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PSYCHOSOCIAL FACTORS AND MUSCULO-SKELETAL DISEASE

A review of the literature

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SUMMARY

It is generally agreed that musculoskeletal disease is of multifactorial origin and that mechanical load explains only part of this disease. Recently, the role of psychosocial factors at work has received increasing attention. The objective of this review is to establish whether the epidemiological literature presents evidence for an association between psychosocial work factors and musculoskeletal disease. Based on a hypothetical model it is suggested that individual characteristics and stress may modify this relation. The reviewed studies do not present conclusive evidence because of high correlations between psychosocial factors and physical load and difficulties to measure dependent and independent variable. Nevertheless, it is concluded that monotonous work, high perceived workload and time pressure are related to musculoskeletal symptoms. In addition, the data suggest that low control on the job and lack of social support by colleagues are positively associated with musculoskeletal disease. Perceived stress may be an intermediate in this process.

1. INTRODUCTION

Work-related musculoskeletal disease (in particular back pain and back disorders) account for a very large number of workers compensation days and disability in many different countries. In the last decade the disability due to musculoskeletal disease is still increasing, making work-related musculoskeletal problems one of the most expensive health problems in modern industrial society. Data from the American National Center for Health Statistics show that the number of people disabled from back pain has increased by 168% between 1971 and 1986 which is 14 times faster than the population growth (cited in Haldeman, 1991).

It is generally agreed that back pain and other musculoskeletal diseases are of multifactorial origin. Many epidemiological studies have been concerned with the relationship between musculoskeletal disease and physical load at work (among others cf Hagberg et al., 1987; Hildebrandt et al., 1987; Riihimäki, 1991). Some of these studies report an association, while others do not. Several authors have presented possible explanations for the rather weak and sometimes contradictory evidence for the relationship between physical load and musculoskeletal disease. Poor measurement of current and historical exposure, lack of a specific diagnosis and health-based selection in industry are the most important. Nevertheless, heavy physical work, prolonged static load and driving of motor vehicles are generally accepted as risk factors for musculoskeletal trouble. In addition to the physical load, also several individual factors (e.g. age, previous symptoms) seem to be a risk factor for musculoskeletal complaints. It is generally agreed though that the work-related physical load in relation to the individual functional capacity can only explain part of the very prevalent musculoskeletal disease. Walsh et al. (1989) estimated that for symptoms of the back, the etiologic fraction explained by physical load is only 20%. Recently the potential etiologic significance for musculoskeletal trouble of psychosocial factors has received increasing attention in the musculoskeletal epidemiology. The analyses of the role of these variables in the development and persistence of musculoskeletal trouble may contribute to the understanding and reduction of work-related musculoskeletal disease and disability. To our knowledge, no review of the epidemiologic literature on this relationship has been published.

The epidemiological studies investigating the relation between psychosocial variables and musculoskeletal disease are very heterogeneous in study design, measurement of outcome and the psychosocial variables studied. These studies originate from three different traditions of research:

1. studies on the relationship between (work-related) stressors, stress and symptoms of ill-health,

2. studies on the personality and psychological disorders of chronic (back) pain patients and
3. epidemiological studies on the determinants of musculoskeletal disease.

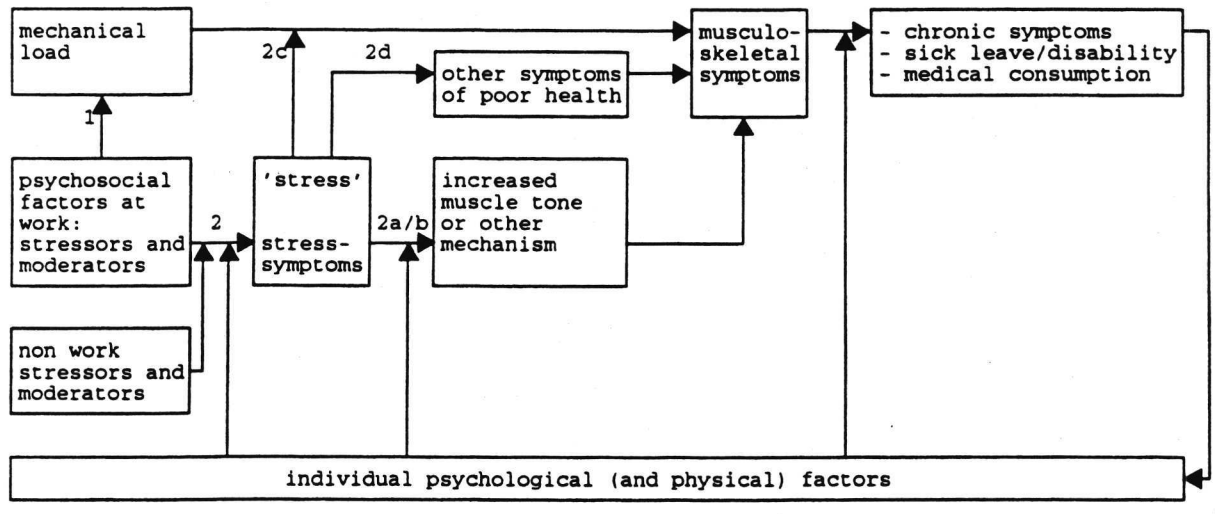
In each of these research areas different concepts and methods are applied. These are briefly illustrated below.

1. Stress may arise when a person does not feel able to cope with the demands placed upon him or her. Personal characteristics, such as age, gender, experience, ambitions, needs and personality, influence one's coping capacity. According to Karasek et al. (1987) and others, work load, clarity and conflict at work are the relevant work-related characteristics to predict job-dissatisfaction, work-stress and ill-health, but their effect is moderated by decision latitude (control), career development opportunities and social support at work. In particular, the combination between high demands and low control at work is supposed to be stressful and related to adverse health effects. Most studies on the relation between stress and adverse health effects reported in the literature, analyzed the relevance of stress for the development of heart disease, gastro-intestinal problems or poor subjective health in general (e.g. Cohen, 1982; Theorell, 1987). Only few of these studies investigated the relationship between work-stress and musculoskeletal symptoms. This body of research shows that psychosocial factors at work (job-demands modified by job control and social support), influenced by the individual coping capacity may predict stress. This work-related stress may be related to musculoskeletal symptoms. In this process also the stressors in the non-work situation such as emotional life-events, unfavourable living-conditions and moderating factors such as support by relatives or social engagement may play a part and moderate the relationship between psychosocial factors at work and stress.
2. The correlation between personality, psychological dysfunctioning and chronic musculoskeletal pain has been extensively studied in the clinical setting (e.g. Romano & Turner, 1985; Love & Peck, 1987). Although in this research, the focus is on the chronic pain patient with a whole different set of relevant issues, it supports the concept that the individual psychological capacity may be important when dealing with musculoskeletal symptoms. These factors may be important for the development of symptoms or the exacerbation or continuation of symptoms.
3. In the epidemiologic research of musculoskeletal disease the individual capacity has been mainly interpreted as the physical capacity (e.g. muscle strength, range of movement) and little attention has been devoted to the psychological capacity or the interaction between the physical load and the coping capacity. This may not be correct, in particular when dealing with symptoms (pain) and not with physical pathology.

When the concepts and relations from these research-traditions are combined and specifically directed to the subject of this literature review, the following associations between psychosocial factors, stress, personality and musculoskeletal disease may be indicated (illustrated in figure 1.1):

1. stressors at work (e.g. too much work, monotonous work) may have a direct influence on the mechanical load, due to changes in posture, movement and exerted forces (e.g. time pressure may increase hurried movements with high accelerations, the number of cycles of repetitive movements and poor posture);
2. stressors at work, both work demands and moderating factors such as job-control and social support, together with the personal capacity to cope with them and stressors from the non-work situation, may increase the work-related stress. This increase in stress may:
   a. increase the muscle tone, which may in the long term lead to the development of musculoskeletal symptoms;
   b. increase the musculoskeletal symptoms due to some yet unknown mechanism;
   c. moderate the relation between mechanical load and musculoskeletal symptoms due to enhancement of the perception of symptoms (due to physical pathology) or reduction of the capacity to cope with them or recover from them. This may prolong or intensify the symptoms;
   d. increase symptoms of poor health in general, including musculoskeletal symptoms.

Figure 1.1 Possible associations between psychosocial factors at work, stress and musculoskeletal symptoms



This model has mainly illustrative value and provides a structure for the discussion of the possible associations between psychosocial factors and musculoskeletal disease presented in the literature. These factors may be clustered in the categories mentioned in figure 1.1 (table 1.1). In the description and discussion of the literature, attention will be given to each of these clusters of

variables. This means that a rather broad definition of psychosocial factors has been applied. In fact, all associations between musculoskeletal disease and non-physical factors presented in the literature will be discussed.

Table 1.1 Non-physical factors that may be positively associated to musculoskeletal symptoms

1. psychosocial factors at work; stressors and moderators	2. non-work stressors and moderators*	3. job dissatisfaction	4. stress symptoms	5. symptoms of poor health**	6. individual psychological factors
- job demands • time pressures • high concentration • monotonous work • little opportunities to take breaks • high responsibilities • lack of clarity - poor social support - low control/little autonomy	- living alone - low social class - low educational level - poor social support at home/ social contacts - life events	- low job satisfaction - high perceived workstress	- anxiety - nervousness - worry/tension - tiredness/exhaustion during work or after work - physiological parameters	- poor physical health - respiratory disease - chronic cough - stomach trouble - cardiovascular disease - headache - utilization of health services	- personality type, e.g. • neuroticism - type A behaviour - psychological dysfunctioning, e.g. • depression - verbal skills/intelligence - coping styles - attitude towards own health

* In this category also the general sociologic factors are included. Variables such as social class combine unfavourable physical and psychosocial environments.

** These symptoms may of course also be due to other risk factors.

Most of these factors included in the categories of table 1.1 are already introduced in the description of the hypothesized associations, but before the empirical data will be presented a few variables need some additional introduction. In category two, the non-work stressors and moderators, also more general sociologic variables (like education, social class and marital status) are included. In several population based studies the effect on musculoskeletal disorders of these variables has been analyzed. It is not very plausible that these variables in itself are related to musculoskeletal trouble but these factors may increase psychological stress, which in turn may influence the prevalence of musculoskeletal symptoms or the willingness to report symptoms. The same reasoning applies to life-events, these are supposed to be causes of emotional and stressful periods that may be associated with health impairment e.g. musculoskeletal trouble. In addition, according to Karasek et al. (1987) income and social contacts are moderators of the association between psychosocial work stress and health effects. Empirical information on the relationship between other (psycho-somatic) health effects (category 5) and musculoskeletal trouble may shed some light on the question whether musculoskeletal pain is an exponent of 'poor (subjective) health in general', in reaction to stress, or is the result of a more specific mechanism. The last category (individual psychological factors) combines all the individual differences that may influence the persons capacity to deal with (chronic) environmental stressors and pain. The factors combined in this category are of various nature (personality type, coping styles etc). This division of the variables may be disputed. It may be argued for instance that variables like little education and low

social class are personal characteristics that influence e.g. the coping capacity and should be included in category 6 and that job dissatisfaction could be included in category 4. In addition, emotional factors as depression may be seen as a reaction to environmental stressors or a factor more related to the personality. This division of variables in clusters however enables us to discuss the different relations between the large variety of non-physical risk factors and musculoskeletal disease in a structured manner.

Presentation of the literature data

Due to the fact that there are no a-priori hypotheses on the similarity of the relationships between psychosocial factors and each musculoskeletal location, the studies on symptoms of the back, neck/shoulder region and musculoskeletal system (all locations combined) are discussed separately. The results of cross-sectional and longitudinal studies are also presented separately, since the results of the cross-sectional studies may suffer from a larger bias due to differential health based selection. In addition, the cross-sectional studies do not provide information on the temporal relation between events. Therefore from these studies no clues will be obtained wether the psychosocial factors are related to the development of symptoms, exacerbation or prolongation of symptoms or are a consequence of these symptoms. The longitudinal studies may provide more data on the sequence of events. If indicated, the strength of the association is given. In addition, comments are made on the study-population and wether the study dealt with potential confounders (in particular the physical load). In the presentation of the longitudinal studies is indicated wether adjustment is made for musculoskeletal pain in the anamneses at the start of follow-up, necessary to distinguish between development and continuation of symptoms. Attention will be given to studies on self-reported symptoms, symptoms and disorders established during physical examination and sick leave and disability data.

Selection of the literature

The available literature was selected by an automatic search of several data bases such as OSH-ROM, CISDOC, Psychinfo and Medline, by a manual search of Current Contents (Life Sciences and Social Sciences), Psychological abstracts, Safety and Health at Work, ILO/CIS bulletin and CIS-abstracts, by screening recent issues of scientific journals on occupational musculoskeletal disorders and work-related stress and by checking the relevant references in current publications on the subject. All studies analyzing the relationship between musculoskeletal disease and any of the variables from table 1.1 were initially selected. However, studies on the influence of psychological and social factors on the prognosis of (chronic) back pain patients (e.g. Bergquist-Ullman &

Larsson, 1977) and studies comparing characteristics of patients with clinical signs to patients without clinical sign (e.g. Vällfors et al., 1985; Bergenudd & Johnell, 1991) were not included in the result section but will be addressed in the discussion paragraph. Descriptive studies that did not compare the results of exposed workers in some way to a reference population of non or less exposed workers were also excluded. No other exclusion criteria were applied.

In the next paragraph emphasis is on *the description* of the results presented in the literature. A critical qualitative evaluation will be presented in the discussion paragraph. In paragraph two a considerable amount of detail is presented that may not be of interest to all readers. These readers are suggested, to read only the summary paragraphs of section 2 and continue to the discussion (section 3).

2. RESULTS

2.1 Back pain and back disorders

2.1.1 Description of the studies

Cross-sectional studies

Table 2.1 presents the cross-sectional studies on back pain and back disorders (chronological order), these studies are presented with more detail in appendix 1. These studies are rather heterogeneous in design, outcome variable, independent variable(s) and the way potential confounders are treated. Most studies in the working population deal with work-related variables, either self-reported work characteristics or experienced stress at work (Magora, 1973; Dehlin & Berg, 1977; Åstrand, 1987; Skovron, 1987; Linton & Kamwendo, 1989; Lundberg et al., 1989; Linton et al., 1990). Whereas only few of the population based cross-sectional studies deal with these variables (Westrin et al., 1972; Svensson et al., 1982; 1983; 1989; Heliövaara et al., 1991). All the rest of the population based studies are concerned with the relationship between back trouble and general demographic and social variables such as marital status, income, social class and educational level (Nagi et al., 1973; Reisbord et al., 1984), life events (Frymoyer et al., 1980), psychological and emotional problems, personality traits (Nagi et al., 1973; Ryden et al., 1979; Frymoyer et al., 1980; Haanen, 1984) or parameters of poor health (Nagi et al., 1973; Svensson & Andersson, 1983;1989; Heliövaara et al., 1991). In most studies only questionnaires are administered to assess the back trouble at present or in the past (Magora, 1973; Dehlin & Berg, 1977; Linton & Kamwendo, 1989; Linton, 1990). Assessed were back pain ever (Dehlin & Berg, 1977) or the last year (Linton & Kamwendo, 1989; Linton, 1990), back pain sometimes (Wickstrom et al., 1987) or often (Nagi et al., 1973; Boshuizen et al., in press), all self-reported discomfort (Svensson et al., 1983; 1989; Linton & Kamwendo, 1989; Linton, 1990) or back pain serious enough to seek medical advice (Ryden et al., 1979; Frymoyer et al., 1980). Only in the studies of Haanen (1984), Åstrand (1987) and Heliövaara et al. (1991) the back trouble was assessed after physical examination. Several studies do not adjust for confounding factors (Magora, 1973; Nagi, 1973; Dehlin & Berg, 1977; Frymoyer, 1980; 1983; Wickstrom, 1987; Linton & Kamwendo, 1989) or only for age (Haanen, 1984; Linton, 1990). Only in seven studies age and other confounders such as physical load were taken in consideration (Svensson, 1982; 1989; Reisbord & Greenland, 1986; Åstrand, 1987; Ryden et al., 1989; Heliöva-

Table 2.1 Summary of the associations between back trouble and several categories of psychosocial and psychological variables: + positive association; ++ positive association after adjustment for confounders; +/- conflicting data; - no association; o not studied

authors	follow-up (yrs)	N, ♀/♂	back pain (BP) or back disorders (BD	job demands[1]	social support	non-work factors	job dissatisfaction	stress-symptoms	symptoms of poor health	individual psychological factors
cross-sectional studies										
working population:										
Magora (1973)		3,316	BP >3 days	+/-	o	o	o	+/-	o	o
Dehlin & Berg (1977)		273	BP ever	o	+	o	+	o	o	o
Åstrand (1987)[2]		391 ♂	BP often	-	o	+	-	o	+	++
Skovron et al. (1987)		787 ♀	troublesome LBP last 3 m.	o	-	o	o	o	o	o
Ryden et al. (1989)[2]		252	BP episode medical service	o	o	o	o	-	o	-
Lundberg et al. (1989)[2]		20 ♂	perceived back load	+/-	o	o	o	+/-	o	o
Wickström et al. (1989)		461	BP, sciatica	o	o	o	o	o	o	+
Linton & Kamwendo (1989)		420 ♀	BP last 12 months	+	+	o	o	o	o	o
Linton (1990)		22,180	BP last 12 months	+	+	o	o	o	o	o
Boshuizen et al. (in press)		4,054 ♂	BP regularly	-	o	-	-	++	o	o
general population:										
Nagi et al. (1973)		1,135	BP often	o	o	+	o	+	+	+
Frymoyer et al. (1980), (1983)		3,920	BP patients family practice	o	o	+	o	+	o	o
Gilchrist (1976)		1,499	BP patients family practice	o	o	o	o	o	o	+
Gilchrist (1983)		143	BP patients and controls	o	o	o	o	o	o	+
Svensson & Andersson (1982/83)		940 ♂	BP life time	++	o	-	+	++	+	o
Haanen (1984)		6,612	BP life time/sciatica or BP	o	o	+	o	+	+	+
Reisbord & Greenland (1985)		2,792	BP last 12 months	o	o	+	o	o	o	o
Svensson & Andersson (1989)		1,746 ♀	BP life time	+	o	-	++	++	o	o
Heliövaraa et al. (1991)[2]		5,673	BD, unspecified sciatica	++	o	o	o	++	++	o
Westrin et al. (1972)		269	sicklisted > 8d for BP	o	o	+/-	+	o	o	-
longitudinal studies										
working population:										
Gyntelberg (1974)	1	4,753 ♂	BP	o	o	+	o	o	+	o
Riihimäki et al. (1989)[2,3]	5, 10	328 ♂	sciatica	o	o	o	o	++	o	o
Bigos et al. (1991)[2,3]	3	3,020 ♂	BP episode medical service	o	++	-	++	o	o	++

authors	follow-up (yrs)	N, ♀/♂	back pain (BP) or back disorders (BD	job demands[1]	social support	non-work factors	job dissatisfaction	stress-symptoms	symptoms of poor health	individual psychological factors
general population:										
Haanen (1984)[3]	1, 5	630	BP	o	o	o	+	o	o	+
Heliövaraa et al. (1987)[2,3]	11	57,000	HNP, hospital/HNP, sciatica	o	o	++	o	++(♀)	++	o
Bergenudd & Nilsson (1988)	45, 19	575	BP pain drawing	o	o	+	+	o	o	o
Biering-Sørensen et al. (1989)[3]	1	928	BP	o	o	+	+	+	++	o
Viikari-Juntera et al. (1991)	33	154	BP > 7 days last 12 months	o	o	++(♀)	o	o	o	o
Åstrand & Isacsson (1988)[2,3]	22	391 ♂	BP disability	-	o	-	o	o	++	-

[1] The variables included in each category are indicated in table 1.1, the work related variables were divided in job demands and social support; expected is a positive association with the values indicated in table 1.1.
[2] Adjusted for physical load.
[3] Association analyzed for those without previous symptoms.

ara et al., 1991; Boshuizen et al., in press). From the above can be concluded that from the studies in table 2.1, the multivariate studies investigating the relationship between work related psychosocial variables and back trouble other than 'have you ever had back pain' are the most informative (Åstrand, 1987; Heliövaara et al., 1991; Boshuizen et al., in press).

