimulus from the work, a high psychological work load and poor supervisor climate. The relationship between psychosocial job factors and musculoskeletal pain among 22,180 employees was examined by Linton (24) in a cross-section of a study base; he found that a poor psychosocial work environment increased the risk for neck and back pain, and in a study including six occupations it was found that high psychological demands were significantly associated with back, neck and shoulder symptoms (38). A combination of a poor psychological work environment and a high physical load has been found to increase the risk for musculoskeletal symptoms (15, 24). Studies by Johansson (15) and Holmström et al. (11, 12) show that psychosocial factors also have to be considered when one is dealing with workers exposed to a heavy physical work load. In addition, a "poor" psychological work environment has been reported to be related to a higher prevalence of neck and shoulder pain among occupations in the white-collar sector (26).

However, it is not known whether psychosocial factors are also of importance among white- and blue-collar workers in general. It also seems important to examine the association between, on the one hand, the physical work-load and the psychosocial work environment and, on the other hand,

work-related musculoskeletal symptoms in the same study in order to increase our understanding of the importance of different types of potential risk indicators.

The aims of this study were, firstly, to describe the psychosocial working environment and physical work-load and to assess the prevalence of neck, shoulder and low-back symptoms (both in general and work-related) among blue- and white-collar workers and, secondly, to analyse the relationships between, on the one hand, psychosocial work factors and physical work-load factors and, on the other, self-reported musculoskeletal symptoms (both in general and work-related).

MATERIALS AND METHODS

Procedure

The study was based on questionnaire surveys carried out at eight companies during working hours. The subjects answered the questionnaire anonymously. The researcher explained the purpose of the study and was present during the data collection.

Study sample

The study was carried out at eight large metal industry companies in Sweden. The companies represented different sectors such as manufacture, assembly and the mechanical industry. The data, among the blue-collar workers, were based on occupations such as assemblers, truck drivers, packers, NC-operators, punchers, welders, smith workers, lathe-machine operators and milling-machine operators. The sub-samples were in most cases randomly selected, but in some cases an entire division at a company participated. In such a case it was pointed out that it was important to choose a division which did not have prevalences of musculoskeletal symptoms deviating from the average at the company. This judgement was made by the researcher jointly with members of the occupational health service. The participation rate was approximately 90%.

The study sample included 241 blue-collar workers of whom 39% were females. Eighty-seven per cent had more than 2 years of employment at the company and approximately 1% less than 1 year. Seventy-four per cent had more than 2 years of experience of their present job and 7% less than 1 year of experience. The sample also included 209 white-collar workers of whom 35% were females. Ninety-five per cent had more than 2 years of employment at the company and approximately 1% less than 1 year. Seventy-seven per cent had more than 2 years' experience of their present job and 6% less than 1 year's experience.

Instrument

The questionnaire comprised four parts: individual and employee-related variables, occurrence of musculoskeletal symptoms, the psychosocial work environment, and the physical work-load.

Individual and employee-related variables: This part consisted of items concerning years of employment, age and sex.

Musculoskeletal symptoms: The questions were derived from the standardised Nordic questionnaire for the analysis of musculoskeletal symptoms (NMQ) (22), which refers to the human body as divided into anatomical regions and requires the respondent to answer if he or she has had any symptoms (aches, pain, discomfort) in the previous 12-month period. According to Kuorinka & Kilbom (23), simultaneous self-reporting of symptoms and estimations of postures can be carried out without systematic errors. This report deals with neck, shoulder and low-back symptoms.

The NMQ was supplemented with an additional question regarding whether or not the symptoms were believed to be related to the subject's present work. This question had three fixed response alternatives: 1) "The symptoms are solely related to my present work" (WR), 2) "The symptoms are partly related to my present work, partly not", 3) "The symptoms are solely related to other factors than my present work". The importance of reports of symptoms that are believed to be work-related has been pointed out by Dickinson et al. (6).

The analyses of work-related symptoms included only those who specifically considered their symptoms to be due to their present work (alternative 1) and, hence, those subjects were categorised as belonging to the "work-related symptom group" (WR) (for each locomotive organ).

