Scand J Rehab Med 23: 165–173, 1991

PSYCHOSOCIAL JOB FACTORS AND SYMPTOMS FROM THE LOCOMOTOR SYSTEM—A MULTICAUSAL ANALYSIS

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ABSTRACT. The effects of physical and psychosocial work environment factors on emotions, psychosomatic and endocrine (cortisol and testosterone) states, back pain, symptoms of degenerative joint disease, and absenteeism for sickness, were studied in 147 men and 60 women in six occupations representing widely different physical and psychological activities. In most subjects, measurements were carried out twice to four times over one year. Statistical analyses were performed of the associations between different factor levels, such as age, gender, height, body mass index, and physical stressors at work. It was found that psychological work demands were associated with physiological indicators of strain (plasma cortisol and self-reported muscle tension) and that self-reported muscle tension was associated with several emotional reactions as well as with symptoms from the back, neck and shoulders. Little possibility for decision-making was associated with a high rate of absenteeism for sickness. In men, a high plasma testosterone level was associated with self-reported muscle tension. The results indicate that work environment factors influence mood, bodily tension and somatic symptoms, but that load on the locomotor system and opportunity to influence decisions play an important and more direct role in absenteeism for sickness.

Key words: muscle tension, psychosocial job stress, plasma cortisol, plasma testosterone, spine, sickness absenteeism, pain.

The etiology of locomotor symptoms is multifactorial. Environmental load, i.e. physical load and psychosocial conditions, as well as individual disposition are frequently discussed as etiological factors in the literature. Several studies show that ergonomic factors such as lifting in bent and twisted body postures have an impact on low back pain (10). Repetitive strain or maintained strained postures may have an impact on occupational cervico-brachial disorders (12). However, a specific kind of occupational exposure may cause discomfort/pain for some individuals but not for all. Kihlbom et al. (7) found that the individual's way of performing the work, e.g. the shoulder abduction and neck flexion angles, was correlated with symptoms from the neck and shoulder, indicating more problems at higher loads.

The perceived pain and the ability to work despite locomotor discomfort/pain also varies among individuals. Early ergonomic and/or therapeutic interventions may reduce the duration of sickness (3, 11).

Neck and shoulder pain has been found to correlate with psychosomatic symptoms as well as with perceived anxiety and stress at work (9). It has also been shown that serious illness in the spouse during one year increases the risk of developing back pain during the following year in middle-aged construction workers (13). Also workers in occupations characterized as monotonous or boring or not giving the worker an opportunity to influence decisions showed a higher frequency of back pain than those in other occupations (1).

Thus, there is a need for further clarification of the interplay between mechanical load, psychosocial factors and such bodily reactions, e.g. muscle tensions and endocrine responses, as may induce locomotor symptoms. One problem with analyses of this kind is that independent variables such as work load, years at work, monotony, and opportunity to influence decisions might be interrelated.

The aim of the present study was to analyse how variables such as job conditions and individual factors correlate with psychological and physiological reactions and how all these factors influence perceived locomotor pain and health. Job conditions (physical as well as psychosocial) were hypothesized to influence physiological, emotional and psychiatric states as well as perceived muscle tension. These states were then hypothesized to influence the likelihood of back, neck and joint pain. The interrelationships between these classes of factors were analysed.

Table I *a. Number of participants in measurements of psychosocial factors and body mass index*

	Men	Women	Total
Psychosocial factors	136	52	188
Body mass index	132	49	181

STUDY GROUP AND METHODS

In order to provide a diversified study group with many kinds of psychosocial and physical stressors, participants were recruited from a stratified sample of six different occupational groups, namely physicians, symphony musicians, air traffic controllers, waiters, airplane mechanics, and freight handlers. All were recruited from workplaces within the Stockholm region (14).

The intention was to sample as many women as men for each occupational group and for each one of three age groups, namely 25–30, 40–45 and 55–60 years of age. Owing to shortage of subjects in some of the cells this was not possible. Among the airplane mechanics and freight handlers there were no women. Among musicians and air traffic controllers only a few women were available. Of the 323 subjects who were selected from the lists of employers, 207 (64%) participated. Women had a higher participation rate than men (81% versus 61%). Table I *a* shows the number of subjects within each occupation. In all, 136 men and 52 women filled out questionnaires about psychosocial work conditions (Table I *b*).