Longitudinal studies

Table 2.1 also presents the characteristics of the longitudinal studies. For a more detailed description see appendix 2. Although the longitudinal studies are definitely more homogeneous than the cross-sectional studies as far as the measurement of the dependant and independent variables are concerned, still many differences exist. The duration of follow-up varies between 1 year (Gyntelberg, 1974; Haanen, 1984; Biering-Sørensen et al., 1989), 3 years (Bigos et al., 1991), 10 years (Riihimäki et al., 1989), 11 years (Heliövaara et al., 1987), 22 years (Åstrand & Isacsson, 1988) to almost lifelong (Bergenudd & Nilsson, 1988; Viikari-Juntura et al., 1991). The measurement of back pain varies form self-reported pain in the lower back (Gyntelberg, 1973; Haanen, 1984; Bergenudd & Nilsson, 1988; Biering-Sørensen et al., 1989), episodes registered at the medical service (Bigos et al., 1991), sciatica diagnosed after physical examination (Riihimäki et al., 1989), hospital admittance due to herniated disc or sciatica (Heliövaara et al., 1987) or disability (with early retirement) due to back pain (Åstrand & Isacsson, 1988). Except for the early longitudinal study of Gyntelberg and the studies of Haanen and Bergenudd and Nilsson, potential confounders are dealt with in the design or analysis. In these studies the emphasis is on the personal psychological and emotional problems (Gyntelberg, 1974; Haanen, 1984; Heliövaara et al., 1987; Åstrand & Isacsson, 1988; Biering-Sørensen et al., 1989; Riihimäki et al., 1989; Bigos et al., 1991), experienced health (Gyntelberg, 1974; Åstrand & Isaacsson, 1987; Heliövaara et al., 1987; Biering-Sørensen et al., 1989) or utilization of medical services and demographic variables (Gyntelberg, 1974; Heliövaara et al., 1987; Biering-Sørensen et al., 1991; Bigos et al., 1991). In some of these longitudinal studies also some self-reported work-related psychosocial variables were studied such as satisfaction with the job (Bergenudd & Nilsson, 1988; Biering-Sørensen et al., 1989; Bigos et al., 1991), social relations at work (Bigos et al., 1991) and work demands (Åstrand & Isacsson, 1988). Almost all longitudinal studies present information on psychosocial factors measured before the development of symptoms.

2.1.2 Description of the results

Table 2.2 indicates per cluster of psychosocial variables, which of the studies described above reported a positive association between one of the psychosocial variables and back troubles and which did study that relationship but did not report a positive association. For each of these clusters the longitudinal evidence will be discussed.

Psychosocial factors at work; stressors and moderators

The relationship between back trouble and *work demands* is conflicting. In the cross-sectional studies a positive univariate association was observed with self-reported high demands on concentration in some occupations but not in others and for the possibilities to take a break between the scheduled breaks (Magora, 1973). Svensson and Andersson (1983) observed also a univariate association between back pain and these variables, but no association remained after adjustment for other variables. A univariate relation with back pain for high responsibility in bank-employees but not in other occupations is reported by Magora (1973). After adjustment for potential confounders including physical load and previous back pain, Heliövaara et al. (1991) reported a relation of work-related variables (monotony, time-pressure and worry about mistakes) with symptoms of the back established after a physical examination (odds ratio 2.0). This relation was supported by the study of Svensson and co-workers (1983) who reported an adjusted association of monotonous work with self-reported back pain. The perceived time pressure during work is also related to the perceived back load during the same period (Lundberg et al., 1989). However, the study of Åstrand (1987), who studied symptoms and clinical signs and adjusted for confounders did not report a relationship with time pressure and Boshuizen et al. (in press) did also not observe a significant relation between back pain prevalence and self-reported time pressure. The work-related stressors measured in the study of Åstrand (1987) did also not predict future disability due to back disorders in the same population (Åstrand & Isacsson, 1978). None of the other longitudinal studies investigated this relationship.

As far as the *social relations* at work are concerned: poor social support by colleagues and/or superiors not adjusted for confounders is associated with back pain in the study of Dehlin and Berg (1977). The total score for poor psychosocial work-environment (several questions on high work content and poor social relations at work) was positively associated with back trouble (no adjustment for physical load) in the study of Linton and Kamwendo (1989) and Linton (1990). In the study of Boshuizen et al. (in press), which is rather similar in population and design as the study of Linton, no significant association between self-reported psychosocial environment and

Table 2.2 The relationship with back pain (back disorders) reported in the literature for several categories of psychosocial, psychological and other self-reported non-specific health parameters (longitudinal studies bold)

psychosocial or psychological variable studied	studies reporting a positive association with back symptoms	studies reporting no association with back symptoms or a negative (-) association
1. psychosocial factors at work; stressors and moderators		
work demands:		
- monotonous work	- Svensson & Andersson (1983); Heliövaraa et al. (1991)[1]	- Svensson & Andersson ♀ (1989)[2]
- time pressure	- Lundberg et al. (1989); Heliövaraa et al. (1991)[1]	- Åstrand (1987); Boshuizen et al. (in press)
- high level of concentration	- Magora (1973)[3]	- Svensson & Andersson (1983)[2]; Svensson & Andersson ♀ (1989)
- high level of responsibility	- Magora (1973)[3]	- Magora (1973)[3]; **Åstrand & Isaceson (1988)**
- few possibilities to take breaks/low control		- Svensson & Andersson ♀ (1983)[2]; Svensson & Andersson (1989); Boshuizen et al. (in press); Skovron et al. (1987)
- poor work content	- Linton (1990)	- Dehlin & Berg (1977)[3]; Svensson & Andersson ♀ (1989)[2]
terms of employment:		
- over time (less!)	- Svensson & Andersson ♂ (1983)	- Svensson & Andersson (1989)
- full-time/shift work		- Åstrand (1987); Svensson & Andersson ♀ (1989)
psychosocial work environment:		
- poor social support/relation with colleagues	- Dehlin & Berg (1977)[3]; Linton (1990); **Bigos et al. (1991)**	- Skovron et al. (1987)
- need for education		- Dehlin & Berg (1977)[3]
Sum-score for psychosocial factors at work	- Linton & Kamwendo (1989)[3]; Linton (1990)	
2. non-work stressors and moderators		
- poor social support 'at home'		- Åstrand ♂ (1987); **Bergenudd & Nilsson (1988)[3]; Bigos et al. (1991)**
- marital status (not or no longer married)	- Nagi et al. (1973)[3], Gyntelberg ♂ (1974)[3]; Reisbord & Greenland ♀ (1985); **Biering-Sørensen et al. ♂ (1989); Gilchrist (1976)**	- Åstrand ♂ (1987); Heliövaraa et al. (1987)[4]; Ryden et al. (1989); Boshuizen et al. ♂ (in press); Svensson et al. ♀ (1983)
- low social class	- **Gyntelberg (1974)[3]; Heliövaraa et al. (1987)[4]**	- **Åstrand & Isaceson (1988); Biering-Sørensen et al. ♀ (1989)[2]**; Åstrand (1987)[2]
- low educational level	- Nagi et al. (1983)[3]; Haanen (1984)[3]; Reisbord & Greenland (1985); **Bergenudd & Nilsson (1988)[3]**; Deyo et al. (1989); **Vihlikaari-Juntera et al. (1991)**	- Åstrand (1987)[2]; **Åstrand & Isaceson (1988); Svensson & Andersson (1989)**
- stressful life events	- Frymoyer et al. (1980)[3]; Haanen (1984)[3]	
- problems/stress at home	- **Gyntelberg (1974)[3]**	- Ryden et al. (1989)
3. job dissatisfaction		
- dissatisfied with the work/work-environment, problems at work	- Magora (1973)[3]; Dehlin & Berg (1977)[3]; **Haanen (1984b)[3]; Bergenudd & Nilsson (1988)[3]**; Svensson & Andersson ♂ (1989); **Bigos et al. (1991)**	- Svensson & Andersson (1983)[2]; **Biering-Sørensen et al. ♀ (1989)[2]**; Boshuizen et al. (in press); Åstrand (1987); Ryden et al. (1989)
- perceived stressful work	- **Gyntelberg (1974)[3]**	- Svensson et al. (1983)[2]

psychosocial or psychological variable studied	studies reporting a positive association with back symptoms	studies reporting no association with back symptoms or a negative (-) association
4. stress symptoms[5]		
- stress-episodes/psychological anxiety/nervousness (after work)/worry and tension (after work)	- Nagi et al. (1973)[3]; Frymoyer (1980)[3]; Magora (1973)[3]; Svensson & Andersson (1983); **Haanen (1984)[3]; Heliövaara et al. ♀ (1987)[4]**; Svensson & Andersson (1989); **Riihimäki et al. (1989)**; Heliövaara et al. (1991); Boshuizen et al. (in press)	- **Biering-Sørensen et al. (1989)[2]**; Ryden et al. (1989)
- physical anxiety	- Nagi et al. (1973)[3]; **Haanen (1984)[3]**	
- immobilization	- Nagi et al. (1973)[3]; **Haanen (1984)[3]**	
- exhausted after work/tiredness at work (fatigue)	- Magora (1973)[3]; Lundberg et al. (1989)	- Magora (1973)[3]; Svensson et al. (1983)[2]; **Biering-Sørensen et al. (1989)[2]**; Svensson & Andersson (1989)[2]; Ryden et al. (1989)
5. symptoms of poor health		
- poor experienced physical health	- Nagi et al. (1973)[3]; Haanen (1984)[3]; Åstrand (1987); **Åstrand & Isacsson (1988)**	- **Biering-Sørensen et al. (1989)[2]**
- respiratory disease/chronic cough	- Gyntelberg (1974)[3]; **Heliövaara et al. ♂ (1987)[4]**; Heliövaara et al. (1991); Deyo et al. (1989); **Troup et al. (1987)**	- Svensson et al. (1983)[2]; Åstrand (1987)[2]; **Biering-Sørensen et al. (1989)[2]; Heliövaara et al. ♀ (1987)[4]**
- stomach ache	- **Biering-Sørensen et al. (1989); Westrin et al. (1972); Bergquist-Ullman & Larsson (1977); Vallfors et al. (1985)**	
- cardiovascular disease	- Gyntelberg (1974)[3]; Heliövaara et al. (1991)	- Svensson et al. (1983)[2]; Åstrand (1987)[2]; **Biering-Sørensen et al. (1989)[2]**
- headache	- **Gyntelberg (1974)[3]**	- Åstrand (1987)[2]; **Biering-Sørensen et al. ♂ (1989)[2]**
- hospital admittance (at least once)	- **Biering-Sørensen et al. (1989)**	
- use of analgesics/tranquillizers	- **Gyntelberg (1974)[3]; Heliövaara et al. ♀ (1978)[4]**	- **Heliövaara et al. ♂ (1987)[4]**
- general utilization medical services	- Nagi et al. (1973)[3]	- **Heliövaara et al. (1987)[4]; Biering-Sørensen et al. (1989)[2]**
6. individual psychological factors[5]		
- neuroticism	- Åstrand (1987)	- **Åstrand & Isacsson (1988); Gilchrist (1983)**
- depression/inadequateness	- **Haanen (1984)[3]**	- Ryden et al. (1989); **Bigos et al. (1991); Gilchrist et al. (1983)**
- hysteria (MMPI)	- **Bigos et al. (1991)**	
- anti-social (MMPI)	- **Bigos et al. (1991)**	- **Haanen (1984)[3]**
- rigid/dominance		- **Haanen (1984)[3]**
- low self-esteem	- **Haanen (1984)[3]**	
- locus of control/weak sense of coherence		- **Bigos et al. (1991)**
- type A behaviour	- Wickström et al. (1989)	
- extrovert personality	- **Gilchrist (1983)**	- Wickström et al. (1989)
- psychological test/intelligence/verbal skills	- Åstrand (1987); **Bergenudd & Wilsson (1988)[3]**	- **Åstrand & Isacsson (1988)**
- psychological disorders	- Heliövaara et al. (1991)	

[1] Sum score of several variables: uninteresting, monotonous work, time pressure, worry about mistakes.
[2] These variables did show a univariate relation to LBP.
[3] No adequate adjustment for potential confounders, i.e. age and physical work load.
[4] Related to HNP, sciatica.
[5] The distinction between psychological dysfunctioning as a personality trait or a reaction to the environment in relation to the personal capacity is not always well defined. Therefore, the variables grouped in category 5 may be similar to those of category 8.

back trouble was observed after adjustment for other variables. Skovron et al. (1987) unexpectedly observed a positive cross-sectional association between a good relationship with colleagues and troublesome back pain. In contrast, workers reporting that they had poor social relations at work with fellow workers reported more frequent an episode of back pain at the medical department or filed a claim in the next three years (Bigos et al., 1991). This also applied for workers without back pain episodes at the start of follow-up. In the analysis adjustment is made for physical load and other potential confounders. A similar association between episodes of back pain registered at the medical office was also previously found in a retrospective study by Bigos et al. (1989). The authors state that these variables may be related to the back pain episodes as well as to the readiness to report them at the medical department or file a claim.

In summary: The cross-sectional studies yield some evidence for a relationship between back trouble and some aspects of self-reported *work demands* (monotonous work and working under time pressure), whereas the evidence for other aspects is not convincing (demands on concentration/mental load, responsibility, poor career prospects and possibility to take extra breaks) or absent (need for additional schooling). These variables did not predict future disability due to back disorders in the only longitudinal study that analyzed their influence.

Poor *social relations* at work were associated with the incidence of reported back trouble in the only longitudinal study studying it. In addition, few cross-sectional studies analyzed the relation between social support at work and back pain. The results of these studies are conflicting.

Non-work stressors and moderators

Investigated were the relation between general sociologic variables (income, social class, education), marital status, social contacts at home and emotional life-events and symptoms of the back.

Income, social class and education are highly correlated and are also correlated with physical demands at work (e.g. Reisbord & Greenland, 1985). Therefore a correlation between these variables and musculoskeletal trouble is most likely biased by differences in work-related physical load. Low educational level was associated with the back pain prevalence according to Nagi et al. (1973), Haanen (1984), Åstrand (1987) and Reisbord and Greenland (1985), but not to Svensson and Andersson (1989). It is remarkable that in the study of Åstrand (1987) variables such as low income and little education are related to back pain as well as back abnormalities, the latter association being even stronger. These variables however did not predict later disability due to back problems (Åstrand & Isacsson, 1988). In the longitudinal study of Heliövaara et al. (1987) low or

intermediate social class was related to hospitalization due to sciatica (after adjustment for confounders). In the longitudinal study of Bergenudd and Nilsson (1988) low childhood intelligence and (subsequent) low educational level was also related to back symptoms in middle age. No adjustment for physical load was made in the latter study. Lower education in women was also associated with the prevalence of back symptoms in a similar study of Viikari-Juntura et al. (1991) after adjustment for work-related physical load. This relation was not observed for the men in that study. In general, the data on the association between these variables and musculoskeletal symptoms are conflicting. Only the longitudinal studies of Heliövaara et al. (1987) and Viikari-Juntura et al. (1991) tentatively support a relation between low educational level or low social class and back trouble at later age after adjustment to some extent for physical load during work.

