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Are Psychosocial Factors, Risk Factors for Symptoms and Signs of the Shoulder, Elbow, or Hand/Wrist?: A Review of the Epidemiological Literature

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Background *In 1993, an extensive review on the role of psychosocial factors in the development of musculoskeletal problems was published by Bongers et al (1993). Since then, additional reviews on this topic have been published; however, none of these focussed on upper limb problems.*
Methods *In this systematic review, the methodological quality of all studies was assessed and levels of evidence were apriori defined.*
Results *The large majority of the studies reported an association between at least one work-related psychosocial factor and adverse upper extremity symptoms or signs. High-perceived job stress was consistently associated with all upper extremity problems (UEP) in high and lower quality studies. Although not often studied, non-work-related stress was also consistently associated with UEP. In addition, there was some evidence for a relationship between high job demands and UEP, although the results did not meet the pre-set criterion for consistency.*
Conclusions *High job stress and non-work-related stress reactions are consistently associated with UEP. In addition, high job demands is also in most studies associated with these disorders. Firm conclusions on the role of these factors in the etiology of UEP are not possible due to the cross-sectional nature of most studies.* Am. J. Ind. Med. 41:315–342, 2002. © *2002 Wiley-Liss, Inc.*

KEY WORDS: psychosocial factors; upper extremity signs and symptoms; work organization; job stress; job demands; job control; stress

INTRODUCTION

Shoulder, upper arm, and wrist problems are common in the working population. Many recent publications focus on the empirical evidence that supports the etiology and work-related character of these problems [Buckle and Devereux, 1999; Health Council of the Netherlands, 2000; National Research Council and the Institute of Medicine, 2001].

The last decades reveal growing evidence that several aspects of work organizations that increase the likelihood of job stress, may in the long run lead to adverse health effects [Marmot, 1999; Huang et al., 2002, this issue]. Several reviews show that these factors may also relate to musculoskeletal problems [Bongers et al., 1993; Davis and Heaney, 2000; Hoogendoorn et al., 2000; Linton, 2000; Windt et al., 2000; Ariëns et al., 2001a; National Research Council and the Institute of Medicine, 2001]. Although all of these reviews conclude that it is likely that some (work-related) psychosocial factors are associated with musculoskeletal problems, the evidence on specific associations is still

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inconclusive. These reviews concern work-related neck, back, and shoulder problems. No previous review has focussed on the relationship between psychosocial factors and upper limb problems, i.e., symptoms and disorders of the hand/wrist, elbow/forearm, and shoulder. Therefore, a systematic review was conducted to study this relationship. The purpose of this systematic review is to provide a critical analysis of the scientific epidemiological literature on the role of occupational psychosocial, individual psychosocial, and work organization factors in the development, exacerbation, and maintenance of work-related upper extremity symptoms and disorders.

Figure 1 shows a simple model indicating how the different potential psychosocial, individual, and physical risk factors may interact in relation to the development of musculoskeletal disorders or the transition to more chronic disorders. This model was presented in 1993 [Bongers et al., 1993] and several other, more detailed, models have been proposed since than [Huang et al., 2002, this issue]. The following potential pathways have been suggested:

- Psychosocial workplace characteristics such as job demands may have a direct impact on velocity and acceleration of movements, *applied force* and postures;
- Psychological workplace characteristics may trigger several (sustained) stress responses that *may cause* physiological changes that may lead to musculoskeletal problems;
- Stress responses may also lead to different appraisal of the work situation and of musculoskeletal symptoms;
- Stress responses may in addition influence the transition from acute to sub-acute and chronic musculoskeletal pain.

Several specific patho-physiological pathways have been hypothesized, such as:

- High mental load and job demands may increase muscle tension and decrease micro-pauses in muscle activity. This may lead to muscle fatigue, even in case of low loads due to continuous firing of low threshold motor units, which are not only triggered by low level physical loading, but also by mental loading [Westgaard, 1999; Sjogaard et al., 2000];
- Job stress may illicit responses that increase muscle co-activation and thus increase loading of the musculoskeletal system;
- Job stress may reduce the ability to unwind, that is, it may hamper the ability to reduce the physiological activation to resting levels during breaks and after work and thus adversely influence recovery [Lundberg, 2002, this issue];
- High mental load and job demands may lead to adverse changes in immune response [Theorell et al., 2000];
- Responses of the central nervous system to job stress may lead to increased sensitization for pain stimuli;
- A certain work style response to increased work demands can result in a cascade of physiological changes that if repeatedly evoked can contribute to the development, exacerbation, and/or maintenance of work-related upper extremity symptoms. This high-risk work