Psychosocial work environment: Workers' attitudes to their job were assessed using a "standardised" questionnaire (33, 34). According to Rubenowitz, it is possible to distinguish five important psychosocial factors (based on factor analytical procedures) which should be satisfied at work in order to meet the person's fundamental psychological needs. The questionnaire measures the factors by mean values. Each factor comprises five items and each item has five fixed response alternatives which are given points from 1 to 5, where 1 means very unsatisfactory and 5 very satisfactory.

Internal-consistency data (the Cronbach alpha coefficients) have previously been calculated on a "standard" data material of 9333 subjects (35). The alpha coefficient is an indication of reliability (4). The data are based on almost one hundred different occupational groups, such as workers (blue- and white-collar) in assembly and manufacturing plants, the metal industry, home care, schools and offices. The distribution between the sexes is almost equal here: 49.3% males and 50.7% females. These factors, with Cronbach alpha coefficients in brackets, are:

1) Influence on and control over work (alpha = 0.65)
   The items are: Influence on the rate of work, influence on working methods, influence on the allocation of tasks, technical control, and influence on rules and regulations.
2) Supervisor climate (alpha = 0.84)
   The items are: Contact with immediate supervisor, if immediate supervisor asks for advice on work-related problems, immediate supervisor considering viewpoints, immediate supervisor providing information, and the communication climate in the organisation.
3) Stimulus from the work itself (alpha = 0.85)
   The items are: If work is stimulating and interesting, if work is varied and diversified, opportunity to use talents and skills, opportunity to learn new things at work, and the general feeling about the work.
4) Relations with fellow workers (alpha = 0.82)
   The items are: Relationships and contacts with fellow workers, talking with fellow workers about the job, extent of experiencing a cheerful atmosphere, discussion of work-related problems, and regarding fellow workers as good friends or not.
5) Psychological work load (alpha = 0.83)

The items are: Stress at work, work-load, extent of feeling tired and exhausted after work, possiblity of relaxing and having a break, and mental strain

Subjective estimation of physical work-load: The self-reported exposures to physical work-load consisted of 1) nine illustrated questions regarding different work postures (all with 6-point response scales): trunk bent forward 20–60° (both duration and frequency), trunk bent forward > 60° (both duration and frequency), trunk rotation > 45° (duration), work with the hands above shoulder level (duration), head bent forward (duration), head bent backward (duration) and head rotation (duration), 2) one question regarding sitting (6-point response scale, duration), 3) eight questions concerning manual materials handling (6-point response scale for duration and 5-point response scale for frequency): carrying, pushing or pulling using force corresponding to 1–5 kg (duration), carrying, pushing or pulling using force corresponding to 0·1 – < 1 kg (duration), pushing or pulling force corresponding to 6–15 kg (duration), carrying, pushing or pulling using force corresponding to > 15 kg (duration), lifting weight 0.1– < 1 kg (frequency), lifting weight 1–5 kg (frequency), lifting weight 6–15 kg (frequency) and lifting weight > 15 kg (frequency) and 4) one question about precision movements (6-point scale, duration). For these questions both the reliability and the validity have been reported (40, 41, 42).

Two additional questions were used in the present study. These questions concerned repetitive movements (6-point scale, duration) and static stress (6-point scale, duration). Static stress was explained in the questionnaire as "Static stress is the type of stress occurring during prolonged tension of the same muscles without any movements", which is a quotation form the National Swedish Board of Occupational Safety and Health ordinance concerning "Work postures and working movements" (31).

Statistical analyses

Partial correlation coefficients were calculated as second-order partials, adjusted for the effects of sex and age, to measure the association between a risk indicator and a locomotive organ (i.e. neck, shoulder *or* low-back symptoms). The level of significance was set at $p < 0.05$.