Living alone (not or no longer married) as opposed to being married is cross-sectionally related to back pain according to Nagi et al. (1973), Gilchrist (1976), Reisbord and Greenland (1985 ♀) but not to Åstrand (1987 ♂), Ryden et al. (1989) and Boshuizen et al. (in press). Not all of these studies reported an association adjusted for potential confounders such as age. Westrin et al. reported in 1972 also a relation between living alone and sick leave due to back symptoms. The longitudinal studies of Gyntelberg (1974 ♂) and Biering-Sørensen et al. (1989 ♂ only and for recurrence of symptoms) report an association between self-reported back pain and living alone (one year before), while several other studies report no relationship (Heliövaara et al., 1987; Ryden et al., 1989; Bigos et al., 1991 ♂). Heliövaara et al. (1987), Åstrand (1987) and Bigos et al. (1991) adjusted for potential confounders such as age and physical demands at work. The studies of Heliövaara et al. and Bigos et al. also have a rather long follow-up. The marital status was also not related to back symptoms and signs established after physical examination. From the studies that adjusted properly for age, it is concluded that an association is reported in some cross-sectional studies and the longitudinal studies with a short duration of follow-up. This seems to suggest that the reporting of symptoms is most likely a consequence of emotional stress due to being no longer married. The emotional stress may influence the perception and readiness to report the symptoms. This variable therefore may be considered an emotional life event rather than a general sociologic variable.

The effect of *life-events* is only analyzed in the studies of Frymoyer et al. (1980) and Haanen (1984), they both report a positive association but did not adjust for confounders such as age. According to several studies relating stress to ill-health, chronic stress (at work or daily hassles) is of greater importance than single emotional events.

Only three studies analyzed a relation between social support or *social contacts outside the work environment* (Åstrand, 1987; Bergenudd & Nilsson, 1988; Bigos et al., 1991). These variables seem

to be of minor or no importance in the prediction of back trouble. Karasek et al. (1987) also reported a much larger influence of work-related variables in the prediction of adverse health symptoms than the variables from the non-work situation.

In summary: Few studies have studied the association between low education or low social class while adjusting for physical load at work. However, a tentative association between the development of back pain and general sociological and demographic variables, such as low education and low social class independent from physical load at work is reported by two longitudinal studies. A positive association between back trouble and living alone (no longer married) is more present in the cross sectional studies than in the longitudinal studies with a long duration of follow-up, suggesting that the back pain symptoms most likely are related to the emotional problems associated with divorce. Only few studies analyzed the relation between life events or social relations outside the work environment. The results of these studies suggest that these variables are of minor importance.

Job dissatisfaction

In the cross-sectional studies dissatisfaction with the working conditions was significantly associated with self-reported symptoms of the back in Magora (1973), Dehlin and Berg (1977) and Haanen (1984) without additional adjustment for confounders. Westrin et al. (1972) reported an association with sick leave due to back trouble. Svensson and Andersson (1989) also reported an association with back pain after adjustment for confounders but no relation with self-reported symptoms was observed in their study in 1983 and in the study of Boshuizen et al. (in press). In addition, no association was observed in relation to back trouble assessed after physical examination (Åstrand, 1987). In the longitudinal studies, dissatisfaction with the working conditions was positively associated with reported back episodes in the study of Bigos et al. (1991) and with self-reported back pain symptoms in Bergenudd and Nilsson (1988), with measurement of job-dissatisfaction 3 years (Bigos et al., 1991) and 12 and 19 years (Bergenudd & Nilsson, 1988) prior to symptom assessment. Biering-Sørensen et al. (1989) however, reported no association (duration of follow-up 1 year). Bigos et al. and Biering-Sørensen et al. adjusted for other variables including previous back trouble, which is important in this analysis. Thus, after adjustment for confounders, a positive association between job-dissatisfaction and back trouble is reported by Bigos et al. (1991) and Svensson and Andersson (1989) but not by Svensson and Andersson (1983), Åstrand (1987), Boshuizen et al. (in press) and Biering-Sørensen et al. (1989). It is possible that dissatisfaction with the job is associated with the readiness to report claims or symptoms, the perception of symptoms or the development of symptoms.

Perceived work-stress (many stressful moments at work and continuous perception of stress) were univariately associated with back trouble in the study of Svensson et al. (1983), but after adjustment for other confounders no significant association remained between back trouble and these variables. In the longitudinal study of Gyntelberg (1974) perceived stress at work was also related with back trouble. In this study confounders were not accounted for. All other studies did not analyze the relationship between the perception of stress at work and back trouble, but between stress symptoms such as nervousness, anxiety, feeling tense and exhausted during or after work and back trouble.

In summary: No consistent results are obtained on the relationship between dissatisfaction with the work and (self reported) back trouble. The relation between perceived stress at work was only analyzed in a two studies.

Stress symptoms

An association between back trouble and psychological stress symptoms is reported in several cross-sectional studies (Nagi et al., 1973; Frymoyer et al., 1980; Svensson & Andersson, 1983; Haanen, 1984; Svensson & Andersson, 1989; Heliövaara et al., 1991; Boshuizen et al., in press). Ryden et al. (1989) did not report a univariate association between nervousness and back symptoms. The positive relationships are of different character. Feeling of worry and tension was significantly associated with self-reported back trouble in the studies of Svensson and Andersson in 1983 and in 1989 after adjustment for other risk-factors. Worry about making mistakes (combined in one score with time pressure and monotonous work) was positively associated with 'objectively' assessed back pain in the study of Heliövaara et al. (1991). Magora (1983) reports a univariate association between nervousness after work and back pain in bank employees but not in other occupations. Stress episodes or feeling of stress (nervousness, tenseness, sleeping difficulties) were univariately associated with back trouble in the study of Nagi et al. (1973), Frymoyer et al. (1980) and Haanen (1984) and also in the study of Boshuizen et al. (in press) after adjustment for confounders. However, perceived demands and tenseness did not relate to simultaneously experienced back load (Lundberg et al., 1989). In the longitudinal studies stress symptoms also seem to increase the risk of symptoms of back pain (Haanen, 1984) or sciatica (Heliövaara et al., 1987; Riihimäki et al., 1989), although the odds ratios are close to one and not significant for all groups. This also applied to those without a history of sciatica or low back pain before the start of follow-up. Although several studies report an association between exhaustion and tiredness and back trouble, this association disappears after adjustment for other risk factors, including physical load (Svensson et al., 1983;1989; Biering-Sørensen et al., 1989).

In summary: The association between back trouble and stress symptoms reported in several cross-sectional studies seems to be tentatively supported by the longitudinal studies. This applies to the self-reported back pain parameters as well as the signs and symptoms of the back observed during physical examination.

Symptoms of poor health

Nagi et al. (1973), Haanen (1984) and Åstrand (1987) reported a positive cross-sectional association between self-reported back symptoms and poor experienced health in general. In addition, experienced health less than good was associated with symptoms of the back assessed by clinical examination. This variable was also a predictor of future disability due to back trouble after adjustment for other risk factors (Åstrand, 1987; Åstrand & Isacsson, 1988). In the longitudinal study of Biering-Sørensen et al. (1989) a similar relation was observed, but this relation was no longer significant when all other variables were taken into account. Biering-Sørensen et al. (1989) did report that among 25 medical history variables only 'rumbling of the stomach' in women showed a significant correlation in a multivariate analysis with back trouble. Epigastric pain proved to be an indicator of first-time occurrence of low back trouble. The authors state that these symptoms, which may be considered psycho-somatic, have also in other studies shown a correlation with back trouble (Westrin et al., 1972; Bergquist-Ullmann & Larsson, 1977; Vallfors et al., 1985). Diagnosed respiratory disease was associated with self-reported symptoms of the back (Deyo et al., 1989), with clinically assessed unspecified low back pain (Heliövaara et al., 1991) and with back trouble after one year (Troup et al., 1987). However, no association between respiratory disease and back trouble was observed in the studies of Svensson et al. (1983), Åstrand (1987) and Biering-Sørensen et al. (1989), after adjustment for confounders. Respiratory disease was a predictor of hospitalization due to a herniated disc and sciatica after ten years, in men but not in women (Heliövaara et al., 1987). Clinically diagnosed cardiovascular disease was associated with clinically assessed unspecified low back pain in the study of Heliövaara et al. (1991) but not with back trouble in the study of Svensson et al. (1983), Åstrand (1987) and Biering-Sørensen et al. (1989), after adjustment for confounders.

In summary: In several studies an association between back trouble and other symptoms of poor health has been observed. This relation was observed both with self-reported symptoms as with clinically assessed disease and both in cross-sectional studies and in longitudinal studies. However, several of these associations do not remain significant after adjustment for other factors and several other studies report no association with other symptoms of poor health.

Individual psychological factors

Almost all cross-sectional studies on the association between psychological dysfunctioning and emotional problems report a positive association with the self-reported back pain (Nagi et al., 1973; Frymoyer, 1980; Svensson & Andersson, 1983; Haanen, 1984; Åstrand, 1987; Svensson & Andersson, 1989; Boshuizen et al., in press) and 'back disorders' diagnosed after physical examination (Åstrand, 1987; Heliövaara et al., 1991). In the study of Ryden et al. (1989), no association between back episodes registered at the medical service and psychological problems or nervousness (/) was reported. Two longitudinal studies report a positive association between certain personality characteristics and episodes of back pain reported at the medical service or insurance company (Bigos et al., 1991: MMPI scales hysteria and anti-social) and self-reported back pain (Haanen, 1984). This also applied for those not reporting previous back pain at the start of follow-up. Neuroticism however did not predict disability due to back pain in the study of Åstrand and Isacsson (1988), although it showed a strong cross-sectional association in the same population (Åstrand, 1987). Three studies observed an association between type A personality (competitiveness) and back trouble (Wickstrom et al., 1987; Hagg, 1990; Flodmark, 1991).

In summary: psychological dysfunctioning is not only associated with back trouble in the cross-sectional studies but also in the longitudinal studies. The results suggest that these variables predict back trouble also for the respondents who did not experience back pain before.

2.2 Symptoms and disorders of neck/shoulder

2.2.1 Description of the studies

We found only ten cross-sectional studies and five longitudinal studies on the relationship between psychosocial factors at work or psychological problems and symptoms of the neck/shoulder region (table 2.3 and appendix 3). Studies on the symptoms of the arm (elbow, wrist) are not presented here. Five of these studies (Dehlin & Berg, 1977; Katalainen, 1978; Linton & Kamwendo, 1989; Linton, 1990; Viikari-Juntura et al., 1991) were also presented earlier because both symptoms of the back and the neck/shoulder region were analyzed.

Most studies on neck and shoulder pain present data on self-reported symptoms (Dehlin & Berg, 1977; Katilainen, 1978; Westerling & Johnsson, 1980; Bergenudd et al., 1988; Tola et al., 1988;

Table 2.3 Summary of the associations between musculoskeletal trouble and several categories of psychosocial and psychological variables: + positive association; ++ positive assocation after adjustment for confounders; +/- conflicting data; - no association; o not studied

authors	follow-up (yrs)	N ♀/♂	neck pain (NP)/back pain (BP)/ low back pain (LBP)/shoulder pain (SP)	job demands[1]	social support	non-work factors	job dissa-tisfaction	stress-symptoms	symptoms of poor health	individual psychologi-cal factors
neck pain/neck disorders										
cross-sectional studies:										
Ohara et al. (1976)		848 ♀	NP at periodical phys. ex.	+	o	o	o	o	o	o
Dehlin & Berg (1977)		273	NP life time	-	-	o	-	o	o	o
Katilainen (1978)[2]		4,167	repeated NP/SP	++	o	o	o	++	o	o
Westerling & Jonsson (1980)		2,537	NP last 12 months	o	o	-	o	o	o	o
Kvarnström & Halden (1983)		224	4 weeks sick leave due to SP	+	+/-	o	o	o	o	o
Ryan et al. (1988)[2]		143	NP life time	++	+/-	-	o	+	o	o
Tola et al. (1988)[2]		3,232 ♂	NP >8 days last 12 months	o	o	++	++	o	o	o
Linton & Kamwendo (1989)		420	NP/SP last 12 months	+	+	o	o	-[3]	o	o
Linton (1990)		22,180	NP/SP last 12 months	+	+	o	o	o	o	o
Flodmark & Aase (1991)		58	SP last 12 months	o	o	o	-	o	o	+
longitudinal studies:										
Bergenudd et al. (1988)	0/35/45	575	SP >24 hours last 12 months	o	o	+/-	+/-	o	o	o
Hägg et al. (1990)[2]	2	83 ♀	NP/SP physical examination	o	o	o	o	o	o	+
Westgaard et al. (1991)[2]	6 months/1 yr	30 ♂	NP/SP last 10 weeks	o	o	o	o	++	o	-
Takala et al. (1991)[2,4]	3/6/9 months	351	NP, physical examination	++	o	o	o	++	o	o
Viikari-Juntura et al. (1991)[2]	1/33	154	NP/SP >7 days last 12 months	o	o	+/-	o	o	++	++
musculoskeletal disease not specified										
cross-sectional studies:										
Sauter et al. (1983)[2]		248	NP/BP	++	o	o	o	o	o	o
Karasek et al. (1987)		8,700	muscular skeletal ache	+	+/-	+	o	o	o	o
Pot et al. (1987)		222	often musculoskeletal pain	+/-	+	o	o	o	o	o
Ursin et al. (1988)		474	muscle pain	+	o	o	o	o	o	+
Kompier et al. (1988)[2]		158	musculoskeletal pain last 12 m.	++	++	-	o	o	++	++
Hopkins (1990)		291	muscular pain last 6 months	+	+	o	+	o	o	o
Magni et al. (1990)		3,023	musc. trouble >1 m. last 12 m.	o	o	o	o	o	o	+
Smulders (1990)[2]		9,000	LBP + leg/feet pain regularly	++	-	o	o	o	o	o
Theorell et al. (1991)[2]		207	frequent BP/NP/SP, joint pain	++	-	o	o	++[4]	++[4]	-

authors	follow-up (yrs)	N ♀/♂	neck pain (NP)/back pain (BP)/ low back pain (LBP)/shoulder pain (SP)	job demands[1]	social support	non-work factors	job dissa-tisfaction	stress-symptoms	symptoms of poor health	individual psychologi-cal factors
longitudinal studies:										
Leino (1989), (1990)[2,4]	10	902	changes in muscular symptoms and signs	+/-	+/-	o	o	++	o	o

[1] The variables included in each category are indicated in table 1.1, the work related variables were divided in job demands and social support; expected is a positive association with the values indicated in table 1.1.
[2] Adjusted for physical load.
[3] Within subgroup of those with symptoms
[4] Association analyzed for those without previous symptoms.

Linton & Kamwendo, 1989; Linton, 1990; Takala et al., 1991; Viikari-Juntura et al., 1991). The other studies are concerned with registered data of periodical physical examination (Ohara et al., 1976; Linton, 1990), visits to the medical service (Westgaard et al., 1991), sick leave (Kvarnström & Halden, 1983) or symptoms and signs reported during physical examination (Bergenudd et al., 1988; Ryan & Bampton, 1988; Hägg et al., 1990). The analysis of each of the cross-sectional studies concentrates on self-reported work characteristics. In the studies by Ryan et al. (1988), Viikari-Juntura et al. (1991), Tola et al. (1989) and Westgaard et al. (1991) the association between several psychosocial factors at work and symptoms of the neck are analyzed after adjusting in some respect for postural load.

The longitudinal studies are very different in design, the studies of Takela et al. (1991) and Westgaard et al. (1991) compare the characteristics and perception of the job of (newly hired) workers developing symptoms with those who do not develop symptoms. Viikari-Juntura et al. (1991) compared the scores on childhood intelligence tests for those reporting symptoms of neck or shoulder 33 years later with those who stayed symptom free. A similar study was conducted by Bergenudd et al. (1991). They compared scores on intelligence tests and teacher rating of intelligence at age 10 and 20 between respondents who reported shoulder symptoms at age 55. In addition they analyzed the difference as job-satisfaction, social support outside the work environment and self-rated success in life at the time of outcome assessment. Bergenudd and Nilsson (1991) also compared for the same population scores on childhood intelligence tests for respondents with symptoms (of the shoulder) ***and*** clinical signs to the scores of those with symptoms but no clinical signs. Viikari-Juntura et al. (1991) also studied the relationship between some demographic variables, self-reported job characteristics such as mental workload and job-satisfaction in the year prior to the assessment of symptoms.

2.2.2 Description of the results

In table 2.3 and 2.4 the results of the studies for each cluster of variables are schematically presented. These relations are discussed.

Psychosocial factors at work; stressors and moderators

In most of the cross-sectional studies a relationship between several psychosocial factors (job demands variables) at work and symptoms of the neck/shoulder region are reported. Only some of the results are somewhat conflicting. Kvarnström and Halden (1983) reported that high responsibility

did not have a significant influence on the prevalence of shoulder/neck complaints. The other studies provide no data on this variable. Dehlin and Berg (1977) did not observe a relationship between symptoms of neck/shoulder and whether the workers perceived their work content as poor or good while others did report an association between symptoms of the neck or shoulder and these factors (Kvarnström & Halden, 1983; Ryan & Bampton, 1988; Linton & Kamwendo, 1989). The discrepancy in the results between Dehlin and Berg (1977) and the studies of Ryan and Bampton (1988) and Linton and Kamwendo (1989) may be partly due to the fact that these latter studies increased the contrast between index and reference group in the measurement of effect (Ryan & Bampton, 1988) or exposure (Linton & Kamwendo, 1989; Linton, 1990). But even if this contrast is not enlarged a positive relation between neck/shoulder pain and a poor psychosocial work environment was observed (Kamwendo et al., 1991). Monotonous work, time pressure, poor work content and high perceived workload are all positively related to the prevalence of symptoms of the shoulder/neck region in several studies. Linton and Kamwendo (1989) observed that from all variables characterising the psychosocial work environment the psychological work demand index was only weakly associated to the neck/shoulder symptoms. Only Katilainen (1978) reported data adjusted in some way for physical load (occupational class). In the studies of Linton (1990) and Ryan et al. (1988) it was indicated that the combined effect of psychosocial variables and variables for physical load was larger than the individual effects. Only one longitudinal study investigated the relationship between job demands and (time-pressure) and symptoms of neck and shoulder and reported a positive association, after adjustment for postural load (Takala et al., 1991).