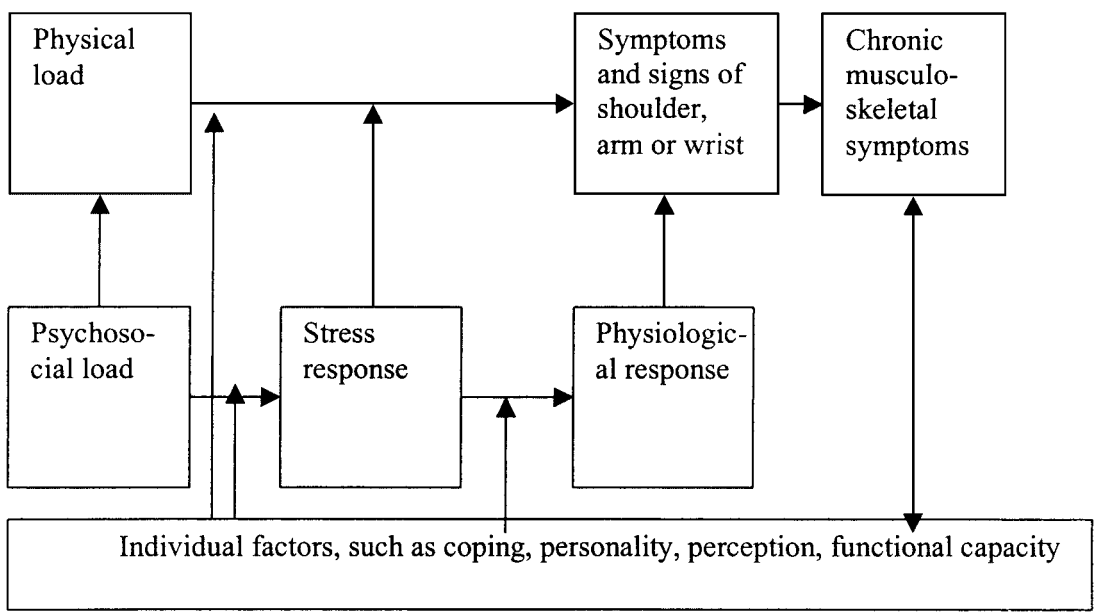

FIGURE 1. Interaction between psychosocial load, physical load, and individual factors and symptoms and signs of shoulder, arm, or wrist.

style can be triggered by an increase in actual work demands or perceived increase in demands that are self imposed by the worker [Feuerstein et al., 2002, this issue].

In addition, the fact that the assessment of musculoskeletal problems primarily relies on symptom reporting, implicates that psychological processes involved with attending to, interpreting and reacting to stimuli, most likely play a role in the development and maintenance of acute, sub acute, and chronic musculoskeletal pain [Linton and Skevington, 1999].

In the existing body of epidemiological literature, most often no distinction is made between risk factors for development (i.e., first episodes) and exacerbation and maintenance (recurrences, prognosis). Therefore, the possibilities to distinguish between these processes in this review are limited.

The muscle responses to job stressors may be different at different anatomical sites. For most of the other above-mentioned patho-physiological responses that is not very likely. However, the direct influence of work organization factors on movement, force, and posture may have a different effect on different anatomical sites. In addition, the underlying mechanisms and interplay with physical factors may be different at different anatomical sites. Therefore, this review focuses on symptoms and disorders of the hand/wrist, elbow/forearm, and shoulder separately.

METHODS

Search Strategy and Inclusion Criteria

This review will focus entirely on the epidemiological studies reported in the peer-reviewed literature on psychosocial risk factors for upper extremity disorders; studies on the effectiveness of interventions aimed at reducing upper extremity disorders by reducing psychosocial risk factors are not included. Additionally, studies on the effectiveness of 'treatments or programs' aimed at influencing, i.e., cognitive behavioral processes are not part of this review.

Publications were retrieved by a search of Medline (1980–September 1999), Psychinfo (1980–October 1999), Oshrom (1980–April 1999), and Ergonomics Abstracts (1980–October 1999), using the following keywords (MeSH heading and text-words): arm, elbow, forearm, hand, fingers, shoulder, wrist, musculoskeletal diseases, tendinitis, white finger syndrome, carpal tunnel syndrome, Quervain's syndrome, Dupuyten's syndrome, Guyon tunnel syndrome, epicondylitis, cumulative trauma disorders, repetitive strain injury, cervicobrachial disorders, psychosocial factors, psychological and social factors, organization factors, work, workload, occupation, job demands, risk factors, determinants, causality, etiology, etiology, exacerbation, chronicity, and prognosis.

The search was restricted to peer-reviewed reports published in English; abstracts, letters, and reviews were not included. No restriction was made with respect to study design, with the exception of experimental studies. Studies were included if information was presented on the role of occupational or individual psychosocial and work organization factors in relation to upper extremity symptoms and disorders. Additional exclusion criteria were:

- Participation rate of less than 70%;
- Published before 1980;
- Studies evaluating individual factors (age, gender, or medical conditions) or physical/ergonomic risk factors only;
- Studies presenting data on combined neck–shoulder or neck–shoulder–arm, or all musculoskeletal symptoms or signs.

Two reviewers applied the selection criteria to the abstracts of the publications retrieved by the search strategy described above. The publications were retrieved and read if the abstracts provided insufficient information to enable selection. During a consensus meeting, any disagreement concerning selection were resolved. Reference lists of relevant studies (i.e., recent reviews) and included studies of recent date, were screened for additional references.

Data Extraction

From all the included studies, the data presented on study design, study setting, study population, assessment of exposure, assessment of outcome, adjustment for confounding, and the estimated effect size of the association between exposure and effect were documented and summarized in a standardized form.

Quality Assessment of the Included Studies

The methodological quality of all studies that entered the review was assessed by means of a methodological quality assessment list developed by Windt et al. [2000]. This criteria list is based on previous systematic reviews of observational studies of risk factors for musculoskeletal problems [Hoogendoorn et al., 1999, 2000; Ariëns et al., 2000]. The criteria list contains items on information and validity and/or precision in five categories: study objective, study population, exposure measurements and assessment of the outcome and analysis, and data presentation. Separate quality assessment lists were constructed for cross-sectional, case-control, and cohort studies. Table I presents the items of the methodological quality assessment lists.