Factor analysis was used in the form of principal component extraction. The number of factors was determined with the extraction rule roots (eigenvalues) greater than one (Kaiser's criterion). The transformation method used the Orthotran/Varimax orthogonal solution (yielding independent factors). In order to determine if, in general, the collection of correlations in the correlation matrix was different from zero, Bartlett's Test of Sphericity was used. The Cronbach alpha coefficient was calculated for each factor that consisted of three or more items, but for factors which only consisted of two items the Pearson product-moment correlation coefficient (r) was used. Some adjustments of the items were made for items with a skewed distribution, that is, some of the 5 and 6-point response scales were categorised into 2 to 4-point response scales. Point biserial correlations and phi coefficients were applied to data containing dichotomous variables; according to Gorsuch (7), it is quite legitimate to intermix both phis and point biserials with product-moment correlations, with no major problems.

RESULTS

Musculoskeletal symptoms

The prevalences of musculoskeletal symptoms in the previous 12-month period according to the NMQ (symptoms in general) were P = 0.39 (CI: 0.33–0.45) for neck symptoms, P = 0.44 (CI: 0.38–0.50) for shoulder symptoms and P = 0.43 (CI: 0.37–0.50) for low-back symptoms among the blue-collar workers. The prevalences were P = 0.45 (CI: 0.38–0.52) for neck symptoms, P = 0.39 (CI: 0.32–0.46) for shoulder symptoms and P = 0.42 (CI: 0.35–0.49) for low-back symptoms among the white-collar workers.

When solely work-related symptoms were taken into consideration the prevalences of musculoskeletal symptoms decreased to P = 0.31 (CI: 0.25–0.37) for neck symptoms, P = 0.36 (CI: 0.29–0.42) for shoulder symptoms and P = 0.32 (CI: 0.26–0.39) for low-back symptoms among the blue-collar workers. As regards the white-collar workers the prevalences of musculoskeletal symptoms decreased to P = 0.29 (CI: 0.22–0.36) for neck symptoms, P = 0.26 (CI: 0.19–0.32) for shoulder symptoms and P = 0.18 (CI: 0.11–0.24) for low-back symptoms. For more details, see Johansson (16).

Psychosocial work environment

The blue-collar workers were less satisfied with their "Influence on and control over work" ($t = -6.1$, $df = 448$, $p < 0.001$), "Supervisor climate" ($t = -2.5$, $df = 448$, $p < 0.05$), "Stimulus from the work itself" ($t = -14.0$, $df = 448$, $p < 0.001$) and "Relations with fellow workers" ($t = -6.1$, $df = 448$, $p < 0.001$), compared with the white-collar workers (see Fig. 1). For more details, see Johansson & Rubenowitz (19).

Subjective estimation of physical work load

Inspection of the data in Table I shows that the 53% of the blue-collar workers reported repetitive movements and 22% static stress almost all the time, but the estimated duration with the head bent backward was very low. As can be seen in Tables III and IV, the exposure to weights more than 15 kg was rather low.

Table II shows that the subjects' exposure (white-collar workers) was very low for trunk bent forwards more than 60°, work with the hands above shoulder level and head bent backward. Tables V and VI show the

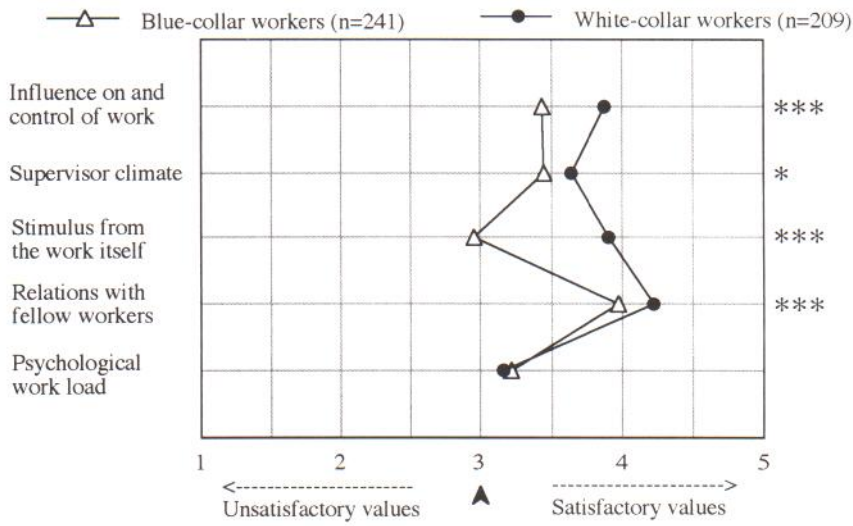

Fig. 1. Profile of attitudes to work, measuring the psychosocial work environmental factors by mean values. Note: significant differences are marked with asterisks (* $p < 0.05$; *** $p < 0.001$).

duration and frequency of manual material handling and, as can be seen, the exposures to weights more than 5 kg was very low among the white-collar workers.