Data from four different measurement days during one year were collected. On each occasion a number of measurements were performed. Diaries describing emotional states to be filled out once an hour (or at least as close to once an hour as possible) during working hours and leisure as well as self-triggered blood pressure measurements (reported in detail elsewhere (14)), on the same occasion were used. This part of the study was completed by 182 subjects. Questionnaires describing the work environment were distributed in the morning with the diaries. On the same mornings blood specimens were taken in the fasting state before work started. Such measurements were available from all the 207 participants on at least one occasion. For most variables measured there were between one and four observations for each subject. When two or more observations were available (80% of the subjects) the mean was calculated and used in the present analysis.

As height and obesity might have an impact on locomotor symptoms (2) it was considered necessary to adjust all the results for height and body mass index (weight in kilograms/the square of height in meters). This information was available for 181 subjects (Table I *b*).

In the final analysis additional drop-outs took place owing to the fact that information regarding all the studied variables was required for the multivariate analysis. Therefore, the number of men varied between 132 and 136 in the different multivariate analyses, and the number of women varied between 48 and 52. Ages ranged between 26 and 62 (mean 41). The age and sex distribution was comparable across occupations except in freight handlers and airplane mechanics (men only) and in air traffic controllers (women younger than other groups). All analyses have been adjusted for age and sex.

The variables studied were grouped into six classes, namely physical and psychosocial stressors, psychological states, physiological states, musculoskeletal symptoms, and absenteeism for sickness.

Physical stressors at work

Measures of physical stressors were obtained from the questionnaire constructed by the Foundation for Occupational Medicine in Örebro (16). The question: "Does your work mean ... (yes/no)?" regarding four different physical stressors, namely heavy lifting, monotonous movements, difficult postures and physical inactivity was utilized. These questions were distributed on two different examination days only (occasions 1 and 3, respectively), and the data accordingly was based upon one or two measurements.

Psychosocial stressors at work

Measures of psychosocial stressors were obtained on all measurement days. A Swedish version of Karasek's demand/control questionnaire was utilized (6). This provides measures of psychological demands (five questions), intellectual discretion (four questions) and authority over decisions (two questions).

In addition, a special questionnaire regarding psychosocial factors at work, that had been introduced in our previous studies, was utilized (15). By means of factor analysis the following indices were constructed from this questionnaire, namely "positive factors", roughly corresponding to social support at work (six questions, ... calm and pleasant atmosphere ..., ... good cohesion ..., ... work mates supporting me ..., ... understanding for a bad day ..., ... easily agreeing with superiors ..., ... at ease with work mates ...), "conflict" (four questions, ... boss treating in humiliating ways ..., ... boss not able to distribute and delegate work ..., ... frequent conflict with superiors ..., ... frequent conflicts at my work site ...), "lack of possibility to talk" (two questions, ... nobody I can talk to about personal problems ..., nobody I can talk to about job problems) and "rush" (two questions, ... important to be fast and hang on ..., ... personnel turnover high ... (14)).

Table I *b. Number of male and female participants in the analysis of blood specimens according to occupation*

	Men	Women	Total
Physicians	19	17	36
Air traffic controllers	20	8	28
Freight handlers	28	–	28
Waiters	20	26	46
Airplane mechanics	30	–	30
Symphony musicians	30	9	39

Psychological states and psychosomatic reactions

Psychological states were measured by means of two different methods. The first method was based on diary protocols on emotional states. As close to once an hour as possible the subject was asked to fill out a protocol. The question was: "How do you feel right now?" An adjective check list was used. For each adjective there were four response categories ranging from "not at all" to "a lot". Three "emotion" states were constructed on the basis of the responses. On a given occasion the subject was considered "sad" when he/she had noted "somewhat" or "a lot" of "sad" or "depressed". He/she was considered "angry" if he/she had noted "angry" or "irritated" to the same degree. For "worried" the same method was used for the adjectives "worried", "tense" and "rushed". For each subject six measurement occasions were required for a calculation of emotional states that day. For some subjects there were up to seventeen measurements in a day, and there could be between one and four measurement days. On the basis of all available measurements from the subject, the percentage of "sad", "angry" and "worried" was calculated (14).