For every item in the quality list, two independent reviewers (PB and AK) rated each study either 'positive'

TABLE I. Checklist for the Assessment of Methodological Quality of Cross-Sectional Studies (CS), Case-Control Studies (CC), and Prospective Cohort Studies (PC)

Study objective	
1. Positive, if the study had a clearly defined objective	CS/CC/PC
Study population	
2. Positive, if the main features of the study population are described (sampling frame and distribution of the population according to age and sex)	CS/CC/PC
3. Positive, if cases and controls are drawn from the same population and a clear definition of cases and controls is given and if subjects with the disease/symptom in the past three months are excluded from the control group	CC
4. Positive, if the participation rate is at least 80% or if the participation rate is 60–80% and the non-response is not selective (data shown)	CS/CC/PC
5. Positive, if the participation rate at main moment of follow-up is at least 80% or if the non-response is not selective (data shown)	PC
Exposure measurements, other	
6. Positive, if data on history of the disease/symptom is collected and included in the statistical analysis	CS/CC/PC
7. Positive, if the exposure is measured in an identical manner among cases and controls	CC
8. Positive, if the exposure assessments is blinded with respect to disease status	CS/CC
9. Positive, if the exposure is assessed at a time prior to the occurrence of the disease/symptom	CC
Assessment of the outcome	
10. Positive, if the time period on which the assessment of disease/symptom was based was at least 1 year	PC
11. Method for assessing outcome: physical examination blinded to exposure status (+); self-reported: specific questions relating to symptoms/disease/use of mannikin (+), single question (−)	CS/CC/PC
12. Positive, if incident cases were included (prospective enrollment)	CC
Analysis and data-presentation	
13. Positive, if the measures of association estimated were presented (OR/RR), including confidence intervals and numbers in the analysis	CS/PC/CC
14. Positive, if the analysis is controlled for confounding or effect modification: individual factors	CS/CC/PC
15. Positive, if the analysis is controlled for confounding or effect modification other psycho (social) factors	CS/CC/PC
16. Positive, if the analysis is controlled for confounding or effect modification physical factors	CS/CC/PC
17. Positive, if the number of cases in the final multivariate model was at least ten times the number of independent variables in the analysis	CS/CC/PC

(+), 'negative' (−), or 'unclear' (?), if a study did or did not meet an item, or if no clear information was stated regarding that item, respectively. Results of these two independent reviewers were compared, and if differing, consensus upon each item was reached in a meeting. For each study, a total quality score was calculated by counting the number of validity/precision items that were rated positively. In addition, the reviewers rated after data extraction and before applying the scoring system, all studies as good, moderate, and poor, based on their own qualitative, subjective evaluation of the study.

Assessment of Strength of Evidence

The assessment of the strength of the evidence is also based on the systematic review on risk factors for shoulder pain from Windt et al. [2000]. The strength of evidence for potential risk factors was assessed by evaluating:

- Whether the design of the study allows conclusions on the temporal relationship;
- Consistency of the findings across studies;
- Strength of the associations; and
- The quality of the studies.

These aspects were judged and summarized based on the following statements:

- Prospective cohort studies provide better evidence for an association than case-control or cross-sectional studies;
- Studies with a score of more than 60% of the maximum attainable score will contribute more to the conclusions than studies with a lower score. In addition, conclusions will be stronger when the average method score of the positive studies seems to be high; and
- At least 75% of the studies have to report an association in order to conclude that the results across studies are consistent.

In this study, an association is judged to be positive when the risk estimate is increased, irrespective of the level of significance, while no association was concluded when the effect estimate indicated no increased or decreased risk for a certain risk factor or was reported to be statistically non-significant without reporting the risk estimate.

RESULTS

Identification of Studies

The search of the computerized databases identified a total of 200 articles. After checking for doubles, and excluding studies clearly not related to the objective of our review (e.g., studies on low back pain), 120 abstracts were

considered in the selection procedure. The two reviewers could not decide on the eligibility of 40 and the full papers were retrieved. Based on the abstracts and full papers, 26 studies were included in the review. Since the databases are a few months behind, recent issues of four major journals concerning the research topic were screened (Ergonomics 1999;42(1–12) and 2000;43(1–2), Journal of Occupational Environmental Medicine 1999;41(1–12) and 2000;42(1), Scandinavian Journal of Work Environment Health 1999; 25(1–6), and Work & Stress 1999;13(1–3)). Screening of references of recent reviews [Cole and Hudak, 1996; Punnett and Bergqvist, 1997; Sluiter et al., 1998; Linton and Skevington, 1999; National Research Council, 1999; Windt et al., 2000; Ariëns et al., 2001b] and included papers resulted in 36 additional studies, of which 2 were included in the review.

Consequently, a total of 28 studies were included in the review. A total of 107 papers did not meet the selection criteria. The reason for exclusion were: physical risk factors only (25); prevalence studies (19); abstracts, letters, or reviews (39); participation rate $< 70\%$ (13); or a variety of other reasons (11). When studies with a participation rate of 60–70% that otherwise met the inclusion criteria, would be included, an additional five studies would have been selected [Bergenudd et al., 1988; Bergenudd and Nilsson, 1994; Silverstein and Hughes, 1996; Skov et al., 1996; Fredriksson et al., 1999]. Seventeen studies did meet all inclusion criteria except that they did not report on symptoms or disorders from the shoulder, arm, wrist/hand region separated from other regions. That means that they included, for instance, all musculoskeletal sites or combined the neck, shoulder, and arm region or the neck and shoulder region.

Description of the Studies

All studies are described in Appendix A. Only one prospective cohort [Bergqvist 1995] and one case-control study [Roquelaure et al., 1997] were identified. All other studies are cross-sectional studies or an analysis of the cross-sectional measurements of a longitudinal study. The majority of the included studies concern the relationships between psychosocial factors at work and wrist/hand problems or shoulder problems. The factors assessed in the 28 studies included in the review can be divided into work-related psychosocial factors and non-work-related psychosocial factors and grouped in several categories (see Table II). However, this grouping is quite problematic. Since few standard instruments are used, there is much confusion regarding what is meant by psychosocial exposures, and very often several different aspects of the psychosocial work environment are grouped in one multidimensional score.