Two factor analyses regarding physical work load were performed, separately, for blue and white collar workers. Twenty physical work load items was performed among the blue-collar workers and five factors emerged from the analysis (Table VII). Bartlett's Test of Sphericity resulted in a Chi Square value significant at the $p < 0.0001$ level. These factors, with Cronbach alpha coefficients or the Pearson product-moment correlation coefficient, are: Factor 1 (6 items)

Table I. *Work postures and working movements among blue-collar workers ($n = 241$) in eight manufacturing companies*

Duration per working day.

	Not at all	About 1/10 of the time	About 1/4 of the time	About half the time	About 3/4 of the time	Almost all the time
Precision movements	22%	12%	9%	15%	12%	30%
Repetitive movements	9%	7%	4%	16%	11%	53%
Static stress	36%	16%	8%	12%	5%	22%
Sitting	25%	26%	14%	18%	7%	10%
Trunk bent forward 20–60°	8%	19%	16%	25%	13%	19%
Trunk bent forward > 60°	23%	42%	20%	9%	3%	3%
Trunk rotation > 45°	26%	44%	12%	9%	3%	6%
Work with the hands above shoulder level	46%	31%	13%	5%	3%	2%
Head bent forward	10%	26%	17%	16%	10%	21%
Head bent backward	73%	17%	6%	3%	1%	0%
Head rotation > 45°	48%	29%	7%	9%	3%	4%

Table II. *Work postures and working movements among white-collar workers (n = 209) in eight manufacturing companies*
Duration per working day.

	Not at all	About 1/10 of the time	About 1/4 of the time	About half the time	About 3/4 of the time	Almost all the time
Precision movements	62%	14%	6%	9%	3%	6%
Repetitive movements	38%	12%	11%	18%	9%	12%
Static stress	68%	9%	8%	10%	1%	4%
Sitting	1%	3%	8%	17%	33%	38%
Trunk bent forward 20–60°	16%	12%	17%	20%	20%	15%
Trunk bent forward > 60°	83%	16%	0%	1%	0%	0%
Trunk rotation > 45°	57%	34%	6%	2%	1%	0%
Work with the hands above shoulder level	91%	7%	2%	0%	0%	0%
Head bent forward	12%	21%	16%	16%	16%	19%
Head bent backward	94%	5%	1%	0%	0%	0%
Head rotation > 45°	58%	30%	8%	3%	1%	0%

"Heavy manual materials handling" (alpha = 0.87), Factor 2 (2 items) "Light manual materials handling" (r = 0.68), Factor 3 (6 items) "Extreme work postures" (alpha = 0.74), Factor 4 (3 items) "Light bent work postures" (alpha = 0.68) and Factor 5 (3 items) "Monotonous working movements" (alpha = 0.60). In the following analysis this result from the factor analysis has been taken into consideration, that is, the 20 physical work load items have been grouped into five fundamental physical workload factors.

Thirteen physical work load items were performed among the white-collar workers. Self-reported work postures and manual materials handling with very low exposure levels were excluded in the analysis (see Tables II, V and VI). Table VIII shows that four factors emerged from the factor analysis. Bartlett's Test of Sphericity resulted in a Chi Square-value significant at the $p < 0.0001$ level. These factors, with Cronbach alpha coefficients or the Pearson product-moment correlation coefficient, are: Factor 1 (4 items) "Bent work postures" (alpha = 0.67), Factor 2 (4 items) "Light manual materials handling" (alpha = 0.80), Factor 3 (3 items) "Monotonous working movements" (alpha = 0.62) and Factor 4 (2 items) "Twisted work postures" ($r = 0.50$). In the following analysis this result from the factor analysis has been taken into consideration, that is, the 13 physical work

Table III. *Manual materials handling among blue-collar workers (n = 241) in eight manufacturing companies*
Duration per working day.