Measures of "tiredness" and "difficulty in falling asleep" were obtained from two separate four graded questions in a symptom questionnaire (15). Two gastrointestinal indices were obtained by means of factor analysis from the same questionnaire, namely "dyspepsia" (three questions on heart burn, diarrhea and flatulence), and "malaise" (three questions on poor appetite, constipation and epigastralgia).

Physiological states

Measurements of physiological states were obtained during all the measurement days (one to four days) both from objective measures and from self-administered questionnaires. The details of the objective measurement procedures have been described elsewhere (15). Plasma cortisol and plasma testosterone (men only) were measured in the fasting state in the morning before work started (14, 15). Blood specimens were centrifuged immediately after blood clotting. The plasma was frozen within four hours. Systolic blood pressure during working hours was measured by the subjects themselves by means of self-triggered equipment (reported elsewhere (14)). The procedure has been shown to provide reliable measurements (14).

Muscle tension was measured by means of a self-administered questionnaire, constructed by one of the authors (Westin). It has eleven questions

Do you frequently
wrinkle your forehead?
contract your eyelids?
raise your shoulders?
contract your neck?
contract your chewing muscles?
hold tools unnecessarily tensely?
hold your breath?
breathe tensely?
contract your stomach muscles?
sit in the front part of the chair?
grind your teeth?

There were three response categories—not at all—yes, sometimes—yes, often. By means of factor analysis four indices were constructed, namely "muscle tension" (raise shoulders and contract neck muscles, hold tools unnecessarily tensely, contract stomach muscles, eigen value = 3.36, factor loadings 0.36–0.43) "type A tension" (two items, wrinkle forehead and sit in the front part of the chair, eigen value = 1.0 factor loadings 0.45–0.66) "breath tension (two items, hold breath and breath tensely, eigen value = 1.1, factor loadings 0.51–0.57) and finally chewing muscle tension (grind teeth, contract chewing muscles, eigen value = 1.36 factor loadings = 0.51–0.57).

Symptoms from back, neck and shoulders and from other joints

Measures of symptoms from back, neck and shoulders and from other joints were obtained from the symptom questionnaire constructed by the Foundation for Occupational Medicine in Örebro (16). The two questions were: Do you frequently experience ... symptoms from your back, neck or shoulders? ... other joints? (yes/no). A total score for each individual was calculated on the basis of one to four observations.

Absenteeism for sickness

Measures of absenteeism for sickness were obtained from self-administered questionnaires distributed on all the four measurement days. On the first occasion the subjects were asked to describe absence for sickness during the past twelve months and on the other three occasions they were asked to describe this for the past three months. On each occasion they were questioned regarding total number of occasions absent (five response categories ranging from zero to more than ten times) and total number of days absent (six response categories ranging from zero to more than two months).

Statistical analysis

A series of canonical correlations were computed. In these analyses, each subject's average score based upon one to four measurements was utilized. All the analyses were adjusted for age, gender, height and body mass index. In addition, the analyses of associations between psychosocial working environment factors and psychological states, between psychosocial working conditions and physiological states and between psychological states and physiological states were adjusted for physical stress at work. In this adjustment each one of the four questions regarding physical stress was used as a dichotomous variable (yes/no). The correlations between psychosocial working conditions and symptoms firstly from the back, neck and shoulders and secondly from other joints were computed in two versions, one adjusted for physical stress at work and the other unadjusted for physical stress at work. A separate analysis including plasma testosterone was made for men only. In the case of plasma cortisol, women who were pregnant, breast-feeding or on the pill were excluded.