The categories of Table II contain aspects of work task design (job demands, stimulus from work, job control), interpersonal relationships (support from supervisors and colleagues), and organizational characteristics (rest break opportunities) [Huang et al., 2002, this issue]. Other work organization factors, such as management style, institutional policy, reorganization, or teamwork were only studied incidentally [Kamwendo et al., 1991; Bernard et al., 1994; Bru and Mykletun, 1996; Ferreira et al., 1997; Leclerc et al., 1998]. In several studies, the individual responses (i.e., job dissatisfaction and perceived job stress), which maybe partly caused by these risk factors, were included in the analysis. We identified only a few studies that dealt with the relationship between non-work-related psychosocial factors and upper extremity symptoms and signs. Three studies investigated the relationship between upper extremity outcomes and social and emotional support by family and friends [Westgaard and Jansen, 1992; Bernard et al., 1994; Hales et al., 1994]. Another four studies investigated the relationship between these outcome measures and worry, tension and not work-related stress reactions [Westgaard and Jansen, 1992; Bergqvist et al., 1995; Leclerc et al., 1998]. We did not identify any study that was eligible for inclusion that specifically dealt with upper extremity health outcomes and pain coping, pain behavior, pain beliefs, personality, or life events.

Quality Assessment

In Table III, the scoring of the methodological quality of the studies is presented, and in the last column also, the subjective qualitative assessment of the studies by the reviewers is presented. Eleven of the 28 studies received two-thirds or more of the attainable maximum score and 6 of the 28 studies received one-third or less of the total score. The average score was 56%. One study actually reached the maximum attainable score [Bergqvist et al., 1995]. All cross-sectional studies that did not adjust for confounding had a low rating [Dimberg et al., 1989; Kamwendo et al., 1991; Johansson et al., 1993; Johansson and Rubenowitz, 1994; Pickett and Lees, 1991].

Ten studies were rated good, 12 moderate, and 6 poor by the reviewers. The quality scoring and the subjective quality assessment of the reviewers are fairly consistent, except for three studies with a fairly high [Johansson and Rubenowitz, 1994; Magnavita et al., 1999] or low [Pocekay et al., 1995] assessment of the quality by the reviewers compared to the scoring.

Levels of Evidence

Since only one prospective cohort study was identified for none of the associations, the evidence can be judged strong. A summary of the strength of the evidence for the identified risk factors in relation to the outcome is presented in Table IV (hand/wrist/underarm), Table V

TABLE II. Overview of Concepts Included in the Different Categories of Psychosocial Factors

Psychosocial factor	Concepts included
High quantitative job demands	Time pressure; work pace; presence of deadline; extensive overtime; high work load; work overload; surges in workload; given too much to do;
High qualitative job demands	Job responsibilities; concentration; lack of clarity; high information processing demands;
Low stimulus from work	Monotonous work; low skill discretion, few development opportunities; poor skill utilization; limited work task variability; no challenges in task; no stimulus from work; no interesting work;
Low job control	Authority over decisions; perceived lack of participation in job decision making; influence on work; influence on time of break, pace, quantity of work; control over pace, quality and scheduled hours, quantity, availability of materials, policies and procedures;
Low social support	Social support of supervisor, support/cooperation among colleagues; relationships at work; atmosphere at work; limited peer contacts;
Few rest break opportunities	Variety of job tasks; job rotation; work (load) variability;
Low job satisfaction	Satisfaction with several aspects of the job, i.e., workstation, workload, relations at work; how often is work satisfying;
High job stress	Perceived job stress/exhaustion; index for all aspects of job stress; mental stress; extent of feeling tired after work; job is very demanding; job is very tiring; job is very stressful; occupational stress index; multi-item index including stress due to reorganization; mental stress due to task or new work, reorganizational stress, effect of redundancies, including lack of support;
Support non-work	Social support: emotional support; family relations;
Worry, distress, and stress reactions not primarily work related	Worry, tension, anxiety, fear, frustration, anger, emotional problems, depression, well-being, psychological problems, stomach-related stress reactions, psychological and psychosomatic well-being, time workers perceived themselves under emotional or mental stress.

(shoulder/upper arm), Table VI (elbow), and Table VII (all of the regions in Tables IV, V, and VI combined). These tables address the evidence for several variables related to qualitative and quantitative job demands, stimulus from work, job control, social support, job satisfaction, perceived job stress, rest break opportunities in a job and two non-work psychosocial factors, i.e., support by family and friends and worry, distress and non-work stress reactions. In the following, the results will be discussed first per musculoskeletal region.

HAND/WRIST/LOWER ARM

High-perceived job stress is a component in all studies associated with hand/wrist problems (see Table IV). In none of the other studied, relationships was a consistent (i.e., more than 75% of the studies report an association) association between the risk factor and the effect observed. However, this association was reported in three studies of lower quality and in only one study with a high quality score resulting in a low average score for the studies with a positive finding.

Low job control (authority over decisions and autonomy in the job) and low job satisfaction do not seem to be associated with hand/wrist problems, since the majority of the studies of that association did not show a relationship. To a lesser extent (positive findings in 50% of the studies or more), high job demands and monotonous work with few development opportunities show some association with hand/wrist problems. Although these associations are reported more often in low quality studies than in studies of high quality. When perceived job stress is evaluated combined with high job demands (both quantitative and qualitative demands), 83% of all studies show a relationship between high job demands or perceived job stress and hand/wrist problems.

The association between non-work-related psychosocial factors and hand/wrist problems is only reported in five studies. In three studies the role of emotional and social support from family and friends is investigated and none of these studies reported an association with the effect. Two out of three studies, investigating the role of worry and non-work stress problems, did show a positive association with hand/wrist problems.