	Not at all	About 1/10 of the time	About 1/4 of the time	About half the time	About 3/4 of the time	Almost all the time
0.1–< 1 kg	6%	16%	9%	9%	9%	51%
1–5 kg	12%	29%	15%	15%	12%	17%
6–15 kg	29%	28%	17%	11%	7%	8%
> 15 kg	47%	27%	9%	8%	3%	6%

Table IV. *Manual materials handling among blue-collar workers (n = 241) in eight manufacturing companies* Frequency per working hour (h^{-1}).

	Not at all	< 1 h^{-1}	1–10 h^{-1}	11–30 h^{-1}	> 30 h^{-1}
0.1– < 1 kg	6%	12%	27%	23%	32%
1–5 kg	12%	25%	37%	12%	14%
6–15 kg	29%	28%	31%	8%	4%
> 15 kg	47%	28%	18%	2%	5%

Table V. *Manual materials handling among white-collar workers (n = 209) in eight manufacturing companies* Duration per working day

	Not at all	About 1/10 of the time	About 1/4 of the time	About half the time	About 3/4 of the time	Almost all the time
0.1– < 1 kg	26%	37%	10%	7%	6%	14%
1–5 kg	57%	34%	5%	2%	1%	1%
6–15 kg	90%	8%	1%	0%	1%	0%
> 15 kg	93%	6%	1%	0%	0%	0%

load items have been grouped into four fundamental physical work load factors.

Associations between risk indicators and musculoskeletal symptoms

Examination of the data in Table IX suggests, firstly, that in general the partial correlation coefficients increased when solely *work-related* symptoms were included in the analysis among the blue-collar workers. Secondly, several psychosocial and physical work load factors show *non*-significant partial correlations with musculoskeletal symptoms according to the NMQ, but become significant when an adjusted NMQ (i.e., solely work-related symptoms) was used. Thirdly, out of 15 correlation tests regarding psychosocial job factors and *work-related* neck, shoulder and low-back symptoms, 10 tests were significant. By way of comparison, out of 15 correlation tests regarding physical work load factors and *work-related* neck, shoulder and low-back symptoms, only 3 tests were significant.

Table X shows the relationships between psychosocial and physical work load factors on the one hand and self-reported neck, shoulder and low-back symptoms on the other, among the white-collar workers. The psychosocial factors show *non*-significant partial correlations with neck, shoulder and low-back symptoms in general according to the NMQ. However, regarding the adjusted NMQ, that is, *work-related* symptoms, there were significant partial correlations between 1) shoulder symptoms and five psychosocial factors out of five and 2) neck symptoms and two psychosocial factors out of five. The significant associations between work-related musculoskeletal symptoms and psychosocial factors are of the same magnitude as that between 1) bent work postures and neck symptoms, 2) light manual materials

Table VI. *Manual materials handling among white-collar workers (n = 209) in eight manufacturing companies* Frequency per working hour (h^{-1}).

	Not at all	< 1 h^{-1}	1–10 h^{-1}	11–30 h^{-1}	> 30 h^{-1}
0.1– < 1 kg	25%	25%	33%	10%	7%
1–5 kg	56%	28%	14%	2%	0%
6–15 kg	86%	14%	1%	0%	0%
> 15 kg	91%	8%	1%	0%	0%

Table VII. *Factor analysis with factor loadings among 241 blue-collar workers in eight plants*
D = duration and F = frequency. Five factors which had an impact on a high proportion of the aspects in question; (–) indicates that the factor has an impact on a low proportion of the aspects in question. Decimal points are not given for the factor loadings. Salient loadings > 0.50 (marked bold and underlined).