In the tables, two-tailed significance levels are presented for each canonical correlation. However, owing to the large number of analyses, a significance level of at least 0.01 is used in the text. The only exception from this rule is the results regarding absence for sickness in relation to the work environment. In this case hypotheses could be more easily formulated in advance. Accordingly, in this case the less conservative 0.05 level of significance is used in the text.

Table II. *Psychosocial conditions in relation to psychological states and symptoms*

Canonical correlations adjusted for age, gender, height, body mass index and physical stressors ($n=134$)

	Sadness	Anger	Worry	Tiredness	Sleep disturbance	Dyspepsia	Loss of appetite	Job characteristics
Conflicts at work, high score = bad condition	−0.04	0.04	0.20*	0.21*	0.24**	0.09	0.20*	Psychosocial stressors
Lack of possibility to talk, high score = bad condition	−0.02	−0.04	0.19*	0.22**	0.27**	0.20*	0.22**	
Rush, high score = bad condition	−0.16	−0.15	0.08	0.19*	0.21	0.15	0.29*	
Demands, high score = bad condition	0.03	0.03	0.27**	0.21*	0.25**	−0.05	0.13	
Intellectual discretion high score = good condition	0.06	−0.01	0.16	0.02	0.08	−0.17	0.02	Psychosocial resources
Authority over decisions, high score = good condition	0.04	0.04	0.01	−0.20*	−0.16	−0.12	−0.07	
Positive factors, high score = good condition	0.07	−0.18*	−0.25**	−0.30**	−0.24**	−0.21*	−0.23**	

*$p<0.05$. **$p<0.01$.

Table III. *Psychosocial conditions in relation to physiological states*

Canonical correlations adjusted for age, gender, height, body mass index and physical stressors ($n=136$)

	Plasma cortisol	Syst. BP at work	Muscle tension	Breath tension	Chewing tension	Type A tension	Job characteristics
Conflicts at work, high score = bad condition	0.04	0.12	0.08	0.24**	−0.08	0.06	Psychosocial stressors
Lack of possibility to talk, high score = bad condition	0.04	−0.05	0.21*	0.23**	0.05	0.19*	
Rush, high score = bad condition	−0.12	0.02	0.16	0.18*	0.09	0.18*	
Demands, high score = bad condition	0.17*	−0.09	0.21*	0.10	−0.03	0.16	
Intellectual discretion high score = good condition	0.13	0.03	0.02	−0.03	0.06	−0.01	Psychosocial resources
Authority over decisions, high score = good condition	0.08	0.11	−0.12	−0.14	−0.08	−0.07	
Positive factors, high score = good condition	−0.11	−0.09	−0.09	−0.10	−0.09	−0.13	

*$p<0.05$. **$p<0.01$.

Table IV. *Psychosocial conditions and physical stressors at work in relation to symptoms from back, neck and shoulders and from other joints*

Canonical correlations adjusted for age, gender, height and body mass index. Within parentheses adjustment also for physical stressors (n=140–150)

	Back, neck and shoulders		Other joints		Job characteristics
Conflicts at work, high score = bad condition	0.01	(0.03)	0.09	(0.17*)	Psychosocial stressors
Lack of possibility to talk, high score = bad condition	0.17*	(0.14)	0.05	(0.04)	
Rush, high score = bad condition	0.11	(0.04)	0.07	(0.09)	
Demands, high score = bad condition	0.26**	(0.23**)	0.17*	(0.13)	
Intellectual discretion, high score = good condition	−0.15	(−0.07)	−0.03	(0.06)	Psychosocial resources
Authority over decisions, high score = good condition	−0.15	(−0.03)	−0.17*	(−0.11)	
Positive factors, high score = good condition	−0.02	(0.02)	0.03	(0.07)	
Heavy lifting	0.23**		0.22**		Physical stressors
Monotonous movements	0.28**		0.31**		
Difficult postures	0.34**		0.34**		
Physical inactivity	0.14		0.01		

*$p<0.05$. **$p<0.01$.

RESULTS

Table II shows the associations between psychosocial factors at work and psychological states. In the diaries, worry is the emotion that correlates most strongly with psychosocial working conditions, namely with psychological demands, and negatively with positive factors. Tiredness correlates with lack of possibility to talk and negatively with positive factors. Sleep disturbance correlates with conflicts, lack of possibility to talk, rush, psychological demands and negatively with positive factors. Loss of appetite finally correlates with lack of possibility to talk and negatively with positive factors.