The data on the influence of social support on the neck/shoulder symptoms are not consistent. Dehlin and Berg (1977) observed no effect of this variable, Ryan et al. (1988) reported an effect of support by colleagues but not by superiors and for Kvarnström and Halden this was just the other way around. Also for low control in the job conflicting results are reported. All studies however relating a sumscore for psychosocial environment to the prevalence of neck and shoulder pain reported a positive association. All of these sumscores included both demand and support variables. This may indicate that low control and poor support are only relevant in combination with high demands, monotony and poor work content. This would be in agreement with hypotheses derived form the work and stress literature. In the longitudinal study of Takala et al. (1991) the results are adjusted for posture variables and previous symptoms.

In summary: The majority of these studies report a relation between psychosocial variables and symptoms of the neck and shoulder and therefor an association seems likely. Variables such as monotonous work, time pressure, boredom/having to press yourself (poor work content) and high workload seem to be the characteristics of the job that are important. The

Table 2.4 The relationship with symptoms of neck and shoulder reported in the literature for several categories of psychosocial, psychological and other self-reported non-specific health parameters (longitudinal studies bold)

independent psychosocial or psychological variable studied	studies reporting a positive association with neck/shoulder symptoms	studies reporting no association or a negative (-) association with neck/shoulder symptoms
1. psychosocial factors at work; stressors and moderators		
work demands:		
- monotonous work	- Kvarnström & Halden (1983)[1]; Linton (1990)	
- time pressure	- **Takala et al. (1991)**; Kvarnström & Halden (1983)[1]	
- high level of concentration		
- high level of responsibility		- Kvarnström & Halden (1983)[1]
- few possibilities to take breaks	- Ryan & Bampton (1988)[1]	
- poor work content/having to push yourself	- Ryan et al. (1988); Linton & Kamwendo (1989)[1]	- Dehlin & Berg (1977)[1]
- high workload	- Linton & Kamwendo (1989)[1]; Kvarnström & Halden (1983)[1]	- Dehlin & Berg (1977)[1]
- psychological demands		- Linton & Kamwendo (1989)[1]
- sumscore (monotony, time pressure, work-pace & mental strain)	- Katilainen (1978)	
psychosocial work environment:		
- poor social support by colleagues	- Ryan et al. (1988); Linton & Kamwendo (1989)[1]	- Dehlin & Berg (1977)[1]; Kvarnström & Halden (1983)[1]
- poor social support by superiors	- Kvarnström & Halden (1983)[1]; Linton (1990)	- Dehlin & Berg (1977)[1]; Ryan & Bampton (1988)[1]
- little clarity	- Ryan & Bampton (1988)[1]	
- low job control/autonomy	- Ryan & Bampton (1988)[1]; Linton & Kamwendo (1989)[1]	- Dehlin & Berg (1977)[1]; Kvarnström & Halden (1983)[1]
Sum-score for psychosocial work environment	- Linton & Kamwendo (1989)[1]; Linton (1990); **Takala et al. (1991)**	
2. non-work stressors and moderators		
- living alone		- Ryan & Bampton (1988)[1]; **Viikari-Juntura et al. (1991)**
- low social class		- Westerling & Jonsson (1980)
- low educational level	- Tola et al. (1988); **Bergenudd et al. (1989)[1] ♀**	- **Viikari-Juntura et al. (1991) ♀; Bergenudd et al. (1989) 36 yr**
3. job dissatisfaction		
- dissatisfied with the work	- Tola et al. (1988); Bergenudd et al. (1989)[1] ♀	- Dehlin & Berg (1977); **Viikari-Juntura et al. (1991); Bergenudd et al. (1989)[1] ♂**
- perceived stressful work	- Ohara et al. (1972); Ryan & Bampton (1988)[1]; **Westgaard et al. (1991)**; Kvarnström & Halden (1983)[1]	
4. stress symptoms		
- reported stress/stress symptom score	- Ohara et al. (1976)[1]; Katilainen (1987); **Takala et al. (1991)**	
5. symptoms of poor health		

independent psychosocial or psychological variable studied	studies reporting a positive association with neck/shoulder symptoms	studies reporting no association or a negative (-) association with neck/shoulder symptoms
6. individual psychological factors		
- depressive symptoms		- **Westgaard et al. (1991)**
- emotional problems	- Ryan & Bampton (1988)	
- weak sense of coherence	- **Viikari-Juntura et al. (1991)**	
- type A behaviour/competiveness	- Hägg et al. (1990); Flodmark & Aase (1991)	

[1] No adequate adjustment for potential confounders, i.e. age and physical work load.

data on support by colleagues or superiors and low control are conflicting. However, high demands in combination with these variables seem to increase the prevalence of neck-shoulder symptoms in addition to the influence of posture and physical load at work. In the only informative longitudinal study, that analyzed the effect of these variables, a positive relation is reported between psychosocial variables at work and neck pain was reported in particular time pressure seemed to be of importance.

Non-work stressors and moderators

Only few studies analyzed the effect of stressors outside the work environment or general sociologic and demographic variables on neck and shoulder pain. Ryan and Bampton (1988) reported that stress not related to the work and not being married were not related to symptoms of the neck. Westerling and Jonsson (1980) report that social class was not significantly related to these symptoms after adjustment for physical demands. Tola et al. (1988) report that also after adjustment for several confounders including bent and twisted posture, low education was positively related to the prevalence of neck/shoulder symptoms. However Viikari-Juntura et al. (1991) and Bergenudd et al. (1988) did not establish a clear relationship between low eduction at childhood and later on and symptoms at middle age.

In summary: The scarce data on the prevalence of neck/shoulder symptoms in relation to non work stressors or sociologic variables do not suggest a strong relationship.

Job dissatisfaction

Low *job satisfaction* and high perceived mental load at work were no predictor of neck/shoulder symptoms one year later in the study of Viikari-Juntura et al. (1991) but Tola et al. (1988) did report an association of job-dissatisfaction with physical findings of neck and shoulder trouble, after adjustment for confounders. Bergenudd et al. (1988) reported a significant cross-sectional association between job-dissatisfaction and shoulder pain in women but not in men. *High perceived work-stress* did predict development of symptoms in the longitudinal study of Westgaard et al. (1991). Several studies report a cross-sectional relationship between perceived stressful work and neck or shoulder symptoms.

In summary: No consistent relation between dissatisfaction of the job and neck/shoulder trouble has been observed. A positive relationship between perceived stressful work and these symptoms however was consistently observed among all studies reporting on this association.

Stress symptoms

In two cross-sectional studies a positive association between mental stress (Ohara et al., 1976) and stress symptoms (Takilaine, 1978) has been observed. From these two studies the study of Ohara et al is not very informative. The informative longitudinal study of Takala et al. (1991) however supported this relationship.

In summary: According to the scarcely available literature a relation between reported stress or stress symptoms and symptoms of the neck shoulder seems likely.

Symptoms of poor health

None of the reviewed studies presents data on the association between other a-specific symptoms of poor health than those presented as stress symptoms on one hand and at the other hand the prevalence of symptoms of the back or neck.

Individual psychological factors

In the study of Ryan et al. (1988) a relationship between *emotional problems* and symptoms of the neck/shoulder was observed. The longitudinal study of Westgaard et al. (1991) showed that *depressive episodes* in the year before employment were not associated with the development of symptoms of neck or shoulder in the new job. Viikari-Juntura et al. (1991) reported some results that suggest a relationship between the *mental recourse* of a person to promote his or her own health (sense of coherence) and neck/shoulder symptoms. This variable was measured one year before the assessment of the prevalence of shoulder/neck symptoms.

The longitudinal studies show conflicting results on the importance of childhood variables on *intelligence and verbal skills* in the prediction of neck/shoulder symptoms in adult life. Viikari-Juntura et al. (1991) reported that these variables are of little importance. Bergenudd and Nilsson (1988) reported a weak association for men only. In addition it was not possible to discriminate adults experiencing shoulder or back symptoms with clinical shoulder signs from those without clinical signs based on this type of childhood variables (Bergenudd & Nilsson, 1991).

In summary: Few studies have analyzed the relationship between psychological problems and neck/shoulder symptoms and the variables investigated are quite diverse (emotional problems, depressive symptoms, childhood intelligence and sense of coherence).

2.3 Musculoskeletal trouble, locations other than back, neck or shoulder

2.3.1 Description of the studies

Table 2.3 also summarizes the results of the studies on the relationship between psychosocial factors and a combination of back- , neck- and sometimes upperlimb disorders (Sauter et al., 1983; Flodmark & Aase, 1991; Theorell et al., 1991), all types of musculoskeletal signs and/or symptoms (Pot et al., 1987; Kompier, 1988; Leino et al., 1989) and more general muscle pain (Karasek et al., 1987; Ursin et al., 1988; Hopkins, 1990; Magni et al., 1990; Theorell et al., 1991). For a more detailed description of these studies see appendix 4. The study of Magni et al. (1990) deals with chronic pain (musculoskeletal pain lasting a month or more) in relation to psychological functioning and in the study of Ursin et al. (1988), feelings of anxiety, coping styles and job stress were analyzed in relation to muscle pain. The other cross-sectional studies analyzed the relationship between psychosocial factors at work and musculoskeletal symptoms. In contrast to the studies on back and neck/shoulder trouble several studies have analyzed the influence of both job-demands (such as time pressure, monotonous work, high workload and high mental demands) and variables characterising social support at work and control over the job (Sauter et al., 1983; Karasek et al., 1987; Pot et al., 1987; Kompier, 1988; Hopkins, 1990; Leino & Lyrra, 1990; Smulders, 1990; Theorell et al., 1991). Theorell et al. (1991) labels these categories as psychological stressors (demands, time pressure, conflicts with superiors, nobody to talk about job or personal problems) and psychosocial resources (intellectual discretion, authority over decisions and social support by colleagues). In the analyses of the influence of psychosocial factors, several studies adjusted for physical load or conducted the analysis within one group homogeneously exposed to physical load (Sauter et al., 1983; Kompier, 1988; Leino et al., 1989; 1990; Theorell et al., 1991). All cross-sectional studies on work-related psychosocial factors analyses the relationship between perceived psychosocial factors at work and self-reported symptoms. The study of Leino (1989; 1990) is the only longitudinal study that did not specifically study symptoms of the back or neck/shoulder region. This study assessed symptoms of the musculoskeletal system with a questionnaire but also with a physical examination. Analyzed are the relationship between these outcome variables and a sumvariable for stress-symptoms, perceived psychosocial stress at work and at home and social support at work and outside the work environment. Table 2.5 shows the results of these studies for each group of psychosocial variables.

Table 2.5 The relationship with musculoskeletal symptoms reported in the literature for several categories of psychosocial, psychological and other self-reported non-specific health parameters (longitudinal studies bold)

independent psychosocial or psychological variable studied	studies reporting a positive association with musculoskeletal symptoms	studies reporting no association or a negative (-) association with musculoskeletal symptoms
1. psychosocial factors at work; stressors and moderators		
work demands:		
- monotonous work	- Hopkins (1990)[1]	
- time pressure	- Pot et al. (1987); Kompier (1988); Smulders (1990)	- Theorell et al. (1991)
- high level of concentration	- Sauter et al. (1983)[2]	
- few possibilities to take breaks		- Sauter et al. (1983)
- poor work content/having to push yourself	- Smulders (1990)	- Pot et al. (1987)
- high perceived workload/work demands	- Karasek et al. (1987)[1]; Sauter et al. (1983)[2]; Pot et al. (1987); Theorell et al. (1991)	
work organization:		
- poor career development opportunities	- Pot et al. (1987); Smulders (1990)	- Karasek et al. (1987)[1]
psychosocial work environment:		
- poor social support by colleagues	- Pot et al. (1987); Kompier (1988); Hopkins (1990)[1,2]; **Leino & Lyrra (1990)ns**	- Karasek et al. (1987)[1]; Theorell et al. (1991)
- poor social support by superiors	- Pot et al. (1987); Kompier (1988); Hopkins (1990)[1,2]; Theorell et al. (1991); Karasek et al. (1987)[1] ♀	- Karasek et al. (1987)[1] ♂; Smulders (1990); Theorell et al. (1991)
- lack of clarity	- Karasek et al. (1987)[1] ♂; Hopkins (1990)[1,2]	- Karasek et al. (1987)[1] ♀
- low job control/autonomy	- Sauter et al. (1983)[2]; Karasek et al. (1987)[1]; Hopkins (1990)[1,2]; Theorell et al. (1991)	- Pot et al. (1987)
2. non-work stressors and moderators		
- home problems	- Karasek et al. (1987)[1]	
- low income	- Karasek et al. (1987)[1]	
3. job dissatisfaction		
- dissatisfied with the work	- Hopkins (1990)[1]	
- perceived stressful work	- Hopkins (1990)[1]; **Leino & Lyrra (1990)**	- Ursin et al. (1988)[1]
4. stress symptoms		
- anxiety	- Ursin et al. (1988)[1]	
- several stress symptoms in general	- Theorell et al. (1991); **Leino (1989)**	
5. symptoms of poor health		
- poor experienced physical health	- Kompier (1988)	
- gastro-intestinal trouble	- Theorell et al. (1991)	

independent psychosocial or psychological variable studied	studies reporting a positive association with musculoskeletal symptoms	studies reporting no association or a negative (-) association with musculoskeletal symptoms
6. individual psychological factors		
- depressive symptoms	- Magni et al. (1990)	
- coping style	- Ursin et al. (1988)[1]; Kompier (1988)	
- type A behaviour/tension	- Flodmark & Aase (1991); Theorell et al. (1991)	

[1] No adequate adjustment for potential confounders, i.e. age and physical work load.
[2] This variable is part of a sumscore for job demands or psychosocial environment associated with musculoskeletal trouble.

2.3.2 Description of the results

Psychosocial factors at work; stressors and moderators

In almost all of these studies a positive relation between one or more psychosocial factors at work and musculoskeletal symptoms was reported. The following factors, as far as the job-demands variables are concerned, were related to the prevalence of musculoskeletal trouble: monotonous work (Hopkins, 1990), time pressure (Pot et al., 1987; Kompier, 1988; Smulders, 1990), high demands on concentration (Sauter et al., 1983) and high perceived (mental) workload (Sauter et al., 1983; Karasek et al., 1987; Pot et al., 1987; Theorell et al., 1991). However, no significant influence on musculoskeletal trouble was observed for the possibilities to take a break (Sauter et al., 1983) and poor work content (Pot et al., 1987) and, in contrast to the studies mentioned above, time pressure was not significantly related to musculoskeletal trouble in the study of Theorell et al. (1991). In this latter study adjustment for physical load considerably decreased the crude association between time pressure (rush) and symptoms of the back, neck or shoulder. In addition, poor career development opportunities were not significantly related to muscle pain (Karasek et al., 1987). In several studies a sumscore for work demands or work atmosphere (Sauter et al., 1983; Pot et al., 1987) or a combination of both has been analyzed. In the study of Theorell et al. (1991) is reported that the variables job demands and lack of possibilities to talk are not only related to back, neck- and shoulder disorders but also to self-reported muscle tension. Lack of authority over decisions also related to back, neck and shoulder disorders was not significantly related to muscle tension.

Although most studies observed a relationship between musculoskeletal trouble and poor social support at work by colleagues (Pot et al., 1987; Kompier, 1988; Hopkins, 1990) this relationship was not consistent in all studies. Theorell et al. (1991) reported no association between social support at work and back, neck and shoulder symptoms and symptoms of the other joints, neither with or without adjustment for physical load. In the study of Karasek et al. (1987) no significant association between musculoskeletal ache and social support at work was reported (strength of the association not presented). Poor social support by superiors or many conflicts at work between employee and superior was also positively related to musculoskeletal problems in Pot et al. (1987), Kompier (1988) and Hopkins (1990) but not in Smulders (1990). In addition Karasek et al. (1987) report a significant association of this variable with musculoskeletal ache among women but not among men. In the study of Theorell et al. (1990) many conflicts between superiors and employees were after adjustment for physical load significantly associated with joint trouble but not with back, neck or shoulder trouble. The association between a sum-score for social support at work, both by

colleagues and superiors and outside the work-environment is studied in the longitudinal study of Leino and Lyrra (1990). They report only among blue-collar women a significant cross-sectional association between support and musculoskeletal findings at baseline. Poor social support was also associated with musculoskeletal symptoms and signs during the follow-up, but this association was not significant. Kompier (1988) observed a positive association between musculoskeletal trouble and poor social support at work and but not with social support outside the work environment.
Low job-control is related to musculoskeletal symptoms in all studies (Sauter et al., 1983; Karasek et al., 1987; Hopkins, 1990; Theorell et al., 1991) except that of Pot et al. (1987). However, these authors report that only little variation in this variable was present. Autonomy was low for most workers of the study-population. Although several of these studies on psychosocial factors and musculoskeletal trouble analyzed the influence of both job demands and support or control variables, each of these variables is treated as an independent variable and no information on the interaction of these variables is presented.

In summary: Most of these cross-sectional studies report an association between high job demands, poor social support and low control on one side and self reported musculoskeletal trouble on the other side. This is true also for those studies that have adjusted for physical load. However the association does not consistently apply to all work-related variables included or to all of the groups in the study population.

Non work stressors and moderators

Few of these studies report on the relationship between general sociological variables and musculoskeletal trouble. Only Karasek et al. (1987) report a positive association between musculoskeletal ache and low income and problems and home but not with marital status and whether or not the spouse is working.

Job dissatisfaction

In the studies of Karasek et al. (1987) job (dis)satisfaction is treated as an dependant variable and no information on its association with musculoskeletal ache was presented. Only one study analyzed the association between dissatisfaction with the work and musculoskeletal complaints and reports a positive association (Hopkins, 1990). The perception of the work environment as stressful was also related to symptoms in the study of Hopkins (1990) but not in the study of Ursin et al. (1988). A sum-score on perceived psychosocial stress that contains items on work related and non work related stress (overstrained by work, pressed work pace, mentally strenuous work, financial problems, trouble with kids or relatives, afraid of making mistakes) is cross-sectionally related to

musculoskeletal symptoms as well as signs in men only in the baseline measurements of the longitudinal study of Leino and Lyrra (1990). Perceived stress at baseline did not predict symptoms after 10 years of follow-up but did predict musculoskeletal findings in blue collar workers. This sumscore on perceived psychosocial stress contains several job demands variables. It may be hypothesized that the job control in blue collar workers is lower than in white collar workers which may explain the discrepancy in the predictive value of psychosocial stress for musculoskeletal trouble in these occupational categories.