Table IV shows that many studies report at least one positive association between one of the studied work-related psychosocial risk factors and hand/wrist problems (78%), but this is not consistently the same risk factor across studies, except for perceived job stress and to a lesser extent high job demands.

SHOULDER/UPPER ARM

Table V shows that also for shoulder/upper arm problems, more or less consistent positive findings

TABLE III. Scores on the Items of Quality Assessment List (see Table I) for All Studies in the Review, With the Total Score for All Positive Validity/Precision Items (3–17), the Percentage of the Maximum Attainable Score (%) and the Qualitative Assessment of the Reviewer (QA: Poor/Moderate/Good)*

Reference	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total	%	QA
1. Ahlberg Hultén et al. [1995]	+	−		+		−		−			+		−	−	+	−	+	4/9	44	M
2. Bergqvist [1995]	+	+		+	−	−				+	+		+	+	−	−	−	5/10	50	M
3. Bergqvist et al. [1995b]	+	+		+		+		+			+		+	+	+	+	+	9/9	100	G
4. Bernard et al. [1994]	+	+		+		+		−			+		+	+	+	+	+	8/9	88	G
5. Bru and Mykletun [1996]	+	+		+		−		−			+		−	−	+	−	+	4/9	44	M
6. Burdorf et al. [1997]	+	+		+		+		−			+		+	+	+	+	+	8/9	88	G
7. Dimberg et al. [1989]	+	−		+		?		−			+		−	?	−	?	+	3/9	33	P
8. Engström et al. [1995]	+	+		+		−		−			+		−	−	−	+	−	3/9	33	M
10. Ferreira et al. [1997]	+	+		+		−		+			+		−	−	+	+	−	5/9	55	M
11. Hales et al. [1994]	+	+		+		?		+			+		+	+	+	+	+	8/9	88	G
12. Hoekstra et al. [1996]	+	+		+		+		−			+		−	?	+	+	−	5/9	55	M/G
14. Johansson and Rubenowitz [1994]	+	−		+		−		−			+		−	−	−	−	−	2/9	22	M
15. Johansson et al. [1993]	+	+		+		−		−			+		−	−	−	−	−	2/9	22	P
16. Kamwendo et al. [1991]	+	+		+		?		−			+		−	−	−	−	−	2/9	22	P
17. Lagerström et al. [1995]	+	+		+		−		−			+		+	+	+	−	+	6/9	67	G
18. Leclerc et al. [1998]	+	+		+		+		−			+		+	+	+	+	+	8/9	88	G
19. Lemasters et al. [1998]	+	+		+		−		−			+		+	+	+	−	+	6/9	67	G
20. Marcus and Gerr [1996]	+	+		−		−		−			+		+	+	+	−	+	5/9	55	M
21. Pickett and Lees [1991]	−	−		+		−		−			−		−	−	−	−	−	1/9	11	P
22. Pocekay et al. [1995]	+	+		+		−		−			+		−	?	+	?	+	4/9	44	P
24. Silverstein, Fine et al. [1987]	+	+		+		+		+			+		−	+	−	+	−	6/9	67	G
25. Hoekstra et al. [1995]	+	+		+		−		−			+		−	+	+	+	+	6/9	67	M
26. Toomingas et al. [1997]	+	+		−		−		−			+		+	+	−	+	+	5/9	55	M
27. Westgaard et al. [1993]	+	+		+		+		−			+		−	+	−	+	−	5/9	55	M
28. Westgaard and Jansen [1992]	+	−		+		+		+			+		−	+	−	−	+	6/9	67	M
30. Zetterberg et al. [1997]	+	+		+		−		−			+		−	+	+	−	+	4/9	44	P
31. Magnavita et al. [1999]	+	+		−		−		−			+		+	+	−	+	+	5/9	55	G
32. Roquelaure et al. [1997]	+	+		+		+	+	+	−		+	−	+	+	+	+	+	10/12	83	G

*Empty cell in the table implies that the item was not in the methodological quality list for the study design of the study at issue.

across studies were reported for the relationship between high-perceived job stress and shoulder signs and symptoms. This is not the case for all other studied associations between psychosocial factors and shoulder problems. For instance, monotonous work with few development opportunities shows no association with shoulder problems in all but two (out of nine) studies. Low control on the job and high quantitative demands are to some extent associated with shoulder problems. When both qualitative and quantitative job demands are combined with high-perceived job stress, 62% of the studies shows an association with shoulder problems.

Seventy-four percent of all studies that report on associations between work related psychosocial risk factors and shoulder/upper arm problems report at least one positive association.

Few studies report on the associations between non-work-related psychosocial factors and shoulder or upper arm problems. Only one high quality study reports an association between non-work-related stress and shoulder/upper arm problems [Bergqvist et al., 1995] with a quite high estimated relative risk of 4.8.