Table III shows the relationships between psychosocial working conditions and physiological states. Breath tension correlates with conflicts and lack of possibility to talk.

Table IV shows the relationships between psychosocial and physical working conditions on one hand and symptoms firstly from the back, neck and shoulders and secondly from other joints on the other hand. The correlations between psychosocial conditions and symptoms were first unadjusted and then adjusted for physical stressors at work. The unadjusted version of this analysis shows that high psychosocial demands are associated with symptoms from the back, neck and shoulders. After adjustment for physical stressors this association remains significant. The associations between heavy lifting on one hand and symptoms from the back, neck and shoulders as well as from other joints are of the same magnitude as that between psychological demands and symptoms from the back, neck and shoulders. Monotonous movements and difficult postures, on the other hand, show stronger associations with symptoms.

Table V shows the intermediate associations between physiological states, psychological states and psychosomatic symptoms. Plasma cortisol and systolic blood pressure during working hours do not correlate with any of the psychological states. Muscle ten-

Table V. *Physiological states in relation to psychological states and psychosomatic symptoms*

Canonical correlations adjusted for age, gender, height and body mass index and physical stressors ($n=131$)

	Plasma cortisol	Syst. blood pressure during work hours	Muscle tension	Breath tension	Chewing muscle tension	Type A tension
Sadness	−0.05	−0.10	0.16	−0.10	0.29**	0.20*
Anger	−0.11	−0.11	0.22**	−0.05	0.34**	0.23**
Worry	0.01	0.02	0.41**	0.23**	0.25**	0.42**
Tiredness	0.00	0.05	0.29**	0.14	0.15	0.18*
Sleep disturbance	0.00	−0.04	0.25**	0.18*	0.17	0.27**
Dyspepsia	−0.02	−0.09	0.22*	0.20*	0.20*	0.22*
Loss of appetite	−0.14	−0.04	0.23*	0.22*	0.21*	0.29**

*$p<0.05$. **$p<0.01$.

sion correlates with anger, worry, tiredness and sleep disturbance. Breath tension correlates with worry. Chewing muscle tension correlates with sadness, anger and worry. Type A tension correlates with anger, worry, sleep disturbance and loss of appetite.

Table VI shows the intermediate associations between physiological states and symptoms firstly from the back, neck and shoulders and secondly from other joints. This analysis has been adjusted for age, gender and body mass index. Muscle tension correlated with symptoms from the back, neck and shoulders.

Table VII, finally, shows the associations between psychosocial conditions at work and absenteeism for sickness. This analysis was also adjusted for age, gender, body mass index and in the case of psychosocial stressors (a and b) physical stressors. None of these associations reach the 0.01 level of significance. However, using the 0.05 level of significance it is seen that low authority over decisions is associated with a high number of days absent from work. This association disappears when adjustment for physical stressors is made. The corresponding analysis of relationships between physical stressors and absenteeism for sickness indicates a significant association between monotonous movements and difficult postures, and number of days absent. No associations are observed with number of occasions absent.

In the analysis including men only ($n=100$), significant canonical correlations ($p<0.01$) are observed between worry and testosterone ($r=0.26$) and several significant associations are shown between psychosocial working conditions and plasma testosterone (conflict, $r=0.24$, positive factors, $r=-0.28$ and authority over decisions, $r=-0.25$). There is also a significant association between plasma testosterone and self-reported muscle tension ($r=0.25$) as well as a significant negative association between plasma cortisol and plasma testosterone ($r=-0.32$). As with the total analysis no other associations among physiological variables are observed except among the different muscle tension factors.