Physical work load items	Factor 1 Heavy materials handling	Factor 2 Light materials handling	Factor 3 Extreme postures	Factor 4 Light bent work postures	Factor 5 Monotonous movements
Precision movements (D)	–03	–14	–01	–02	**71**
Repetitive movements (D)	–06	31	14	24	**68**
Static stress (D)	04	11	16	05	**67**
Sitting (D)	–23	02	–22	**68**	08
Trunk forward 20–60° (D)	01	20	33	**69**	–04
Trunk forward > 60° (D)	19	–10	**74**	16	–04
Trunk rotation > 45° (D)	23	–05	**62**	10	10
Work with the hands above shoulder level (D)	–02	21	**55**	–29	18
Head bent forward (D)	04	11	11	**80**	16
Head rotation > 45° (D)	07	–17	**60**	03	26
Trunk forward 20–60° (F)	09	29	**64**	11	–05
Trunk forward > 60° (F)	37	01	**68**	–10	06
Materials handling 0.1– < 1 kg (D)	06	**79**	–05	27	09
Materials handling 1–5 kg (D)	**73**	27	19	–02	11
Materials handling 6–15 kg (D)	**89**	00	06	04	06
Materials handling > 15 kg (D)	**77**	–01	24	–05	–13
Materials handling 0.1 – < 1 kg (F)	15	**88**	02	03	03
Materials handling 1–5 kg (F)	**66**	37	24	–13	10
Materials handling 6–15 kg (F)	**89**	–03	01	01	01
Materials handling > 15 kg (F)	**74**	01	25	–11	–16

handling and neck/shoulder symptoms, 3) monotonous working movements and low-back symptoms, and 4) twisted work postures and neck/shoulder symptoms. Monotonous working movements show stronger associations with neck and shoulder symptoms.

DISCUSSION

This study was based upon employees from eight companies and the response rate was high. It would appear that this sample is representative of both the blue- and white-collar category of workers in Sweden, which makes it reasonable to assume that the external validity is high and the observed associations between job factors and musculoskeletal symptoms may exist among the workers as a whole.

The psychosocial work environment measurements are reproducible in different samples and the internal scale reliability as assessed by the Cronbach's alpha coefficient is good (13, 35). Studies show that these scales have a good convergent validity (14, 17, 33) and other researchers have noted a good convergent validity for similar psychosocial measures (20).

Factors were constructed from the physical work-load items in the questionnaire to increase the reliability and the Cronbach's alpha coefficients for these physical work-load factors were satisfactory. A categorisation of physical load items into 2 to 4-point scales was carried out, which implies less detailed information and for some items only categorisation into the two groups of being exposed or unexposed. This categorisation probably means that the validity was increased. Wiktorin et al. (41) found that subjects' ability to discriminate between being exposed and unexposed to certain manual materials handling and postures seems to be acceptable, but their ability to quantify physical load exposures in more detail seems to be rather poor. The factor analyses and the

Table VIII. *Factor analysis with factor loadings among 209 white-collar workers in eight plants*
D = duration and F = frequency. Four factors which had an impact on a high proportion of the aspects in question; (–) indicates that the factor has an impact on a low proportion of the aspects in question. Decimal points are not given for the factor loadings. Salient loadings > 0.50 (marked bold and underlined).

Physical work load items	Factor 1 Bent work postures	Factor 2 Light manual materials handling	Factor 3 Monotonous working movements	Factor 4 Twisted work postures
Precision movements (D)	**52**	02	15	01
Repetitive movements (D)	21	27	**66**	05
Static stress (D)	–07	07	**76**	23
Sitting (D)	34	–20	**66**	–07
Trunk forward 20–60° (D)	**66**	–09	21	42
Trunk rotation > 45° (D)	14	12	12	**76**
Head bent forward (D)	**68**	09	27	30
Head rotation > 45° (D)	23	–01	04	**76**
Trunk forward 20–60° (F)	**66**	31	–20	12
Materials handling 0.1– < 1 kg (D)	23	**77**	–02	–21
Materials handling 1–5 kg (D)	–13	**86**	07	22
Materials handling 0.1 – < 1 kg (F)	27	**78**	03	–10
Materials handling 1–5 kg (F)	–07	**80**	10	29

categorisation of physical work load items have the result that both the reliability and the validity increased for these exposures.