ELBOW

The associations reported in the literature between psychosocial factors and symptoms or signs in the elbow do confirm the consistent association between perceived job stress and hand/wrist and shoulder problems. Although this association is only reported in two or three studies (elbow-arm). None of the other psychosocial factors show a consistent positive association with elbow problems. When high perceived job stress and high job demands are evaluated in one category, 83% of the studies report an association with elbow problems. When also the studies that

TABLE IV. Strength of the Evidence for the Relationship Between Psychosocial Factors and Symptoms and Signs of the Forearm/Wrist/Hand Region

	Study references	Consistency positive findings	Strength of the association (OR, RR)	Average method score (%)
1. High quantitative job demands				
All studies	3*,4, 6,10,11,17,19,22,26	5/9 = 55%	2.2, β = 0.05, 1.1 – 1.5,1.4	Pos: 68
MS > 60%	3,4,6,11,17,19	2/6 = 33%	2.2, 1.6	Neg: 77
MS < 60%	10,22,26	3/3 = 100%	β = 0.05, 1.1 – 1.5, 1.4	
2. High qualitative job demands				
All studies	4,11,17	1/3 = 33%	2.3	Pos: 88
MS > 60%	4,11,17	1/3 = 33%	2.3	Neg: 77
MS < 60%				
3. Low stimulus from work				
All studies	2,3,11,17,24,32	3/6 = 50%	1.7, 1.6, 6.3	Pos: 67
MS > 60%	3,11,17,24,32	2/5 = 40%	1.6, 6.3	Neg: 85
MS < 60%	2	1/1 = 100%	1.7	
4. Low job control				
All studies	3,4,11,12,17,18,19,25,26,32	2/10 = 20%	1.4, 1.6	Pos: 77
MS > 60%	3,4,11,17,18,19,25,32	2/8 = 25%	1.4, 1.6	Neg: 75
MS < 60%	12,26	0/2 = 0%		
5. Low social support				
All studies	3,4,6,11,17,26,30	3/7 = 43%	2.1 (4.5 phys ex.), 1.4,1.8	Pos: 81
MS > 60%	3,4,6,11,17	2/5 = 40%	2.1, 1.4	Neg: 72
MS < 60%	26,30	1/2 = 50%	1.8	
6. Low job satisfaction				
All studies	18,19,24,30	1/4 = 25%	1.4	Pos: 88
MS > 60%	18,19,24	1/3 = 33%	1.4	Neg: 59
MS < 60%	30	—		
7. High perceived job stress				
All studies	7,19,21,30	4/4 = 100%	?, 1.5, ?, ?	Pos: 41
MS > 60%	19	1/1 = 100%	1.5	Neg: —
MS < 60%	7,21,30	3/3 = 100%	?, ?, ?	
8. Few rest break opportunities				
All studies	3,4,10,11,21,31,32	3/7 = 43%	2.7, β = 0.05, 1.5	Pos: 70
MS > 60%	3,4,11,32	1/4 = 25%	2.7	Neg: 67
MS < 60%	10,21,31	2/3 = 67%	β = 0.05, 1.5	
9. Support non-work				
All studies	4,11,28	0/3		Neg: 81
MS > 60%	4,11,28	0/3		
MS < 60%				
10. Worry, distress, stress reactions non-work				
All studies	3,18,28	2/3 = 67%	3.4,2.3	Pos: 94
MS > 60%	3,18,28	2/3 = 67%	3.4,2.3	Neg 67
MS < 60%				

MS = method score.

2, Bergqvist [1995]; 3, Bergqvist et al. [1995]; 4, Bernard et al. [1994]; 6, Burdorf et al. [1997]; 7, Dimberg et al. [1989]; 10, Ferreira et al. [1997]; 11, Hales et al. [1994]; 12, Hoekstra et al. [1996]; 17, Lagerström et al. [1995]; 18, Leclerc et al. [1998]; 19, Lemasters et al. [1998]; 21, Pickett and Lees [1991]; 22, Pocekay et al. [1995]; 24, Silverstein et al. [1987]; 25, Hoekstra et al. [1995]; 26, Toomingas et al. [1997]; 28, Westgaard and Jansen [1992]; 30, Zetterberg et al. [1997]; 31, Magnavita et al. [1999]; 32, Roquelaure et al. [1997].

*Hand/wrist/forearm and elbow.

report on symptoms and signs of the arm are evaluated even 90% (i.e., 9 out of 10) of the studies reports an association between high demands or high-perceived job stress. The association between high demands on one-side and elbow and arm problems on the other is reported in 66% of all studies. No consistent positive associations are reported between elbow problems and poor social support and poor job satisfaction.

TABLE V. Strength of the Evidence for the Relationship Between Psychosocial Factors and Symptoms and Signs of the Upper Arm/Shoulder Region

	Study references	Consistency positive findings	Strength of the association (OR, RR)	Average method score (%)
1. High quantitative job demands				
All studies	1,3,4,5,6,11,14,16,17,19,22,26	6/12 = 50%	1.5, ?, 1.6, 1.5, 1.1	Pos: 50
MS > 60%	3,4,6,11,17,19	2/6 = 33%	1.5, 1.6	Neg: 72
MS < 60%	1,5,14,16,22,26	4/6 = 67%	?, 1.1 – 1.5, 1.1	
2. High qualitative job demands				
All studies	5,11,17	0/3	—	Pos: —
MS > 60%	11,17	0/2		Neg: 66
MS < 60%	5	0/1		
3. Low stimulus from work				
All studies	1,2,3,5,11,14,15,16,17	2/9 = 22%	?, ?	Pos: 33
MS > 60%	3,11,17	0/3	—	Neg:56
MS < 60%	1,2,5,14,15,16	2/6 = 30%	?, ?	
4. Low job control				
All studies	3,4,11,12,14,15,16,17,19,25,26	6/11 = 55%	1.6, ?, ?, 1.7, 1.9, 1.1	Pos: 53
MS > 60%	3,4,11,17,19,25	3/6 = 50%	1.6, 1.7, 1.9	Neg: 66
MS < 60%	12,14,15,16,26	3/5 = 60%	?, ?,1.1	
5. Low social support				
All studies	1,3,4,5*,6,11,14,15,16,17,26,30	5/12 = 42%	?, ?, 1.2, ?, ?	Pos: 38
MS > 60%	3,4,6,11,17	0/5		Neg: 71
MS < 60%	1,5,14,15,16,26,30	5/7 = 72%	?, ?, 1.2, ?, ?	
6. Low job satisfaction				
All studies	19,30	0/2		Pos: —
MS > 60%	19			Neg: 55
MS < 60%	30			
7. High perceived job stress				
All studies	1,7,15,19,21,30	4/6 = 67%	?, 1.5, ?, ?	Pos: 47
MS > 60%	19	1/1 = 100%	1.5	Neg: 44
MS < 60%	1,7,15,21,30	3/5 = 60%	?, ?, ?	
8. Few rest break opportunities				
All studies	3,4,11,21	1/4 = 25%	3.3	Pos: 100
MS > 60%	3,4,11	1/4 = 25%	3.3	Neg: 62
MS < 60%	21	—	—	
9. Support non-work				
All studies	4,11,28	0/3	—	Pos: —
MS > 60%	4,11,28	0/3	—	Neg: 81
MS < 60%	—			
10. Worry, distress, stress reactions non-work				
All studies	3,28	1/2 = 50%	4.8	Pos: 100
MS > 60%	3,28	1/2 = 50%	4.8	Neg: 67
MS < 60%				