DISCUSSION

The present study was based upon six occupations. The attrition rate was relatively high, and the representativeness thus limited. Still, the fact that the subjects studied represent many different kinds of work activities and that it was possible to adjust for individual factors as well as for physical work stress makes it reasonable to assume that the observed associations may exist in the working population as a whole. It should be pointed out, however, that the

Table VI. *Physiological states in relation to symptoms from back, neck and shoulders and from other joints*

Canonical correlations adjusted for age, gender, height and body mass index ($n=144$)

	Back, neck and shoulders	Other joints
Plasma cortisol	0.02	0.06
Systolic blood pressure working hours	−0.06	−0.03
Muscle tension	0.38**	0.15
Breath tension	0.18*	0.13
Tooth tension	0.02	−0.05
Type A tension	0.16	0.13

*$p<0.05$. **$p<0.01$.

Table VII. *Sickness absenteeism and "health" in relation to psychosocial factors and physical stressors at work*

Canonical correlations adjusted for age, gender, height and body mass index (a, b and c). In table a and b adjustment also for physical stressors ($n=130$–140)

	Number of occasions absent	Number of days absent	Job characteristics
Conflicts at work, high score = bad condition	0.01 (a)	−0.05	Psychosocial stressors
Lack of possibility to talk, high score = bad condition	−0.04	−0.02	
Rush, high score = bad condition	0.09	0.05	
Demands, high score = bad condition	0.10	0.03	
Intellectual discretion, high score = good condition	−0.04 (b)	−0.03	Psychosocial resources
Authority over decisions, high score = good condition	−0.10	−0.20*	
Positive factors, high score = good condition	−0.01	0.03	
Heavy lifting	0.06	0.15	Physical stressors (c)
Monotonous movements	0.00	0.19*	
Difficult postures	0.09	0.22*	
Physical inactivity	0.14	0.08	

*$p<0.05$. **$p<0.01$.

attrition rate was in general higher among those with manual work than among others. Thus, the attrition rate among freight handlers was 42%, among airplane mechanics it was 41% and among male waiters 50%. Accordingly, this analysis may underestimate associations that are mediated by factors common in male manual work.

A large number of tests were carried out. Separate hypotheses were formulated for direct associations between work environment factors and sickness absenteeism. Accordingly a somewhat less strict significance criterion was used, the 0.05 level. Out of 22 such tests only three were significant. This is on the whole a weak set of findings since at least one of the three could be completely random. For the other tests on the whole population (excluding the testosterone analyses since they were based upon men only) 181 tests were carried out. Thirty-three of them were significant on the more conservative 0.01 level. This is of course much more than would be expected by chance alone.

We have chosen to treat all the study groups as one study population. Although the occupational groups are different the distributions of the study variables could be expected to be close to those in the normal working population. The sample as a whole, however, reported a higher level of psychological demands than a random sample of working men and women in Stockholm (17). Accordingly it is possible that psychological demands was a more important variable in this study than it would be in others.

The findings are strengthened by the fact that 80% of the subjects studied had measurements for most variables performed on two to four occasions. Thus, for most subjects the measures used have less "randomness" than in most studies of this kind.

The main emphasis in the present study was on the pathways from the psychosocial working environ-

ment to symptoms from the spine and joints. It was assumed that an elevated plasma cortisol level could be of significance since a long-lasting corticosteroid activity could make muscles more vulnerable to load. Although the results showed that, as expected, there was an association between psychological demands at work and a high plasma cortisol level there was no additional pathway from cortisol to symptoms. Also, the results indicated that a high systolic blood pressure during working hours was unrelated to plasma cortisol in the morning when the subjects arrived at work. Sadness in the diaries was unrelated to muscle tension in general, but showed a weak association with high systolic blood pressure at work in men (not in women). Thus, sadness, high systolic blood pressure at work and plasma cortisol were unrelated to symptoms from the back, neck and shoulders and from other joints although there were expected interrelationships between them.

In this study the most striking finding was the strong relationship between muscle tension as it was recorded in the new questionnaire and symptoms from the back, neck and shoulders. Other strong relationships were observed between muscle tension and emotional states as well as between psychological demands and lack of possibility to talk on the one hand and muscle tension on the other hand. These findings support the notion that muscle tension is an important pathway from psychosocially adverse job conditions to symptoms from the locomotor system. Chewing muscle tension and type A tension scores were related to all kinds of negative emotions in the diaries whereas breath tension was only related to worry.