In summary: Only few data are available on the relation between job satisfaction and musculoskeletal trouble. A sumscore on perceived psychosocial stress (including several job demands variables) predicts only musculoskeletal findings (not symptoms) and only in blue collar workers (both men and women).

Stress symptoms

Leino (1989) reports that a sumscore of self-reported stress symptoms is related to self-reported musculoskeletal symptoms and clinical findings at baseline. in addition, the stress symptom score predicted the clinical findings after 10 years of follow-up, adjusted for the clinical findings at baseline. On the other hand also stress during the follow-up was predicted by the musculoskeletal symptoms at baseline, however this association was not as consistent for all groups. In men, the relationship between the stress symptoms and the musculoskeletal symptoms was symmetrical but in women the association of the baseline musculoskeletal symptoms and the stress symptoms at follow-up was weaker than the association of the baseline stress symptoms and the musculoskeletal symptoms at follow-up. Thus this study presents some evidence that not only self-reported musculoskeletal complaints but also adverse changes in clinical symptoms and signs are related to stress symptoms measured 10 years before. In addition this study presents some evidence that also for those without previous musculoskeletal symptoms the stress-symptoms score has predictive value for the development of complaints and disorders of the musculoskeletal system. In the study of Theorell et al. (1991) a positive association between all stress symptoms included in the analysis (anger, worry, tiredness, sleep disturbances, dispersion and loss of appetite) and muscle tension was reported. Muscle tension on its turn was associated with back, neck and shoulder symptoms (this was also true for breath tension, chewing tension and type A tension but not for systolic blood pressure and plasma cortisol). No direct associations between stress symptoms and back, neck and shoulder symptoms are reported.

In summary: A relationship between stress-symptoms and the development or exacerbation of musculoskeletal symptoms established by interview and physical examination seems likely. Muscle tension may be an intermediate in this process.

Symptoms of poor health

Only two studies present data on the association between other health effects and musculoskeletal disorders. Kompier (1988) reports an association between poor health and musculoskeletal trouble. As indicated above several stress symptoms or psychosomatic symptoms such as gastro-intestinal trouble are related to the self-reported musculoskeletal trouble (Theorell et al., 1991).

Individual psychological factors

Anxiety and depressive symptoms were positively related to musculoskeletal symptoms (Ursin et al., 1988; Magni et al., 1990). Theorell et al. (1991) and Flodmark and Aase (1991) report an association between type A behaviour and type A tension respectively and musculoskeletal trouble.

In summary: A relation between psychological and emotional problems and musculoskeletal symptoms is reported in the few studies that investigated its relationship.

3. DISCUSSION AND CONCLUSIONS

3.1 Quality of the studies

We found 42 cross-sectional and 15 longitudinal studies reporting empirical results on the subject of this review. Only 27 cross-sectional and 3 longitudinal studies analyzed the influence of psychosocial factors at work. Recently, the growing attention for the importance of psychosocial factors for work-related musculoskeletal complaints yielded some informative studies in this area. These latter studies adjust for physical load and focus on the variables that have proven to be related to stress at work (e.g. Theorell et al., 1991). One of the main difficulties of most studies of this review is the high mutual correlations between several psychosocial, individual and stress variables. In addition, these variables are often highly correlated with physical load in particular within some of the specific occupations under study (e.g. VDU operators or health care workers). Almost all studies rely on self-reports both for physical load and psychosocial work environment and often also for the outcome assessment.

In this paragraph the relations of the independent factors with back-, neck/shoulder and general musculoskeletal trouble are no longer discussed separately. The presented results suggest similar associations between the psychosocial factors, individual characteristics and stress with symptoms of each of these musculoskeletal sites. Several studies show that the symptoms in one musculoskeletal region correlate high with those in other body parts (e.g. Heliövaara et al., 1991; Leino et al., 1991). This may be due to perception or reporting of symptoms, but may also be an indication of exposure to shared risk factors or of common etiologic factors. The recently observed high correlation between several musculoskeletal diseases (based on more or less defined pathology) lends some support to a role of common etiologic mechanisms (Heliövaara et al., 1991).

Quite a few of the empirical results were conflicting. This may be due to the heterogeneous character of the studies with respect to the measured independent and dependent variable. It is possible that some variables are related to back pain of short duration but not to serious back trouble such as a herniated disc. In addition, several different methods to measure the independent variables are employed. This applies to the measurement of psychosocial factors at work, stress symptoms and personal characteristics. Conflicting data may also be due to chance. In several studies many associations are tested and several of these will be significant if only due to chance. Although, it should be noted that only few studies show associations between musculoskeletal trouble and psychosocial variables in the direction opposite to that expected.

3.2 Hypothesized associations

The relations presented in the results section will be discussed according to the hypothesized associations presented in figure 1.1. These associations were:

1. stressors at work directly influence the mechanical load;
2. psychosocial factors at work (demands, control and social support) modified by individual characteristics, increase work-related stress, which may:
   a. increase the muscle tone and lead to the development of musculoskeletal symptoms,
   b. increase the musculoskeletal symptoms due to some unknown mechanism,
   c. increase the perception of symptoms and thus prolong or intensify the symptoms, or
   d. increase symptoms of poor health in general, including musculoskeletal symptoms.

ad 1. When all the empirical data are combined, it may be concluded that monotonous work, time pressure and perceived high work load each show a positive relation with musculoskeletal trouble. Although this was not observed consistently in all studies. Part or all of this association may be attributed to a high mechanical load associated with these variables. This is illustrated by the study of Theorell (1991), in which the odds ratio for perceived time pressure in relation to symptoms of the back-, neck- or shoulder, considerably decreased after adjustment for physical load. In several studies however, also after adjustment for physical load a significant odds ratio remained. This may be due to residual confounding, since physical load is hard to measure accurately, or it may indicate an effect of these demand variables additional to the associated mechanical load. Some of the other job demand variables that are most likely not as strongly related to mechanical load such as lack of clarity or high demands on concentration show no clear association with musculoskeletal symptoms, but few studies analyzed the role of these variables. The association between low control, social support by colleagues and combinations of these variables on one hand and musculoskeletal trouble on the other, seems to indicate that not only the high mechanical load associated with high job demands is responsible for the association between psychosocial factors at work and musculoskeletal trouble.

ad 2a, 2b. Only one of these epidemiological studies (Theorell et al., 1991) provides data on the possible intermediate role of (chronic) muscle tension. In this study several self-reported stress symptoms were related to self-reported muscle tension. Muscle tension in its turn was related to back, neck or shoulder symptoms. No information is presented on the direct association of the stress symptoms with symptoms of the back, neck or shoulder. Some of the psychosocial factors (high demands and lack of opportunities to talk) were directly associated to muscle tension. The stress variables were also related to other types of self-reported tension (e.g. breath tension), that

were also related to the musculoskeletal symptoms. Several experimental studies previously showed that muscle tension increases with increasing perceived stress.

ad 2c. Perceived stress is most likely an intermediate in the relation between psychosocial stressors at work and the development of musculoskeletal symptoms. It is therefore expected that perceived stress or stress-symptoms correlate with or predict musculoskeletal trouble. To distinguish between stress as a result or as a cause of musculoskeletal pain, stress should be measured before the onset of symptoms. Some of the studies that did so, and adjusted for other factors provide some evidence for a role of stress in the development of musculoskeletal trouble. The evidence supporting the assumption that stress predicts musculoskeletal symptoms is slightly more convincing than that for the reversed relation. Most likely both relations are present. It is not clear whether the relation between stress and musculoskeletal trouble is the result of increased perception of symptoms or of a specific mechanism.

ad 2d. In most studies that analyze a relation between other physical and behavioral health indicators and back trouble, a positive association is reported. It is remarkable that several of these studies report a significant univariate association, which is no longer significant after inclusion of other variables such as other health indicators, stress symptoms and individual factors in a multivariate model. Some informative studies (e.g. Åstrand & Isacsson, 1988) however lend support to the hypothesis that poor health is associated with and may predict back trouble. This seems to suggest that stress influences the perception of both musculoskeletal symptoms and symptoms of other body parts. This association between several indicators of poor health and back trouble is thus a manifestation of the relation indicated under 2c. This correlation between stress and indicators of poor health may also be partly due to shared risk factors for both stress and musculoskeletal trouble (e.g. age). In addition, some medical explanations may account for a small part of this relation (e.g.increased spinal pressure due to chronic cough may be responsible for the association between frequent coughing and back pain).

As indicated in figure 1.1, both psychosocial factors and individual characteristics are important for the development of stress at work. Of these individual characteristics low social class and little education show a weak association with musculoskeletal trouble. This association may at least be partly due to the high correlation of these variables with physical demands as well as poor psychosocial environments at work. Although, in the clinical literature the relation between chronic (musculoskeletal) pain and psychological problems and personality traits received much attention, the empirical results of this review do not show that these individual characteristics are of great importance for the development of work related musculoskeletal trouble. However only scarce data

are available. Type a behaviour may be an exception, but this might be because of the high physical load possibly associated with this behaviour.

In addition to these possible mechanisms, it may be argued that the reported associations are due to methodological shortcomings of the reviewed studies. For instance, it is often suggested that the association between job dissatisfaction and self-reported musculoskeletal symptoms in cross-sectional studies is spurious, because reporting of symptoms could in fact be regarded as a measure of low job satisfaction. Not only job dissatisfaction but also other psychosocial factors are self-reported. Therefore, a relation between these factors and self-reported symptoms may also be based on a tendency to complain about the work as well as physical discomfort. Some arguments against these assumptions can be raised. The studies show not only an association of these variables with self reported musculoskeletal complaints but also with physical findings. In addition, a positive relation between physical findings and job dissatisfaction was also established while the job satisfaction was solely rated by the workers without symptoms. Some longitudinal studies also report that low job satisfaction predicts future musculoskeletal problems, after adjustment for back trouble at the start of follow-up. Thus the epidemiological evidence shows that not all of the reported associations can be attributed to spurious associations introduced by the design of these studies.

3.3 Conclusive evaluation of the epidemiologic evidence

Table 3.1 presents a summary of the relations presented in chapter 2. As indicated before, the relations between the factors mentioned in table 3.1 and symptoms of different musculoskeletal regions do not seem to be essentially different. Depending on the type of musculoskeletal symptoms, however, different associations receive more attention. Due to the high mutual correlation between psychosocial factors and mechanical load, the difficulties to measure these variables accurately and the fact that the studied relations are not very specific, the reviewed studies do not present conclusive evidence. Nevertheless, in conclusion a qualitative evaluation of the evidence for the various relations is presented.

Table 3.1 Summary of the epidemiological evidence for the relationships between psychosocial factors and musculoskeletal disease (+ some evidence for a positive association; - association seems to be absent; +/- conflicting data; ? too little information)

	#C*	#L*	back	neck/ shoulder	other**	total
1. work characteristics	26	3	+/-	?	+	+
- monotonous work			+	+	+	+
- time pressure			+/-	?	+	+
- high concentration			-	?	+	+/-
- high responsibility			-	?	-	?
- poor work content			+	+/-	?	+/-
- high work load			?	+/-	+	+
- lack of clarity			?	?	-	?
- little opportunities to take breaks			-	+/-	-	-
- low control/autonomy			?	?	+	+
- poor social support by colleagues			+	+/-	+	+
- poor social support by superiors			?	+/-	+	+/-
- demand and support variables combined			+	+	?	+
2. non work stressors and moderators	13	8	+/-	-	?	+/-
- living alone/not married			+/-	-	?	+/-
- low social class			+/-	-	-	-
- low educational level			+/-	+/-	?	+/-
3. low job satisfaction	12	4	+/-	+/-	+	+/-
4. stress symptoms	24	8	+	+	+	+
- worry, tension, anxiety, nervousness			+	+	+	+
- physical stress symptoms			+	?	?	?
- tiredness and exhaustion			+/-	?	?	+/-
- high perceived work stress			+	+	+	+
- low job satisfaction			+	+	?	+
- physiological parameters			?	?	?	?
5. symptoms of poor health	7	8	+	?	?	+
- poor physical health			+	?	?	+
- respiratory disease/cough			+	?	?	+
- stomach ache			+	?	?	+
- cardiovascular disease			+/-	?	?	+/-
- headache			+/-	?	?	+/-
- use of medication			+	?	?	+
- use of medical services			+	?	?	+
6. individual psychological factors	15	9	+/-	?	?	?
- neuroticism			+/-	?	?	?
- type A behaviour			?	+	+	+
- extrovert personality			?	-	?	?
- depression			+/-	?	?	?
- coping styles			-	?	?	?
- attitude towards own health			+/-	?	+	+

* #C: number of cross-sectional studies; #L: number of longitudinal studies

** Musculoskeletal system no location specified (neck/shoulder and back or all musculoskeletal sites).

Psychological factors at work: stressors and moderators

None of the studies on *back trouble* analyzed work demands in combination with moderating factors, such as social support at work or job-control. The studies investigating the neck/shoulder symptoms and neck/shoulder/back or muscle pain have devoted more attention to moderating factors such as the amount of control and social support at work. The studies that analyzed the role of the amount of control at work, emphasize its importance in relation to musculoskeletal trouble.

The importance of monotony and time pressure is emphasized in one of the most informative cross-sectional studies on back trouble, that reports a relation between these *work demand* variables (a score for monotony, time-pressure and worry about mistake) and symptoms of the back (physical examination), after adjustment for potential confounders including physical load and previous back pain. The importance of monotonous work was also indicated in a cross-sectional study. However, two other informative cross-sectional studies did not report a relation between back trouble and time-pressure. Monotonous work and high job-demands (except for responsibility at work) were also related to neck/shoulder trouble. As indicated part of this association for muscular trouble and monotonous work or time pressure may be due to the increased physical load due to these variables, although in some studies the association was adjusted, to some extent for posture variables.

One informative longitudinal studies and two cross-sectional studies present some support for the relevance of *social support* at work in relation to back trouble. This relation was adjusted for physical load, preceding back trouble and other potential confounders. This study however dealt with claims or other registered episodes and thus self-reported poor social support may also be related to the readiness to report symptoms. The studies on neck/shoulder symptoms and those on musculoskeletal disorders without additional specification seem to support that social support at work is related to the prevalence of musculoskeletal symptoms.

In conclusion: It seems that, although the data on time pressure are conflicting in some respect, the epidemiologic studies provide support for a relation between monotonous/boring work and working under time pressure and musculoskeletal trouble. Part of this association may be attributed to the increased physical load due to these variables, although some studies adjust, to some extent for posture variables. The few studies that paid attention to the importance of job-control in relation to musculoskeletal symptoms, indicate that this variable may be important. In addition, workers who indicate that the social support at work is poor seem to have a higher prevalence of musculoskeletal symptoms. A combination between job demands and support variables is consistently related to musculoskeletal trouble.

Non work stressors and moderators

As indicated before these variables include general sociologic variables (income, social class, education), marital status, social contacts at home and emotional life-events. It is not very plausible that these variables in itself predict musculoskeletal symptoms but it is assumed that the emotional stress for these persons is higher and that due to the increased stress the prevalence of musculoskeletal symptoms increases. This is most likely due to an increased perception of symptoms, duration of symptoms or readiness to report them or complain about them. The relation between living alone and back trouble seems to be primarily established in the cross-sectional studies and the studies with a short duration of follow-up, and was not related to clinical symptoms or self-reported symptoms after a longer follow-up. Therefore, the reviewed epidemiologic data suggest that the reporting of symptoms is a temporary consequence of emotional stress.

Income, social class and education are correlated with physical demands at work, but also with poor psychosocial work environments and with use of medical services. This may explain a possible relation of these variables to musculoskeletal trouble. These variables may also be related to the individual capacity to deal with symptoms of poor health. However, two of the longitudinal studies with a considerable duration of follow-up tentatively supported a relation between low social class and musculoskeletal symptoms after adjustment for physical load.

In conclusion: The reviewed studies do not support a strong role of low social class, little education and emotional life events or living conditions in prediction of musculoskeletal pain, when physical load is accounted for.

Job dissatisfaction

As indicated, dissatisfaction with the job may be a consequence of the musculoskeletal trouble. However, Tola et al. (1990) did report an association with physical findings, after adjustment for confounders and in the study of Hopkins (1990) self-reported job stress and dissatisfaction with the job, rated by the workers without symptoms, is correlated with a high prevalence of musculoskeletal discomfort. Some longitudinal studies also report that low job satisfaction may be a predictor of musculoskeletal problems later on, even when adjusted also for back trouble at the start of follow-up. In these studies it is possible that dissatisfaction with the job is associated with the readiness to report claims or symptoms as well as the development of symptoms.

In conclusion: The data on the effect of low job satisfaction on musculoskeletal trouble are conflicting. Some evidence supports the fact that low job satisfaction is a predictor of future musculoskeletal problems.

Stress symptoms

The relation between perceived stress and symptoms of the back, neck/shoulder and several parts of the musculoskeletal system have all been studied. Perceived stress is most likely an intermediate in the relation between psychosocial stressors at work and outside work and the development of musculoskeletal symptoms. It is therefore expected that self-reported perceived stress or the occurrence of psychological stress-symptoms correlate with or predict musculoskeletal trouble. To distinguish between stress as a consequence and a predictor of musculoskeletal pain symptoms of stress should be measured before the development of musculoskeletal symptoms. Some of these studies that adjust for previous musculoskeletal complaints and other factors provide some evidence for a role of stress by the development of musculoskeletal trouble (Haanen, 1984; Heliövaara et al., 1987; Leino, 1989; Riihimäki et al., 1989; Takela et al., 1989; Westgaard et al., 1991). These studies concern both back-, neck and general musculoskeletal clinical signs and symptoms. Heliövaara et al. (1987) state that the most likely explanation for the association between symptoms of psychological distress and hospital admission due to sciatica or herniated disc is that psychological distress is related to proneness to seek medical care in general and hospitalization in particular, rather than to herniation of the intervertebral disc. Riihimäki et al. (1989) state that stress may be a contributory factor in the etiology of sciatic pain but it is also possible that people with stress are more prone to report their somatic symptoms. In the study of Leino (1989), the stress symptom score is both related to the increase in self-reported symptoms as to the increase in clinical findings. This does also apply to the study of Takala et al. (1991) and Westgaard et al. (1991) with respect to the neck symptoms.