MS = method score.
1, Ahlberg Hultén et al. [1995]; 2, Bergqvist [1995]; 3, Bergqvist et al. [1995]; 4, Bernard et al. [1994]; 5, Bru and Mykletun [1996]; 6, Burdorf et al. [1997]; 7, Dimberg et al. [1989]; 11, Hales et al. [1994]; 12, Hoekstra et al. [1996]; 14, Johansson and Rubenowitz [1994]; 15, Johansson et al. [1993]; 16, Kamwendo et al. [1991]; 17, Lagerström et al. [1995]; 19, Lemasters et al. [1998]; 21, Pickett and Lees [1991]; 22, Pocekay et al. [1995]; 25, Hoekstra et al. [1995]; 26, Toomingas et al. [1997]; 28, Westgaard and Jansen [1992]; 30, Zetterberg et al. [1997].

Eighty-three percent of all studies that report on associations between work-related psychosocial risk factors and elbow or arm problems report at least one positive association.

ALL UPPER EXTREMITY

Table VII shows that high-perceived job stress is consistently, i.e., in more than 85% of the studies,

TABLE VI. Strength of the Evidence for the Relationship Between Psychosocial Factors and Symptoms and Signs of the Elbow Region

	Study references	Consistency positive findings	Strength of the association (OR, RR)	Average method score (%)
1. High quantitative job demands				
All studies	6,11,19,26	2/4 = 50%	2.4, 1.3	Pos: 72
MS > 60%	6,11,19	1/3 = 33%	2.4	Neg: 78
MS < 60%	26	1/1 = 100%	1.3	
2. High qualitative job demands				
All studies	11	0/1		Pos: —
MS > 60%	11	0/1		Neg: 88
MS < 60%				
3. Low stimulus from work				
All studies	11	0/1		Pos: —
MS > 60%	11	0/1		Neg: 88
MS < 60%				
4. Low job control				
All studies	11,12,19,25,26	2/5 = 40%	2.8, 1.6	Pos: 77
MS > 60%	11,19,25	2/3 = 67%	2.8, 1.6	Neg: 59
MS < 60%	12,26	0/2		
5. Low social support				
All studies	6,11,26	1/3 = 33%	1.7	Pos: 55
MS > 60%	6,11	0/2		Neg: 88
MS < 60%	26	1/1 = 100%	1.7	
6. Low job satisfaction				
All studies	19	0/1		Pos: —
MS > 60%				Neg: 67
MS < 60%				
7. High perceived job stress				
All studies	7,19	2/2 = 100%	?, 1.4	Pos: 50
MS > 60%	19	1/1	1.4	Neg: —
MS < 60%	7	1/1	?	
8. Few rest break opportunities				
All studies	11	0/1		Pos: —
MS > 60%				Neg: 88
MS < 60%				
9. Support non-work				
All studies	11	0/1		Pos: —
MS > 60%				Neg: 88
MS < 60%				
10. Worry, distress, stress reactions non-work				
All studies	—			Pos: —
MS > 60%				Neg: —
MS < 60%				

MS = method score.
6, Burdorf et al. [1997]; 7, Dimberg et al. [1989]; 11, Hales et al. [1994]; 12, Hoekstra et al. [1996]; 19, Lemasters et al. [1998]; 25, Hoekstra et al. [1995]; 26, Toomingas et al. [1997].

associated with upper extremity problems (UEP). Both in studies of relatively high quality and in studies with lower quality. This does include studies with a health effect, based on a blind physical examination. However, most of the reported cross-sectional associations concern self-reported upper extremity symptoms. The presented effect estimates generally vary between around 1.5 and 2.5.

High job demands are reported to be associated with UEP in most studies. When all upper extremity regions are combined, this is the case in 60% of the studies (66% of the studies on hand/wrist, 50% of the studies on shoulder, and

TABLE VII. Strength of the Evidence for the Relationship Between Psychosocial Factors and Symptoms and Signs of the Shoulder and/or Elbow and/or Wrist Hand Region