In men testosterone was observed to correlate both with muscle tension and worry and also with a number of psychosocial working conditions. Thus, men with high testosterone levels reported more conflicts, fewer positive factors and less authority over decisions than others. Thus testosterone seemed to have more relevance than cortisol in these pathways. A previous study of our group (15), however, has shown that longitudinal variations may follow the opposite pattern—increasing job demands in relation to the decision latitude being associated with decreasing testosterone levels (at least in men without physically strenuous work). In fact a correlation indicating an association between high levels of psychological job strain and high plasma testosterone was found during normal periods (when according to the individual's judgment his psychological job strain did not exceed his habitual level), but when job strain increased this association disappeared. Thus the role of testosterone in stress mechanisms is complicated.

The effort to standardize for physical load and other problems was made by means of four self-administered questions which were treated as separate variables. The validity and reliability of these measures have been shown to be satisfactory (18), as were also the validity and reliability of questions regarding symptoms from the locomotor system.

Data on sickness absenteeism were self-reported and may therefore not be objectively verified. They were also limited by the fact that work absenteeism specifically for symptoms from the back, neck, shoulders and other joints was not identifiable. The lack of association between sickness absenteeism and psychosocial factors may be partly due to the relatively high number of non-participants. It is possible that those who did not participate had a high sickness absenteeism as well as many psychosocial problems. Still, it is of interest that psychosocial working conditions had relatively limited effects on work absenteeism after adjustment for physical stressors. One reason for this finding could be the association between physical and psychosocial stressors.

The measure muscle tension in the present study was the perceived tension in different daily situations. It would be interesting to record by use of electromyography the validity of this measure. There are studies suggesting increased muscle activity in neck muscles induced by mental stress (19, 20). It has ben shown that maintained (static) muscle activity causes fatigue symptoms. An upper limit of 2–5% of maximum muscle force has been suggested to avoid pain symptoms in monotonous work postures (5). However, this limit as well as the force–activity relationship has been thoroughly discussed (21, 22). Even lower levels of maintained muscle activity combined with unfavourable pause patterns might contribute to the development of locomotor symptoms (21). Whether those subjects perceiving high muscle tension have an increased high rest-tension or use higher activity levels than others in different defined situations remains to be answered. Different techniques to reduce perceived tension in chronic pain patients have been shown to reduce the perceived pain (8). It is possible that psychosocial stressors at work influence the psychological states, which influence physiological reactions like increased muscle tension. This may contribute to the development of pain symptoms from the spine. As none of the significant correlation coefficients had a high absolute value, the pathways

between exposure, reactions and symptoms seem to be multifactorial.

While negative psychosocial stressors at work were related to several negative psychological states, tensions, and pain symptoms, positive factors, i.e. 'support at work', were inversely related to the negative psychological factors but not correlated at all with locomotor symptoms or sickness absenteeism. The only psychosocial factor related to absenteeism for sickness was authority over decisions. When subjects have a high decision latitude it may be easier to choose working tasks, breaks and postures that are less painful and thus make working possible in spite of pain. As expected, monotonous work movements and difficult postures were associated both with perceived neck, back and other locomotor symptoms and also with the number of days absent from work. Heavy lifting was only related to pain symptoms. It is possible that the work environment factors influence mood, bodily tension, and perceived pain, but that load on the locomotor system and possibility to influence decisions play an important role for sickness absenteeism.

ACKNOWLEDGEMENTS

This work was supported by grants from the Volvo Research Foundation and by the Work Environment Fund. Valuable theoretical suggestions were contributed by Thomas Berggren at the Foundation for Occupational Medicine in Örebro.