> *In conclusion:* Although clinical findings also rely to some extent on self-reports, these data suggest that perceived stress and stress symptoms may be a risk-factor for the development of musculoskeletal signs, in addition to an increase in symptoms due to a higher incidence, or increase in the duration, perception or reporting of symptoms. Perceived stress is most likely an intermediate in the relation between psychosocial stressors at work and development of musculoskeletal symptoms. Some studies that measured stress before the onset of symptoms and adjusted for other risk factors provide evidence for a role of stress in the development of musculoskeletal trouble.

Symptoms of poor health

It may be argued that stress influences physical health in general or the perception, severity or readiness to report symptoms (somatization). This would result in an association between symptoms of the musculoskeletal system and other non-specific symptoms of ill-health and perceived poor

physical health. Of course these other diseases may also be based on specific pathology related to specific mechanisms. This correlation between psychological and poor health may be confounded by age and the existence of a shared risk factor or accumulation of risk factors for both stress and musculoskeletal trouble. There are also medical explanations that may account for a small part of the dependence between these indicators of health. It is possible that subjects with atherosclerosis have back pain due to aortic atherosclerosis, or the symptoms in the lower limbs interpreted as intermittent claudication may be due to sciatica. The increased spinal pressure due to chronic cough may be responsible for the association between frequent coughing and back pain. In addition, smoking may be a confounder of this relation between cough and musculoskeletal disorders (e.g. Battie et al., 1991). Although Deyo et al. (1989) reported an association of coughing with back pain also after adjustment of smoking. We are not aware of a study analyzing the association between poor health and other musculoskeletal diseases than back trouble.

In conclusion: These variables are only studied in relation to back trouble. These data suggest that back trouble is often accompanied by other symptoms of poor health.

Individual psychological factors

In the clinical literature on chronic (musculoskeletal) pain, psychological dysfunctioning has received much attention. Frymoyer (1973) also indicated that a lot of research suggests that psychological factors such as hysteria, hypochondria, somatization and depression affect the outcome of treatment of low-back disorders but that their relevance to the etiology of low-back pain has not been established. Quite a few of these studies in the seventies analyzed wether the psychological profile of chronic back pain patients without obvious pathology differed from those with pathologic signs. It should be emphasized though that many of these studies were not able to establish wether these variables predicted musculoskeletal pain or were a consequence of musculoskeletal pain. It is also possible that patients who are depressed or anxious have greater awareness of or greater difficulty in coping with low back pain and thus seek medical attention earlier. Frymoyer (1973) also suggest that emotional conditions may be directly associated with the low-back pain by means of an as yet unknown mechanism. Animal experimentation suggested that stressed animals had large discs that were postulated to be result of an increased inhibition of water. As indicate in section 2, recently a prospective association between several MMPI scales (hysteria, anti-social) and reporting of back-episodes was observed (Bigos et al., 1991) and a similar relation was previously reported by Haanen et al. (1984) in those not reporting symptoms at the start of follow-up. Neuroticism however did not predict future musculoskeletal disability although it showed a strong cross-sectional association in the same population. Although cross-

sectionally this variable showed a strong association with both self-reported back pain and 'back abnormalities', the latter association was even stronger. The observed association between type A personality (competitiveness) may be due to the fact that these persons push themselves harder and exhibit more risk taking behaviour.

Low scores on intelligence tests and psychological tests of other skills do not seem to predict symptoms of the musculoskeletal system many years later. Low intelligence may be related to poor locomotor control and a poor concept of bodily functions and relationships. The authors stated that a combination with a social process that selects the less gifted for heavy and unsatisfying labour, could explain the relationship between intelligence test results in childhood and back pain in middle age. However this relationship was only observed in one study.

Little information is available on the personal coping styles and sense of coherence and other indicators of the individual capacity to cope with stress and musculoskeletal symptoms. No analysis of these variables as an intermediate between stressors (physical and psychosocial) and symptoms of the musculoskeletal system has been conducted.

In conclusion: Several emotional and psychological problems are related to musculoskeletal trouble. In the cross-sectional studies these problems may be a cause or a result of musculoskeletal complaints. Two longitudinal studies show that some personality traits have a predictive value for musculoskeletal trouble, whereas two others show that these variables do not predict musculoskeletal symptoms. Therefore the role of these variables in the development of musculoskeletal trouble is not clear.

4. RECOMMENDATION

In future research on the relation between psychosocial variables and musculoskeletal disease it seems important to assess

1. the psychosocial factors at work by observation or with neutral questions);
2. the perception of the workers concerning these variables;
3. the job-satisfaction and the self-reported stress.

When it is expected that perceived work-stress is an intermediate variable between stressors at work and musculoskeletal symptoms, one should concentrate on those work and non-work related variables most strongly related to stress. It is therefore important to direct attention to the job-demands in relation to the job-control variables in analogy of the research on work stress. In addition information on the mechanical load (at work) should be obtained. It may for instance be possible to compare the physical load due to posture, movement and force exertion of those reporting high perceived stress and low job-dissatisfaction to colleagues more satisfied with the work, in otherwise similar jobs.

It also appears to be important to distinguish between several patterns of back pain (e.g. sciatica, transient back pain of short duration with recovery overnight etc). It seems plausible that these parameters are related to different work related risk factors. Since it is generally agreed that back trouble is of multifactorial origin, epidemiologic research should attempt to assess the relevance of all these variables in relation to each other. Longitudinal studies may provide information on the temporal relation and are therefore of primary importance. In future studies, a clear distinction, in study design and analysis, between risk factors of development of musculoskeletal trouble, persistence of symptoms and prediction of sick leave and disability appears to be important. Thus, future studies on psychosocial variables related to musculoskeletal trouble should ideally be longitudinal, directed towards the analysis of development or persistence of symptoms/pathology (disability) and devote attention to the importance and interaction between adequately measured mechanical load, psychosocial stressors at work, perceived stress and musculoskeletal problems. These studies will provide society with better tools to set priorities in the prevention of work-related musculoskeletal disease and job (re)design.

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APPENDICES

Appendix 1 Cross-sectional studies on the relationship between back trouble and psychosocial factors at work, social and demographic variables, life events, experienced stress, personality characteristics, and other non-specific health complaints

Study	dependent variable	variables* positively related to back trouble	variables* not related or negatively related to back trouble	comments**
working population (chronological order)				
1. Magora (1973)	> 3 days of LBP or sick leave due to LBP in anamnesis (postal questionnaire)	- dissatisfied with work; OR 2.9 (bus drivers, post officers, workers of light industry) - high concentration (all occupations); OR 2.9 - high responsibility (bank employees) - nervousness after work (bank employees); OR 2.0 - fatigued (physically, emotionally and mentally!) after work (heavy industry); OR 1.4 (postal questionnaire)	- high responsibility and nervousness after work (all occupations, except bank employees) - fatigue after work (all occupations, except heavy industry	- 3,316 Israeli workers from 8 selected occupational groups - only crude OR's, not stratified for occupation or other variables, e.g. age, region - no adjustment for physical load, some relationships occur within one occupation - both work environment variables and health complaints are self-reported
2. Dehlin & Berg (1977)	- have you ever had pain or ache in the lumbar or sacral spine or pain radiating down into either leg? - also asked for the thoracic and cervical region (interview)	- low overall satisfaction with the job (also related to symptoms at the time of the interview) - poor relations with supervisors and colleagues - high perceived physical (!) and psychological demands (questionnaire)	- satisfaction with the work itself - perceived need for additional education - adjustment to geriatric work	- 273 nursing-aides in a Geriatric Hospital in Sweden (including those sick listed) - no adjustment for potential confounders - no data on the influence of physical load on the prevalence of LBP or on the relation between psychological demands and LBP
3. Åstrand (1987)	- do you often have lumbago or pain in your back? - 'abnormal back' based on signs and symptoms (palpation, inspection, clinical tests) during physical examination (the analysis of the follow-up of this study is described later on)	<u>significant univariate association:</u> - low education - low income - neuroticism - psychological test on verbal skills, general intelligence and arithmetic skills - less than good subjective health; OR 3 for BP and 4.6 for back abnormalities (BA) - pain in heart or chest - breathlessness - headaches <u>multivariate association:</u> - neuroticism; OR for BP: 2.8 (1.4-5.4)*** per point of the score; OR for BA: 3.9 (1.7-8.5) - test on verbal skills; OR for BA 1.6 (1.0-2.6)	<u>no significant association:</u> - marital status - frequent coughing - high blood pressure - work satisfaction - perceived responsibility at work - self-assessed routine work - hustling and nerve racking work - shift work - social contacts	- 391 male workers of a Swedish paper company: 33, 45, 55 and 65 years old (in 1961) - separate analysis for manual and clerical workers - back pain and back abnormalities generally showed similar associations but the strength and statistical significance was greater for back abnormalities - in the multivariate model adjustment is made for heavy work, frequent lifting, age, duration of employment, and the psychological tests - the association of neuroticism was stronger with back abnormalities than with back pain

Study	dependent variable	variables* positively related to back trouble	variables* not related or negatively related to back trouble	comments**
4. Skovron et al. (1987)	'recent troublesome LBP, defined as not related to menstruation urinary tract infections, which was among the three most troublesome musculo-skeletal problems, occurring the past 6 months	univariate analysis: - goodII relationship with co-workers multivariate analysis: - goodII relationship with co-workers (adjusted for job-category and age)	univariate analysis - work schedule - perceived autonomy - relationship with head nurse	- 787 nurses and direct care personnel - data on physical load are collected but not included in the multivariate analysis - no relation was observed between recent troublesome LBP and frequency of patient lifting - the population was followed-up
5. Ryden et al. (1989)	back pain episodes of work-related origin registered at the occupational health service of the hospital		- nervousness - tiredness or feeling weak - problems at work - problems at home - depression - living alone	- 84 cases and 168 matched controls of a large hospital - matching variables were: age, gender, department, function and physical demands - due to the matching on job and work environment no analysis of psychosocial factors at work could be conducted of psychological variables - only univariate analysis
6. Lundberg et al. (1989)	perceived physical (lower back) load during 2 hours of work (7 point Borg-scale: 1=no load at all, 7=a very great load)	- self-reports (11 point scale, 0=minimum, 10=maximum) during the same 2 hours of work on: · time pressure · tiredness · irritation	- self-reports during the same 2 hours of work on: · pressure by demands · tenseness - physiological measurements (i.c. heart rate, blood pressure, catecholamine and cortisol excretion)	- 20 male workers at an assembly line in Sweden, 19 to 25 years old - physical load was rather low (assessed with extensive measurements and use of a biomechanical model) and comparable for all workers
7. Wickström et al. (1989)	- have you sometimes experienced back pain? BP - have you experienced pain radiating down from the back to a leg?; (sciatica)	- type A behaviour (competitiveness) · by manual workers related to sciatica · by sedentary workers related to BP	- type A behaviour no association by sedentary workers with sciatica	- 461 workers from 5 occupations in the metal industry, aged 19-65 years - stratification for manual and sedentary workers - no age adjustment - no information on physical load - there was a significant relation between experienced stress and type A behaviour
8. Linton & Kamwendo (1989)	Did you experience discomfort in the lower back during the last 12 months? (questionnaire)	- poor psychosocial work environment (total score which combines questions on work content, work demands, and social support at work (questionnaire)		- 420 medical secretaries in a Swedish hospital - no adjustment for differences in ergonomical lay-out of the workplace or difference in work tasks or other relevant variables

Study	dependent variable	variables* positively related to back trouble	variables* not related or negatively related to back trouble	comments**
9. Linton et al. (1990)	- have you been to a doctor, nurse, physiotherapist, chiropractor or other health professional during the past year because of BP? - did you experience discomfort in the lower back during the last 12 months?	- poor psychosocial work environment (total score); in particular the subscores for work content and social support; only a weak association for the work demand score - association between psychosocial factors and BP strongest in the younger and older workers: OR<30 years, 33% lowest versus 33% highest score: 3 (1.8-4.9) OR>50 years; 2.6 (1.8-3.8		- 22,180 Swedish workers undergoing a screening examination by the occupational health care service - adjusted for age but not other potential confounders, e.g. physical work load - OR for the combination of poor psychosocial work environment in combination with: • monotonous work: 2.6 (1.9-3.4) • heavy lifting: 2.4 (1.8-3.3) • poor posture: 3.4 (2.6-4.4)
10. Katilainen (1978), presented in: Leino et al. (1991)	repeatedly experienced pain or ache in the low back	7-item stress symptoms score (headache, fatigue or feebleness, sleeping difficulties, heartburn, abdominal pains or diarrhoea, dizziness, irregular heartbeat, anxiety, nervousness or irritability) 1 less than once a month - 5 daily or almost daily RR low stress symptom score 1.0 RR rather low 1.7 RR rather high 2.6 RR high 3.5 adjusted for age, sex and occupational class mental load: a sum scale of reported distractions, tight time schedule, mental strain, monotony and work pace divided in 4 levels. RR_a adjusted for age, sex and occupational class, RR_b in addition adjusted for stress symptoms: RR_a low 1.0 RR_b 1.0 RR_a rather low 1.3 RR_b 1.2 RR_a rather high 1.3 RR_b 1.2 RR_a high 1.7 RR_b 1.7	- 2,018 blue-collar workers and 2,149 white-collar workers representative sample of the finish working population - the positive association between stress symptoms score and LBP was similar to the association with pain in neck/shoulder, upper limbs and lower limbs - adjustment for stress substantially lowered the RR for lifting, repetitive movements, draught and physical strain. Each RR was also greater than 1 after adjustment for stress - the RR for the above mentioned factors were very similar for each musculoskeletal location.	

Study	dependent variable	variables* positively related to back trouble	variables* not related or negatively related to back trouble	comments**
11. Boshuizen et al. (in press)	do you regularly have pain or stiffness in the back?	- psychological distress, sumscore for poor sleeping quality, constant feeling of inadequateness, nervousness: PD 29.2 (20.0-38.3) - treated for nervous complaints during the last 5 years: PD 8.1 (1.4-14.8)	- living alone: PD 43 (-10.4-1.8 - poor career perspectives: PD 1.7 (-5.9-9.2) - high mental demands: PD 1.4 (-3.1-6.0) - possibility to take breaks: PD 1.9 (-3.2-5.8) - time pressure: PD 1.3 (-3.2-5.8) - work satisfaction: PD 3.3. (-5.1-11.7) - good organization of work: PD -1.6 (-7.4-4.2)	- 4,054 male workers, 25-55 years old, teachers, bookkeepers, cost accountants, salesmen, gardeners, woodworkers, lathe operators, packers, busdrivers, truck drivers, house painters, bricklayers and carpenters. The last 3 occupations are analyzed separately - strength of association is expressed as prevalence difference (PD); these prevalence differences are standardized in a multivariate analysis for occupation, age, body height, body mass-index, physical exertion in leisure time and discomfort due to climatic conditions
general population				
12. Nagi et al. (1973)	are you often bothered with pain in your back? (questionnaire) other BP variables are not included in the analysis	- psychological anxiety - physical anxiety - poor general experienced physical health - low education level - not married (any more) - utilization of medical services		- 1,135 inhabitants of Columbia (18-64 years old) - no adjustment for physical load or other confounders except for functional disability due to health in the analysis of utilization of medical services and psychological problems in relation to BP (N.B.: no age adjustment) - strength of association not quantified
13. Frymoyer et al. (1980;1983)	visiting the family practice for LBP	- stressful life events - episodes of depression - episodes of anxiety (systematically kept records with complete anamnesis)		- 3,920 patients of a family practice between 1975-1978 - no adjustment for potential confounders such as age and physical demands - no psychosocial variables included in the later multivariate analysis
14. Gilchrist (1976)	visiting family practice for LBP	- history of psychological illness		1,400 patients of family practice between 1969-1974
15. Gilchrist (1983)	visiting family practice for LBP	- extrovert personality - history of psychological illness in the medical records		- 70 back patients and 73 referent patients with another disease - only univariate analysis

Study	dependent variable	variables* positively related to back trouble	variables* not related or negatively related to back trouble	comments**
16. Svensson (1982) Svensson & Andersson (1983) Svensson et al. (1983)	- LBP (all conditions of pain, ache, stiffness or fatigue localized in the lower back) some time during life (life time incidence group?) - LBP at time of examination or at least once a month - LBP at least 2x a week (prevalence group) (interview)	**a. analysis of health and stress** univariate association only: - angina pectoris - breathlessness during exertion - exhausted at the end of the working day - perception of stress continuously - many stressful moments at work multivariate association (adjusted for variables listed above): - calf pain on exertion - frequent feeling of worry and tension **b. analysis of work-related factors** univariate association only: - little work satisfaction - little demand on concentration - decreased potential to influence work (control) multivariate association (adjusted for variables listed above): - less overtime in the last 2 years - more monotonous and boring work	- marital status - family conditions (dependent children) - changes in income (census data) - breathlessness - all variables not listed under multivariate association do not show a relationship with LBP after adjustment for other variables	- 940 male residents of Göteborg, 40-47 years old - covariance analysis of work-related variables and of experienced (psychological and mental) health; no combined analysis - strength of association not presented - multivariate analysis (a) adjusted for smoking, high physical work demands and physical inactivity in leisure time in addition to the listed variables - multivariate analysis (b) adjusted for higher physical demands at work, less sedentary work, more walking and standing at work, more lifting in addition of listed variables