A number of tests were carried out. The most striking finding, among the blue-collar workers, was that the physical work load factors show *non*-significant partial correlations (adjusted for the effects of sex and age) with neck, shoulder and low-back symptoms according to the NMQ (symptoms in general) and out of 15 correlation tests regarding *work-related* symptoms, only 3 tests were significant. This is on the whole a weak set of findings since one of the significant correlations could be completely random. One explanation for the result in this study among blue-collar workers could be that in correlational studies, or a cross-section of the study base, the selection bias is a serious problem because of health-selective turnover on the job, which results in an underestimate of the true effect (10). In addition, having or not having musculoskeletal symptoms does not seem to cause any differential misclassification of self-reported exposures to work postures (41), which means that this nondifferential misclassification of exposure has an effect-masking consequence. However, according to Wiktorin et al. (41) musculoskeletal symptoms seems to introduce a slight ("tendency") differential bias for some lifting variables; the scientific support for this statement is rather weak and further investigations are necessary to clarify whether self-reported *work-related* musculoskeletal symptoms influence self-reported estimation of physical work-load.

Inspection of the data in Table IX (blue-collar workers) shows that out of 15 partial correlation tests (adjusted for the effects of sex and age) regarding psychosocial job factors and *work-related* musculoskeletal symptoms, 10 tests were significant. By way of comparison, out of 15 correlation tests regarding psychosocial job factors and musculoskeletal symptoms *according to the NMQ*, 7 tests were significant. The strongest associations were between the factor "psychological work-load" and work-related neck, shoulder and low-back symptoms. The significant associations between the factor "psychological work-load" and musculoskeletal symptoms are in conformity with studies in different occupations which have used the same operational definition of this factor (15, 18, 36).

The correlations between psychosocial factors and neck, shoulder and low back symptoms show some striking findings among the white-collar workers (see Table X). Surprisingly, there were *non*-significant correlations between psychosocial job factors and neck, shoulder and low-back symptoms according to the NMQ (i.e. symptoms in general). By way of

Table IX. *Partial correlation coefficients (second-order partials) between risk indicators and locomotive organs (i.e. neck, shoulder or low-back symptoms) among blue-collar workers*

Partial correlation coefficients adjusted for the effects of sex and age. NMQ = Nordic Musculoskeletal Questionnaire, i.e. musculoskeletal symptoms in general in the previous 12-month period ($n = 241$) and WR = work-related musculoskeletal symptoms in the previous 12-month period ($n = 194 - 209$). Significant partial correlation coefficients are marked bold and underlined. Note: Decimal points are omitted. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

	Neck		Shoulder		Low-back	
Risk indicator	NMQ	WR	NMQ	WR	NMQ	WR
Psychosocial factors						
Influence on and control over work (low)	03	03	**14***	**18***	08	07
Supervisor climate (poor)	**13***	**16***	10	**16***	**17****	**18***
Stimulus from the work (low)	08	**14***	**19****	**26*****	11	**16***
Relations with fellow workers (poor)	−02	04	08	09	05	07
Psychological work load (high)	**22*****	**25*****	**18****	**27*****	**34*****	**35*****
Physical work load factors (see Table VII)						
Heavy materials handling (high)	09	08	05	11	06	07
Light materials handling (high)	−06	−10	01	04	04	04
Extreme work postures (high)	06	10	06	**14***	12	**16***
Light bent work postures (high)	03	10	02	03	09	11
Monotonous working movements (high)	06	13	08	**15***	06	08

contrast, five psychosocial factors out of five were significantly associated with *work-related* shoulder symptoms and two psychosocial factors out of five were associated with *work-related* neck symptoms; these associations were of the same magnitude as that between several physical work-load factors and work-related musculoskeletal symptoms. The non-significant correlations between almost all risk indicators and work-related low-back symptoms may partly be explained by the low prevalence of symptoms (18%) among the subjects.

The validity of information regarding the self-reporting of musculoskeletal symptoms as *work-related* or not, could be illustrated by the following points: Firstly, the questionnaire was filled in anonymously thereby reducing the response set due to a need to present oneself in a socially desirable way. Secondly, the content validity is estimated to be high. If this is taken into consideration we believe that the information bias, which has to do with exaggeration and wrong information given on purpose, is not a serious problem in this study. However, we are aware of that self-reporting of musculoskeletal symptoms as work-related or not give rather crude information—but this information is probably better than no information at all (10).