REFERENCES

1. Alfredsson, L., Spetz, C.-L. & Theorell, T.: Type of occupation and near-future hospitalization for myocardial infaraction and some other diagnoses. Int J Epidemiol *14:* 378–388, 1985.
2. Battié, M. C.: The reliability of physical factors as predictors of the occurrence of back pain reports. A prospective study within industry. Thesis, University of Gothenburg, Sweden, 1989.
3. Bergquist-Ullman, M.: Acute low back pain in industry. Thesis, University of Gothenburg, Sweden, 1977.
4. Harms-Ringdahl, K. & Ekholm, J.: Intensity and character of pain and muscular activity levels elicited by maintained extreme flexion position of the lower-cervical-upper-thoracic spine. Scand J Rehab Med *18:* 117–126, 1986.
5. Jonsson, B.: Kinesiology. *In* Contemporary Clinical Neurophysiology, EEG supplement no. 34 (eds. W. Cobb & H. van Duijin), pp. 417–428. Elsevier, Amsterdam, 1978.
6. Karasek, R. A.: Job demands, job decision latitude, and mental strain: Implications for job redesign. Admin Sci Q *24:* 285–307, 1979.
7. Kilbom, Å., Persson, J. & Jonsson, B. G.: Disorders of the cervico-brachial region among female workers in the electronics industry. International Journal of Industrial Ergonomics *1:* 37–47, 1986.
8. Linton, S. J., Melin, L. & Stjernlöf, K.: The effects of applied relaxation and operant activity training on chronic pain. Behavioural Psychotherapy *13:* 87–100, 1985.
9. Ljungberg, P. & Sanne, H.: Ryggbesvär, slutrapport av ett projekt. Göteborg: Statshälsan, 1986. (In Swedish.)
10. Magora, A.: Investigation of the relation between low back pain and occupation. 3. Physical requirements: sitting, standing and weight lifting. Ind Med *41:* 5–9, 1972.
11. Nachemson, A.: När, var och hur behandlas ont i ryggen? Rörelseorganens belastningssjukdomar. Svenska Läkaresällskapets Handlingar, band 94, häfte 3: 205–214, 1985.
12. Silverstein, B.: The prevalence of upper extremity cumulative trauma disorders in industry. Thesis, Occupational Health and Safety Engineering, University of Michigan, Ann Arbor, 1986.
13. Theorell, T., Lind, E. & Flodérus, B.: The relationship of disturbing life changes and emotions to the early development of myocardial infarction and other serious illnesses. Int J Epidemiol *4:* 281, 1975.
14. Theorell, T., Ahlberg-Hultén, F., Sigala, F., Perski, A. & Söderholm, M.: A psychosocial and biomedical comparison between men in six contrasting service occupations. Work Stress *4*: 51–63, 1990.
15. Theorell, T., Perski, A., Åkerstedt, T., Sigala, F., Ahlberg-Hultén, G., Svensson, J. & Eneroth, P.: Changes in job strain in relation to changes in physiological states: A longitudinal study. Scand J Work Environ Health *14:* 189–196, 1988.
16. Örebro Job Survey Instrument 1983, FHV 008 D. Department of Occupational Medicine, Örebro County Hospital, Örebro, Sweden, 1983.
17. Stockholmsundersökningen av belastningssjukdomar. MUSIC I. Stockholm MUSIC, Stockholm, 1990. (In Swedish.)
18. Andersson, K.: Utveckling och prövning av ett frågeformulärsystem rörande arbetsmiljö och hälsotillstånd. Högskolan i Örebro, Rapport 2: 1986. (In Swedish.)
19. Weber, A., Fussler, C., O'Hanlon, J. F., Gierer, R. & Grandjean, E.: Psychophysiological effects of repetitive tasks. Ergonomics *23:* 1033–1046, 1980.
20. Waersted, M., Bjørklund, R. & Westgaard, R. H.: Generation of muscle tension related to a demand of continuing attention. *In* Work with Display Units 86, (ed. B. Knave & P. G. Widebaks), pp. 288–293. Elsevier Science Publishers BV, Amsterdam, 1987.
21. Westgaard, R. H.: Measures and evaluation of postural load in occupational work situations. Eur J Appl Physiol *57:* 291–304, 1988.
22. Schüldt, K. & Harms-Ringdahl, K. E.m.g./moment relationship in neck muscles during isometric cervical spine extension. Clin Biomech *3:* 58–65, 1988.

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