Study	dependent variable	variables* positively related to back trouble	variables* not related or negatively related to back trouble	comments**
17. Haanen (1984)	- BP at the time of examination, BP ever - X-ray abnormalities - ever BP more than 3 months continuously - sciatica - BP with radiation to the leg reaching the foot - herniated disc	Nagi dimensions: - psychological anxiety; RR 2.2 (1.9-2.5) - physical anxiety; RR 2.0 (1.8-2.2) - immobilization; RR 1.8 (1.6-2.0) - poor general experienced physical health; RR 3.4 (2.6-4.5) - RR computed for BP ever, for a low score on the personality trait versus the average score Dutch Personality Inventory: - feelings of insufficiency/inadequateness - low self-esteem - life events (a higher score than average versus a lower score than average): • RR LBP ever 1.2 (1.0-1.4) • RR LBP now 1.4 (1.2-1.6) • RR LBP > 3 months 1.4 (1.2-1.6) - low educational level	no other personality threadiest, such as: - rigidness - dominance - self-righteousness - occupation (very broad category)	- 3,019 ♂ and 3,493 ♀ persons, older than 20 years - no adjustment for potential confounders (e.g. physical load) - the relationships were independent of X-ray abnormalities - the dimensions were mutually correlated - the RR for other BP variables were similar - the score on poor physical health may be influenced by the BP complaints - the life event score was correlated to the dimensions depression and nervousness of the Dutch personality questionnaire
18. Reisbord & Greenland (1985)	frequent BP during the 12 months prior to the interview	multivariate model: - low educational level - not or no longer married		- 2,792 persons older than 18 years - occupation, income and estimated occupational physical load were highly correlated to education; each show a similar univariate association - in addition gender was added to the model; the interaction between sex and the marital status variable was highly significant - no work-related variables included in the model - prevalence of 10% for married men with more than high school education and 44% for no longer married women between 50 and 64 years old

Study	dependent variable	variables* positively related to back trouble	variables* not related or negatively related to back trouble	comments**
19. Svensson & Andersson (1989)	see Svensson et al., 1983; same definitions	univariate association: - dissatisfied with work tasks (older ♀), work environment (younger ♀) - monotonous work (older ♀) - worry and tension at the end of working day - exhaustion at the end of working day multivariate association: - dissatisfied with the work environment - worry and tension at the end of working day	- low level of education - type of employment (part-time/full-time) - over time work - repetitive work - all variables not listed under multivariate association do not show an association with BP after adjustment for other variables - demand on concentration - possibility to take rest periods between scheduled breaks	- 1,746 ♀ aged 38-64, Sweden - in the multivariate analysis adjustment is made for physical work load; in this model these variables are not significant - the strength of the association in the multivariate analysis is not presented
20. Heliövaraa et al. (1991)	"unspecified LBP" or sciatica diagnosed according to standardized criteria after an extensive interview and physical examination	- sum index of occupation psychological stress based on questions such as: • uninteresting or monotonous work • a hurried or tight work schedule • worry about making mistakes (none, mild, severe) OR for LBP and high versus low score: 2.0 (1.4-2.9) and for sciatica 1.4 (1.1-1.9) - psychological disorders - other diagnosed diseases (cardiovascular disease, respiratory disease, other musculoskeletal disease)		- 2,946 ♀ and 2,727 ♂ aged 30-64, Finland - multivariate analysis adjusted for "sum index of occupational physical stress" and sex, age, body mass, height, previous back injury, driving, smoking, alcoholic consumption, parity; interactions tested (not significant) - information on variables included in psychological stress-score not complete - increasing OR's with increasing score for occupational mental stress - data seem to suggest that sciatica is more related to physical stress score, and previous back injury

* Only the variables belonging to the categories mentioned in table heading are listed.
** Addressed are population, strength of the association, adjustment for physical load, adjustment for other variables, general comments on quality of the study.
*** Unless indicated otherwise the 95% confidence of intervals of the risk estimate are given between brackets.

Appendix 2 Longitudinal studies on the relationship between back trouble and psychosocial factors at work, social and demographic variables, life events, experienced stress, personality characteristics, and other non-specific health complaints

Study	dependent variable	variables* positively related to back trouble	variables* not related or negatively related to back trouble	comments**
working population				
1. Gyntelberg (1974)	- have you experienced pains in the lower third of the back - did the pain radiate to the legs (not included in the analysis)	- no longer married - low social class - angina pectoris (intermittent claudication) - headache - cough - psychic stress in leisure time - psychic stress at work - intake of tranquillizers		- 4,753 male workers of Governmental companies Copenhagen - correlation between low social status, physically demanding work and no longer married - physical activity during work and outside work seemed to have opposite effects on BP (increased risk and decreased risk) but these variables were not included in a combined analysis - only univariate associations have been studied, e.g. no age adjustment in the analysis of psychic stress and LBP - only crude odds ratio's may be calculated from the data presented; the association between psychic stress and BP is only slight
2. Riihimäki et al. (1989)	'sciatic pain'; defined as back pain radiating to a leg (interviews) during the follow-up (5 and 10 years), and the last 12 months and the last month	- cross-sectional association • stress-episodes: RR frequent versus very rare 1.3 (1.0-1.7)*** - first occurrence or recurrence during follow-up • stress-episodes adjusted for age only: RR 1.3 (1.0-1.7) - first occurrence only • stress-episodes age adjusted only (although not significant): RR frequent versus very rare 1.2 (0.6-2.1)	- first occurrence or recurrence during follow-up: • stress-episodes (after adjustment for previous symptoms) - first occurrence only: • stress-episodes after adjustment for all variables	- 167 concrete-reinforcement workers and 161 home painters, age 25-54 years, at least 5 years employed, duration of follow-up 5 years - stress-episodes, defined as situation in which a person feels tense, restless, nervous or distressed, or has sleeping difficulties due to worries (6 class-questions) - all analyses are adjusted for age, back accidents, previous back symptoms, degeneration of the lumbar spine, back muscle and abdominal strength, smoking, physical heavy work (index vs referent), and body mass-index - the analysis is conducted separately for people with and without sciatica at the start of the follow-up

Study	dependent variable	variables* positively related to back trouble	variables* not related or negatively related to back trouble	comments**
3. Bigos et al. (1991)	- reporting BP to the medical department - filing an incident report on BP - filing an industrial insurance claim on BP	univariate: - social support at work • do not enjoy job tasks • can not communicate with fellow workers • poor response of peers to emotions • can not turn to fellow workers • little time shared with co-workers - psychological traits (MMPI) • MMPI scale 3, hysteria • MMPI scale 4, anti social multivariate: - do not enjoy job; RR hardly ever versus always 1.7 (1.3-2.2) - MMPI scale 3, hysteria: RR lowest versus highest quintile 1.4 (1.1-1.7); analysis adjusted for previous back injury	- health locus of control - social support outside work-environment - demographic variables (including marital status and educational level) - several MMPI scales, i.e. scale 2: depression scale 5: masculinity/femininity scale 6: paranoia scale 9: hypomania scale 10: social introversion	- 3,020 male aircraft employees, 21-67 years old - average duration of follow-up 3 years - 54% response - analyses with 'survival techniques' - gender, age, working conditions, and demographic variables other than listed were no significant 'predictors' of BP-episodes and therefore not entered in the model - when only the different MMPI scales are included in the model, scale 3 (hysteria) has the strongest predictive value - the multiple comparison problem has been acknowledged; therefore, only p values of 0.000132-(0.05/number of variables) were considered significant - although data on mechanical work load were available, no exact information was reported and it was not simultaneously analyzed; physical work load was no significant predictor by itself - the variables analyzed may be related to BP-episodes as well as the readiness to report them at a medical department or to file a claim
4. Haanen (1984)	- first episode of BP during the follow-up period - sciatica during follow-up period	- high score (25% highest versus 25% lowest score) for feelings of inadequateness: OR for BP during follow-up ♀ 2.8, ♂ 2.4 - cross-sectionally: dissatisfaction with the work		- 280 ♂ and 350 ♀, aged 20-65 years, selected from persons of a population study (table 1.1); selected were those with a high score for feelings of inadequateness and those with a low score; the group is representative for LBP in previous years and at the time of examination - duration of follow-up 1.5 year - no adjustment for confounders (little age difference between high and low group)
5. Heliövaara et al. (1987)	hospital admittance due to: - HNP - HNP or sciatica	- low or intermediate social class: RR ca. 2.5 - psychological distress (♀): RR ca. 1.7 - frequent use of analgetics (♀), only for HNP or sciatica; RR 1.9 (1.2-3.0) - chronic cough (♂), only for HNP or sciatica: RR 1.5	- psychological distress (♂): RR 1.3, ns - not married - use of some medication - frequent use of analgetics ♂: RR 1.1 - chronic cough ♀: RR 1.5, ns	- 57,000 persons in Finland, 20-59 years of age at entry - duration of follow-up 11 years - adjustment for all 'explanatory' variables, e.g. smoking, leisure time, physical activity, age, etc. - no adjustment for biomechanical load - the relationship between psychological distress symptoms and HNP among women (RR ~2) was not very much influenced by other variables; also the risk in men was elevated (RR ca. 1.3) but not significantly; for women no increasing risk with increasing number of distress symptoms was observed

Study	dependent variable	variables* positively related to back trouble	variables* not related or negatively related to back trouble	comments**
6. Bergenudd & Nilsson (1988)	back pain indicated in a pain drawing and visual analogue score for intensity	- less happy with the job (now and at age 43 and 36) - low level of education - low level of intelligence (at age 10 and 20)	- level of income - relationships with family and friends	- 575 residents of Malmö, Sweden (55 years old) - duration of follow-up varies (45 years for intelligence test, 19 years for measurement of job satisfaction) - poor information on exact study design and analysis - no multivariate analysis - no incidence data on BP (only prevalence at age 55)
7. Biering-Sørensen & Hilden (1989)	have you ever/within the last 12 months had pain or other trouble with the lower part of your back?	multivariate analysis: a. recurrence of symptoms: men: living alone women: 'rumbling' of stomach (OR 3.5) b. first occurrence of symptoms (mens and women): • epigastric pain (OR 2.2) • hospitalized at least once (OR 3.4)	only significantly associated in the univariate analysis a. recurrence of symptoms: men: • intermittent claudication • urination trouble • frequent headache • little sleep per day • feeling of fatigue at time of examination > 50 years • frequent nervousness • poor physical fitness • recent visits to general practitioner women: • CNSLD • frequent cough • feeling of fatigue > 50 years • poor physical fitness • poor subjective health b. first occurrence of symptoms (men and women): • low SES • colic • poor subjective health • low job satisfaction (current job)	- 928, 30-40-50 and 60 year old inhabitants of Denmark - duration of follow-up 1 year - analysis stratified for low back pain episodes in the anamnesis - no adequate adjustment for physical load at work - also significantly associated with BP in analysis a: duration period and type of historical BP, and smoking (women only); in analysis b: daily smoking, distance to work, frequent epigastric pain and isometric endurance of the back muscles - many tested variables show not even a significant univariate association with back trouble

Study	dependent variable	variables* positively related to back trouble	variables* not related or negatively related to back trouble	comments**
8. Viihikari-Juntera et al. (1991)	- mild BP:> 7 days ache, stiffness or numbness in the last 12 months or > 15 points on intensity/disability scale used - several BP: both conditions present	- ♀: • good social confidence: OR 3.3 (1.1-9.6), childhood • lower education for severe BP: OR 35 (2-805) - ♂: • good verbal productivity: OR 1.03 (1.0-1.1) • weak sense of coherence: OR 0.95 (0.9-1.0)	- score in intelligence test - weak sense of coherence (♀) - social confidence (♂)	- 153 persons from the 2,900 of the original sample - duration of follow-up: 33 years for childhood intelligence test, 1 year for psychosocial factors at work - 53% of the ♂ and 44% of the ♀ who had BP also had neck/shoulder pain - adjusted for self-reported physical load (including duration of twisted and bent posture) - the OR's are presented for dichotomous and continuous variables; and are rather unstable
sick leave and disability data				
9. Westrin et al. (1972)	- sick listed > 8 days for BP	- intellectual capacity - attitude to environment - emotional contacts - low job satisfaction - marital status (living alone) - level of education	- neurotic symptoms - other psychological diseases - low social class - sick listed for other diagnoses than BP	- 269 random sample of those sick listed for BP in 1964 and 263 controls who had not been sick listed since 1955, matched for age, wage and sex - according to the authors no variation between level of education, differences in working conditions and differences in psychological variables
10. Åstrand & Isacsson (1988)	main or subsidiary diagnosis of back disorders, registered in the medical certificate for early retirement	- self-assessment of health as worse than very good: RR 3.4 (1.1-10.1) - high systolic blood pressure: RR 1.4 (1.1-1.8)	- neuroticism - high degree of responsibility at work - work characterized as routine work - work characterized as independent - psychological test (verbal skills, intelligence, arithmetic skills) - little education - chest pain - doctor's evaluation of general health and working capacity	- 391 male workers of a paper company, aged 35, 45, 55 & 65 years in 1961 - duration of follow-up 22 years - neuroticism was strongly associated with back pain in the cross-sectional database, but was not a predictor of disability due to BP - all variables are tested in a multivariate survival analysis; the observed relation is adjusted for age, back pain or abnormalities but also frequent lifting at work, and physically heavy work load; only poor subjective health next to back abnormalities turned out to be a significant predictor of disability with a diagnosis of back disorder - the association with systolic blood pressure disappeared if only the cases with BP as only diagnosis (and not in combination with cardiovascular disease) was registered

* Only the variables belonging to the categories mentioned in table heading are listed.
** Addressed are population, strength of the association, adjustment for physical load, adjustment for other variables, general comments on quality of the study.
*** Unless indicated otherwise the 95% confidence of intervals of the risk estimate are given between brackets.

Appendix 3 Studies on the relationship between neck/shoulder pain and psychosocial factors at work, social and demographic variables, experienced stress, personality characteristics, and other non-specific health complaints

Study	dependent variable	variables* positively related to neck/shoulder pain	variables* not related or negatively related to neck/shoulder pain	comments**
a. cross-sectional studies				
1. Ohara et al. (1976)	- self reported symptoms - periodical physical examination	- mental stress		- 848 female workers of a large supermarket firm (339 cash registers, 99 office workers, 410 saleswomen and others - no quantification of mental stress in the different groups given. Association seems to be based on qualitative judgement of the working conditions of the cash registers
2. Dehlin & Berg (1977)	have you ever had pain or ache in the cervical region?		- satisfaction with the job in total - satisfaction with the work content - social support by colleagues or superiors - high perceived physical and psychological demands - need for additional education - adjustment to geriatric work	- 273 nursing aides in a geriatric hospital - no adjustment for potential confounders - no data on the influence of physical load on the prevalence of neck pain
3. Katilainen, 1978; presented in Leino et al. (1991)	repeatedly experienced pain or ache in the cervical region	7-item stress-symptoms score: (see appendix 1); RR adjusted for age, sex and occupational class: RR low stress-symptom score 1.0 RR rather low 1.2 RR rather high 3.2 RR high 4.2 mental load: (see appendix 2); RR_a adjusted for age, sex and occupational class; RR_s in addition adjusted for stress symptoms: RR_a low 1.0 RR_s 1.0 RR_a rather low 1.5 RR_s 1.4 RR_a rather high 1.7 RR_s 1.4 RR_a high 2.7 RR_s 2.0		- see appendix 1 - the RR for mental load for neck/shoulder and upper limbs was considerably larger (2.7) than for LBP (1.7) - stress symptoms seem to be a confounder of the relation between neck symptoms and mental load but not fir this relation with low back pain
4. Westerling & Jonsson (1980)	pain, tenderness, stiffness in the shoulder or neck in the last 12 months		- social class (upper class, middle class, manual work)	- 2,537 persons of the general population (random representative sample) - positive and strong correlation between social class and physical demands - after adjustment for physical load, social class showed no significant association with neck/shoulder trouble

Study	dependent variable	variables* positively related to neck/shoulder pain	variables* not related or negatively related to neck/shoulder pain	comments**
5. Kvarnström & Halden (1983)	registered cases with at least 4 weeks of sick leave due to fatigue or tenderness in the shoulder muscles	- piece rate - monotonous work - stressful work - relation with superiors - high perceived work load	- high responsibility - variation in work and pauses - relation with fellow workers	- 112 cases and 112 age and sex matched controls, selected between 1977 and 1979 in a large engineering company - only univariate analysis, no adequate adjustment for confounders - cases do not complain more about cold, draught, etc.
6. Ryan & Bampton (1988) Ryan et al. (1988)	- any symptoms of the neck (interview) - physical examination of the neck for areas of muscle tenderness and hardening (no standardization indicated) 'main finding was diffuse muscle pain and tenderness'	univariate analysis: - not enough time for breaks - job demands: • bored most of the time: OR 7.7 • had to push themselves: OR 3.9 • > than moderately stressful work: OR 3.7 - work environment: • little social support colleagues: OR 6.7 • little autonomy: OR 3.9 • little clarity • high work pressure - general health: • emotional problems multivariate analysis: - having to push yourself: OR 20 high/low - social support by colleagues: OR 5	- marital status - stress not related to work - low social support by superiors: OR 0.2	- 143 data processors - comparison between 41 'cases' (high score on neck symptoms) and 28 controls, low score; middle group left out - posture variables were measured but were not related to neck trouble, and therefore not included in the final model - the multivariate analysis was conducted with the variables that explained most of the variance within each group (having to push yourself/boredom, social support by colleagues and elbow angle)
7. Tola et al. (1988)	have you had 8 or more days of symptoms in the neck or shoulder in the last 12 months?	- low education - job dissatisfaction • low or poor versus very good RR 1.2 (1.1-1.4) • rather good versus very good RR 1.1 (1.0-1.3)		- 1,174 machine operators, 1,054 carpenters, 1,013 office workers (♂), aged 25-49 - adjusted for twisted and bent posture, age, complaints of draft and occupation - the RR's for bent and twisted posture were higher than for job dissatisfaction