The present study suggests that calculations of associations based solely on the NMQ, without the inclusion of questions to elicit reports of symptoms that are believed to be work-related, could have a powerful effect-masking consequence. In other words, the *absence* of significant correlations between

Table X. *Partial correlation coefficients (second-order partials) between risk indicators and locomotive organs (i.e. neck, shoulder or low-back symptoms) among white-collar workers in eight manufacturing companies*
Partial correlation coefficients adjusted for the effects of sex and age. NMQ = Nordic Musculoskeletal Questionnaire, i.e. musculoskeletal symptoms in the previous 12-month period ($n = 209$) and WR=work-related musculoskeletal symptoms in the previous 12-month period ($n = 141–167$). Significant partial correlation coefficients are marked bold and underlined. Note: Decimal points are omitted. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

	Neck		Shoulder		Low-back	
Risk indicator	NMQ	WR	NMQ	WR	NMQ	WR
Psychosocial factors						
Influence on and control over work (low)	07	**17***	08	**17***	−09	−05
Supervisor climate (poor)	03	10	13	**20***	−07	−06
Stimulus from the work (low)	10	15	13	**22****	−04	−02
Relations with fellow workers (poor)	01	07	13	**24****	−13	−11
Psychological work load (high)	11	**21****	13	**21****	08	−01
Physical work load factors (see Table VIII)						
Bent work postures (high)	**19****	**20***	10	13	−05	05
Light materials handling (high)	**15***	14	**18***	**18***	10	09
Monotonous working movements (high)	**35*****	**38*****	**28*****	**32*****	**15***	**22***
Twisted work postures (high)	**22****	**23****	**14***	**16***	03	06

psychosocial job factors and neck/shoulder symptoms according to the NMQ was *not evidence of absence* of significant correlations between psychosocial job factors and *work-related* neck/shoulder symptoms. These findings are strengthened by the fact that studies among home care workers show similar results (15). In a study on nursing aides, Dehlin & Berg (5) compared subjects *with* low-back symptoms and divided them into the two groups: those who considered their low-back symptoms were due to their work and those who did not. They found that the subjects who considered their low-back symptoms to be work-related exhibited less positive relations with supervisors and fellow workers. In general, the validity might improve if future research included questions to indicate which reported symptoms are believed to be work-related. Moreover, the severity of symptoms ought to be quantified.

The white-collar group of workers is estimated to have a rather light physical work-load, and comparisons with blue-collar workers show that the blue-collar workers have significantly higher physical load exposures. However, this study clearly shows that both the physical work-load (especially monotonous working movements) and psychosocial factors should be considered in the prevention of work-related musculoskeletal symptoms among white-collar workers.

Even though most studies do not allow for the determination of cause-effect relationships, it seems reasonable to conclude that several psychosocial factors do correlate with musculoskeletal symptoms. It thus appears that when there are *significant* correlations between psychosocial job factors and musculoskeletal symptoms, the correlations only have *one* direction, that is, *if* the relationship is significant *then* the direction is: "*poor*" psychosocial environ-

ment and *high* prevalence of symptoms. Consequently, future research should assume that the effect under study can have *one direction only*, that is, a *one-sided* test should be used. Future research in this field also requires longitudinal designs.

To recapitulate, the use of the NMQ (without considering the symptoms as work-related or not), the healthy worker effect, and the nondifferential misclassification of self-reported exposures to work postures, have a powerful effect-masking consequence. Hence, the *true* effect of a poor psychosocial work environment and a high physical load is probably even greater than the results from this correlational study indicate. Consequently, this underestimation of the risk can have serious consequences for the workers (10), and therefore even a rather weak, but significant, association between a risk indicator and a symptom should be observed with great interest in the context of disease prevention and rehabilitation.

ACKNOWLEDGEMENTS

This study was supported by grants from the Swedish Work Environment Fund, Stockholm. We are grateful to Professor Jörgen Winkel (NIOH, Solna, Sweden) for his valuable support in the selection and use of questions regarding self-reported exposures to physical work-load.

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