Study	dependent variable	variables* positively related to neck/shoulder pain	variables* not related or negatively related to neck/shoulder pain	comments**
8. Linton & Kamwendo (1989) Kamwendo et al. (1991a) Kamwendo et al. (1991b)	- neck or shoulder discomfort during the last year (seldom/sometimes/often) - did you experience discomfort at any time in the neck/shoulder region during the last 12 months - Nordic questionnaire: neck/shoulder discomfort, ache or pain during the previous year or last 7 days	- overall index for poor psychosocial work environment, only for often neck/shoulder pain versus seldom: OR 2.8 (1.3-6.3)*** for neck pain OR 3.3 (1.5-7.2) for shoulder pain in particular: • possibility to influence one's work • workload (given too much to do) • social support by colleagues - subscales: • work content: OR 2.2 (1.0-4.5) for neck pain OR 2.5 (1.3-4.9) for shoulder pain • social support: OR 1.8 (1.0-3.2) for neck pain OR 1.6 (0.9-2.8) for shoulder pain	work demands	- 420 medical secretaries in hospital - no adjustment for ergonomic variables - the contrast in the work environment variables is enlarged by comparing the 33% highest and the 33% lowest scores - 2 different publications over the same study. The analysis presented differs slightly between these publications but results and conclusions are the same. When the contrast between good and poor environment is not enlarged but dichotomized both neck and shoulder pain were significantly associated with a low sumscore for psychosocial work environment - in Kamwendo et al. (1991b) a more detailed analysis of 79 secretaries with NP+SP. For this subgroup a correlation was observed between the poor social support and prevalence of stress symptoms (no significant relation with total psychosocial environment score). There was no correlation between stress symptoms and observed adverse posture. The stress symptoms were not correlated with ratings during the day (visual analogue scale of fatigue or NP or SP)
9. Linton (1990)	- have you been to a doctor, nurse, physiotherapist, chiropractor or other health professional during the past year for neck/shoulder pain? - did you have neck pain during the last year?	- psychosocial work environment overall score: OR<30 2.6 (1.6-4.7) similar OR's for other age categories - subscales • work content: OR<30 2.2 (1.5-3.1) similar OR's for other age categories • social support: OR<30 2.6 (1.4-4.7) OR decreases with age OR>50 1.4 (0.9-2.2) • workload: OR much lower (~1.3) and non-significant for age 30-39 and >50 • monotonous work: OR<30 2.3 (1.8-2.8) similar OR for other age categories		- 22,180 Swedish workers undergoing a screening examination by the occupational health care service - stratified for age but not for other potential confounders, e.g. physical load - the combined effect for psychosocial work environment and frequent lifting (OR 2.7: 2.8-3.6) and posture (OR 3.5: 2.7-4.5) and monotonous work (OR 3.6: 2.8-4.6) was tested and larger than the single effects

Study	dependent variable	variables* positively related to neck/shoulder pain	variables* not related or negatively related to neck/shoulder pain	comments**
b. longitudinal studies				
10. Bergenudd et al. (1988)	- self-reported shoulder pain of more than 24 hours during the last month - sick leave due to shoulder pain during the last 12 months - physical examination: shoulder joint motion, tenderness on palpation of supraspinatus, biceps tendons and acromioclavicular joints (these data are not included in the analysis due to too small numbers)	- job dissatisfaction - low score on intelligence test at age 10 and 20 (♂) - low educational level with some physical signs for ♀ only		- 575 residents of Malmö, Sweden (55 years old); 319 ♂ and 255 ♀. Same population as Bergenudd & Nilsson (1988) - intelligence test at age 10 and 20 (♂) - starting population 1,542 → large loss to follow-up - those with symptoms or without symptoms did not differ in light, moderate, heavy physical work (with e.g. secretarial work in the light category); only women with tender supraspinatus muscles in the shoulder had had jobs with moderate physical demands - no adjustment for differences in physical load in the analyses of intelligence, income, etc. - no incidence data on shoulder pain
11. Hägg et al. (1990)	shoulder/neck discomfort; questionnaire and clinical investigation	- type A personality		- 83 female assembly workers, mainly new employed - duration of follow-up 2 years - productivity and time of employment were also associated with development or deterioration of neck/shoulder symptoms; this did not apply to EMG-signs of fatigue during or isometric strength - Swedish publication, information from abstract
12. Westgaard et al. (1991)	complaints of neck/shoulder in the last 10 weeks before the interview, serious enough to seek medical advice	job stress first 10 to 20 weeks after employment, although due to the small numbers this was not significant	depressive episodes in the year before employment	- 30 female workers, aged between 17 and 46 (mean 25) - duration of follow-up varied from 6 months to 1 year (start time of employment) - all subjects conduct the same task with similar muscular load; the workers were followed after employment and the characteristics of those developing symptoms were compared to those not developing symptoms
13. Takala et al. (1991)	- symptoms <8 days or alteration of symptoms - symptoms 8-30 days - symptoms >30 days or exacerbation of symptoms in the previous 3 months	- reported stress - work characteristics (29 items) divided in 5 factors; in particular the factor hurry was associated with neck/shoulder symptoms in the baseline study		- 351 ♀ cash workers, aged 20-50 - duration of follow-up 3, 6, 9 years - all performed similar work (adjustment for posture) - adjustment for the frequency of symptoms in the 12 months preceding the baseline survey - no difference in muscle function between cases with frequent neck/shoulder symptoms and a-symptomatic referents

Study	dependent variable	variables* positively related to neck/shoulder pain	variables* not related or negatively related to neck/shoulder pain	comments**
14. Viikari-Juntura et al. (1991)	- mild neck/shoulder pain - severe neck/shoulder pain (same definition as for BP: appendix 1)	- ♀: • weak sense of coherence (severe and mild) • poor social confidence (mild) - ♂: • weak sense of coherence	- ♀: • low verbal productivity in childhood • low education	- description of population see appendix 1 - due to small numbers very imprecise estimates of the OR - results are not consistent between ♀ and ♂ and sometimes in the other direction than expected

* Only the variables belonging to the categories mentioned in table heading are listed.
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*** Unless indicated otherwise, the 95% confidence intervals of the risk estimate are given between brackets.

Appendix 4 Studies on the relationship between musculoskeletal disorders (not specified) and psychosocial factors at work, social and demographic variables, experienced stress, personality characteristics, and other non-specific health complaints

Study	dependent variable	variables* positively related to musculoskeletal disorders	variables* not related or negatively related to musculoskeletal disorders	comments**
a. cross-sectional studies				
1. Sauter et al. (1983)	neck, back and shoulder discomfort	- job demands (quantitative workload, demands on attention/concentration, workplace/process efficiency) - job control (individual participation in the way work is to be performed, control over temporal aspects, supervisory control over work processes, utilization of personal skills and abilities at work)	possibility to take breaks	- 248 VDT-users, mostly women - in the multivariate model also the opinion of the workers about the work station, self-reported adjustability and physical characteristics of the work station, chair comfort, age, hours of VDT use, time waiting for computer response, % of time sitting a day and extent of screen viewing - adding job control to the model increased the explained variance with 25% - although also objective measures of the ergonomical lay-out of the workplace have been conducted no combined analysis of these variables and the psychosocial factors was done
2. Karasek et al. (1987)	muscular skeletal aches; several questions grouped by factor analysis; no precise indication of the questions given	- perceived workload (♀ OR 1.1; ♂ OR 1.2) - conflicts (conflict in opinion about the work between supervisors and employees: ♂ OR ns; ♀ OR 1.2) - lack of clarity (♂ OR 1.1; ♀ OR ns) - low control (♂ OR 1.1.; ♀ OR 1.3) - home problems (♂ OR 1.1; ♀ OR 1.1) - low income (♂ OR 1.2; ♀ OR 1.1)	- conflicts (♂ ns) - clarity (♀ ns) - social support at work - career development opportunities - marital status - working spouse	- 8,700 full-time working members of the Swedish white collar labour union federation (random sample 1:70) - response 87% - only the strength of the significant standardized OR's are presented - no information on physical workload - the analysis was not directed at the relationship between psychosocial factors and musculoskeletal ache specifically; emphasis is on general patterns between health and psychosocial factors in the work and non-work situation
3. Pot et al. (1987)	- often having one or more of five musculoskeletal complaints	- high time pressure - poor working atmosphere (in combination with the VDU-operating time; working atmosphere: pleasant working room, well organized work, personal contacts, good contact among colleagues, good management, sufficient appreciation, secure job, good promotion possibilities, good pay, informed about changes)	- low autonomy (N.B. little variation on this variable in this study population: autonomy was low in most work situations) - uninteresting monotonous task (N.B. little variation in this variable in the population)	- 222 VDU-operators in different offices - an interaction was observed between VDU-operating time, high work pressure and poor working atmosphere. The number of health complaints increased with simultaneous occurrence of these factors - only a weak association between ergonomic variables (measurements) and musculoskeletal complaints was observed - most analyses are concerned with poor health in general, few variables are specifically related to musculoskeletal complaints

Study	dependent variable	variables* positively related to musculoskeletal disorders	variables* not related or negatively related to musculoskeletal disorders	comments**
4. Ursin et al. (1988)	- back pain during the last months/ever - neck pain during the last months/ever - 'muscle pain' factor including pain in the neck, back, arms, shoulders and migraine (result of factor analysis on several health parameters)	- coping styles: • muscle pain: ♂: anxiety, projection ♀: projection • back pain: ♂: anxiety, projection, repression ♀: compensation, intellectualization • neck pain: ♂: anxiety, projection	- other psychological defence mechanisms such as: denial - job stress	- 400 males and 74 females in several occupations in Norway - the explained variance of certain coping styles for the musculoskeletal pain indices was generally low and was higher within occupational groups (maximal 14%) than in the male or female group as a whole (maximal 7%) - anxiety and psychological defence mechanisms (coping styles) are included in the model; in the analysis stratified for job also job stress was included - no information on physical load included in the analysis; several analyses conducted within on job category
5. Kompier (1988)	- musculoskeletal complaints in the last 12 months - sick leave due to musculoskeletal complaints in the last 12 months	- job demands: • perceived time pressure - self-reported high risk taking behaviour (drivers) - social support at work (colleagues and superiors) - coping styles: • palliative responding • depressive responding • emotional responding - poor sleeping quality - symptoms of poor health (including symptoms of musculoskeletal system)	- job demands: • self-reported service to passengers - social support outside work - coping styles: • active problem solving • avoidance behaviour • social support seeking • comforting cognitions	- 158 male city bus drivers (response 73%) - all with similar working conditions - the significant correlation between musculoskeletal complaints and poor health in general may be partly due to overlapping items of the questionnaire - a high correlation was observed between depressive responding for all measurements of poor health (musculoskeletal complaints, poor sleeping quality and subjective health in general)
6. Hopkins (1990)	in the last 6 months, have you experienced any of the following problems in any part of your body while working: pain, aching, stiffness, cramp, swelling, soreness, weakness, tingling or numbness	- high job stress - high boredom - little variety - little work satisfactions - poor work environment • involvement • social support • autonomy • clarity • hierarchical control • innovation (all variables reported by the colleagues without symptoms)		- shorthand secretaries (73(, word processor typists (93), clerical assistants (79) selected from 2 different governmental offices, and VDU compositors (46) of a printing office - the workplace with the highest prevalence is compared to the one with lower prevalence on psychosocial factors score; this score is derived per workplace of the self-reports of those without symptoms! - analyses were conducted within one type of job; no information has been given on ergonomical lay-out of the workplaces - most relationships are not statistical significant; according to the authors due to the aggregated measure of psychosocial factors of a workplace instead of individual data

Study	dependent variable	variables* positively related to musculoskeletal disorders	variables* not related or negatively related to musculoskeletal disorders	comments**
7. Magni et al. (1990)	subjects suffering from pain in the neck, back, hip, knee or having significant swelling and pain of joints on most day for at least 1 month in the 12 months preceding the interview	depressive symptom score only		- 3,023 subjects of a representative sample of the US population between age 25 and 74 with a complete data set - the study concentrates on chronic musculoskeletal pain (>1 month) - adjusted for sex and level of income and in a multiple logistic regression analysis also for race, education and civil status
8. Smulders (1990)	- do you have pain in the lower back regularly? - do you have pain in your legs or feet regularly?	- time pressure - poor career development possibilities - no interesting and independent job	- management style of superior (supportive versus authoritative)	- 9,000 workers in 34 health care centers (hospitals, geriatric institutions, etc.): nurses, physiotherapists, doctors, kitchen personnel between age 25 and 49 - response 60% - adjusted for age, sex and physical strenuous work (self-reported prolonged walking and prolonged standing) - explained variance 13% (age, sex, psychological factors and physical heavy work)
9. Flodmark & Aase (1991)	- prevalence of neck/shoulder/lower back symptoms during the last 12 months	- type A behaviour (competitiveness and speed) only significant for differences in shoulder symptoms		- 58 blue collar workers - type A behaviour assessed with the Bortner questionnaire - no comments on whether all workers had the same physical load (now and historically) - relation might be due to ignorance of symptoms in the work situation, higher load due to increased physical activity

Study	dependent variable	variables* positively related to musculoskeletal disorders	variables* not related or negatively related to musculoskeletal disorders	comments**
10. Theorell et al. (1991)	- frequently experienced symptoms of the back, neck or shoulders - frequently experienced symptoms of other joints - tension, measured with a self-administered questionnaire: • muscle tension (frequently raising shoulders, contracting neck muscles, holding tool unnecessarily tense and contracting stomach muscles)	related to back/neck/shoulder symptoms: - lack of possibilities to talk at work (correlation no longer significant but of similar magnitude after adjustment for physical load - high work demands related to other joint diseases: - many conflicts at work (correlation coefficient became much higher and significant after adjustment for physical load) - high work demands (correlation no longer significant but of similar magnitude after adjustment for physical load) - little authority over decision (correlation no longer significant but of similar magnitude after adjustment for physical load) related to muscle tension, adjusted for physical load: - lack of possibility to talk, high demands - anger, worry, tiredness, sleep disturbance, gastro-intestinal trouble	related to back/neck/shoulder symptoms: - conflicts at work - rush (correlation is substantially decreased after adjustment for physical load) - intellectual discretion - authority over decisions - good work atmosphere related to other joint diseases: - lack of possibility to talk - rush - intellectual discretion - good work atmosphere related to muscle tension, adjusted for physical load: - conflicts at work, rush, demands, intellectual discretion, much authority over decisions, good work atmosphere - sadness	- stratified sample of 207 workers from 6 occupations - in this very informative study it was hypothesized that job conditions (divided in psychosocial demands, psychosocial resources and physical work factors) influenced physiological states, emotional and psychiatric states and perceived (muscle) tension. These states were hypothesized to influence the likelihood of back, neck and joint pain. Each of these relations has been analyzed. Therefore physiological, emotional and psychological states and (muscle tension) are intermediates and may be presented both as dependant and independent variables - physical load is operationalized as work including heavy lifting, monotonous movements, difficult postures and physical inactivity - worry, tiredness, sleep disturbances and loss of appetite were each related to many conflicts at work, lack of possibility to talk, high demands and no positive work atmosphere after adjustment for physical load at work. Time pressure was only related to tiredness and loss of appetite - the data show a direct correlation between psychosocial factors, namely lack of possibilities to talk and high demands and back/neck/shoulder symptoms (adjusted for physical load). These same two psychosocial factors are directly related to muscle tension. No positive atmosphere at work is strongly correlated with emotional state but not with muscle tension and back/neck symptoms - no data on correlations between emotional state and back/neck symptoms

Study	dependent variable	variables* positively related to musculoskeletal disorders	variables* not related or negatively related to musculoskeletal disorders	comments**
b. longitudinal studies				
11. Leino (1989) Leino & Lyrra (1990) Leino et al. (1991)	- have you suffered from aching, stiffness, tenderness or pain (0 never to 4 often or continuously) in arms, feet, knees, hips, back, neck, shoulder, etc. - also sumscore per region (neck/shoulder, low back, upper limbs, lower limbs (Leino, 1991) - clinical findings made by a physiotherapist (standardized) - musculoskeletal diseases reported by the subjects and checked by a physician - have you at present any permanent illness or impairment	stress symptom sumscore (0 never to 3 often or continuously per item) for 18 items: heartburn, loss of appetite, nausea, abdominal pain, sleeping difficulties, nightmares, headache, dizziness, irregular heartbeat, dyspnoea without physical effort, anxiety or nervousness, lack of energy, fatigue or feebleness, irritability or fits of anger, sexual unwillingness, excessive perspiration without physical effort) perceived psychosocial stress sumscore (a score from 1-5 per item) of the following items: overstrained by work, mentally strenuous work, pressed work pace, afraid of making mistakes, uneasy about being fired, financial problems, trouble caused by children or relatives, satisfied with level of interest and variation of work, disagreement between personnel. Only significant association at baseline in ♂ with symptoms and clinical findings. Baseline perceived stress did not predict symptoms after 10 years but did predict musculoskeletal findings in blue collar workers	perceived social support sumscore (a score from 1-5 per item) of the following items: support from colleagues, support by superiors, close friends to confide to, lonely in weekends, relation with spouse. Low support at baseline significantly associated with musculoskeletal findings only in blue collar ♀. Consistent negative association with musculoskeletal symptoms and signs during follow-up, but not significant	- 902 workers of Finish metal companies - 10 year follow-up, baseline examination in 1973 followed by a re-examination in 1978 and 1983; minimum of 15 months employment in 1973 - loss to follow-up: ♀ 25% and ♂ 37% - there is a clear relation between the stress symptom score at baseline and the self-reported symptoms and clinical findings (both in blue collar and white collar workers) - there was an association of the baseline stress symptoms score with the incidence of chronic disease among those without such a disease at baseline - in addition the baseline stress symptom score predicted the clinical findings score after 10 years, adjusted for the clinical symptoms at baseline - the predictions of stress during the follow-up by the musculoskeletal score at baseline was less consistent - no interaction between perceived stress at work and support

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