	Study references	Consistency positive findings	Strength of the association (OR, RR)	Average method score (%)
1. High quantitative job demands				
All studies	1,3,4,5,6,8,10,11,14,16,17,19,20,22,26	9/15 = 60%	1.1–2.4	Pos: 62
MS > 60%	3,4,6,11,17,19	4/6 = 67%	1.6–2.4	Neg: 55
MS < 60%	1,5,8,10,14,16,20,22,26	5/19 = 55%	1.1–1.5	
2. High qualitative job demands				
All studies	4,5,11,17,8	2/5 = 40%	2.3	Pos: 71
MS > 60%	4,11,17	1/3 = 33%	2.3	Neg: 66
MS < 60%	5,8	1/2 = 50%	—	
3. Low stimulus from				
All studies	1,2,3,5,11,14,15,16,17,24,32	5/11 = 45%	1.6–6.3	Pos: 53
MS > 60%	3,11,17,24,32	2/5 = 40%	1.6–6.3	Neg: 57
MS < 60%	1,2,5,14,15,16	3/6 = 50%	1.7	
4. Low job control				
All studies	3,4,11,12,14,15,16,17,18,19,20,25,26,32	8/14 = 56%	1.4–3.0	Pos: 62
MS > 60%	3,4,11,17,18,19,25,32	5/8 = 62%	1.4–2.8	Neg: 61
MS < 60%	12,14,15,16,26,20	3/6 = 50%	1.6–3.0	
5. Low social support				
All studies	1,3,4,5,6,8,11,14,15,16,17,20,26,30	8/14 = 56%	1.2–2.1	Pos: 54
MS > 60%	3,4,6,11,17	2/5 = 40%	1.4–2.1	Neg: 61
MS < 60%	1,5,8,14,15,16,20,26,30	6/9 = 66%	1.2–1.8	
6. Low job satisfaction				
All studies	18,19,20,24,30	1/5 = 20%	1.4	Pos: 88
MS > 60%	18,19,24	1/3 = 33%	1.4	Neg: 58
MS < 60%	20,30	0	—	
7. High perceived job stress				
All studies	1,7,15,19,20,21,30	6/7 = 85%	1.5–2.0	Pos: 39
MS > 60%	19	1/1 = 100%	1.5	Neg: 44
MS < 60%	1,7,15,20,21,30	5/6 = 83%	1.5–2.0	
8. Few rest break opportunities				
All studies	3,4,10,11,21,31,32	3/7 = 43%	1.5–3.1	Pos: 70
MS > 60%	3,4,11,32	1/4 = 25%	2.7	Neg: 67
MS < 60%	10,21,31	2/3 = 67%	3.1	
9. Support non-work				
All studies	4,11,28	0/3	—	Pos: –
MS > 60%	4,11,28	0/3	—	Neg: 81
MS < 60%	—	—	—	
10. Worry, distress, stress reactions non-work				
All studies	3,18,22,28	3/4 = 75%	1.8–4.8	Pos: 77
MS > 60%	3,18,28	2/3 = 60%	2.3–4.8	Neg: 67
MS < 60%	22	1/1 = 100%	1.8	

MS = method score.

1, Ahlberg Hultén et al. [1995]; 2, Bergqvist [1995]; 3, Bergqvist et al. [1995]; 4, Bernard et al. [1994]; 5, Bru and Mykletun [1996]; 6, Burdorf et al. [1997]; 7, Dimberg et al. [1989]; 8, Engström et al. [1995]; 10, Ferreira et al. [1997]; 11, Hales et al. [1994]; 12, Hoekstra et al. [1996]; 14, Johansson and Rubenowitz [1994]; 15, Johansson et al. [1993]; 16, Kamwendo et al. [1991]; 17, Lagerström et al. [1995]; 18, Leclerc et al. [1998]; 19, Lemasters et al. [1998]; 20, Marcus and Gerr [1996]; 21, Pickett and Lees [1991]; 22, Pocekay et al. [1995]; 24, Silverstein et al. [1987]; 25, Hoekstra et al. [1995]; 26, Toomingas et al. [1997]; 28, Westgaard and Jansen [1992]; 30, Zetterberg et al. [1997]; 31, Magnavita et al. [1999]; 32, Roquelaure et al. [1997].

66% of the studies on elbow/arm problems). Although the summarized findings for the role of job demands do not meet the preset criterion for consistency across studies, this factor also seems relevant.

The summarized findings only tentatively support an association between upper limb problems and low job control and poor support. These factors were a risk factor in 56% of the selected studies. No support is found for the association between little stimulus from work and poor job satisfaction. The majority of the selected studies (75%) that analyzed the role of the more personal psychosocial risk factors such as worry, tension, and general distress reported an association between these factors and upper limb problems.

In order to compare the results of this review with three other recent reviews on related topics (i.e., psychosocial factors and low back pain and physical load at work and upper limb problems), the results are also presented in a slightly different way (Table VIII). This table presents the number of studies with a null association, i.e., the confidence interval of the risk estimate includes the null association (RR or OR of 1.0), and the number of studies with a positive association, i.e., the lower limit of the confidence interval is above 1.0. Due to these definitions, this table shows slightly different numbers of positive studies than in Table VII. This is due to the fact that in Table VII all associations with a risk estimate clearly above 1 are considered positive even when the association was not statistically significant. Table VIII, however, does lead to the same conclusions, i.e., that there seems to be evidence that high job stress and high job demands are associated with upper limb problems and that general psychological distress, although based on few studies, is likely to be related to upper limb problems.

In the last column of Table VIII, the so-called attributable fraction for each risk factor is presented. This attributable fraction is an estimate of the proportion by which the rate of UEP would be reduced, if the risk factor were eliminated. Although, the way this measure is calculated for the included studies it is only an approximation, the attributable fraction gives a rough indication of the relative importance of the risk factors studied. From Table VIII, it can be concluded that when the risks are truly what they have been estimated in several studies, there is quite a potential for effective preventive action.

DISCUSSION

Identification and Inclusion of Studies

In this review, studies dated before 1980 were excluded. This is done for practical reasons, since we thought that few, if any, relevant publications would be found before 1980, while it would considerably increase the time needed for the selection process of inclusion of studies.

Recently, two other literature reviews on this topic were conducted, i.e., a review of the literature on the relationship between psychosocial risk factors and all musculoskeletal disorders by Faucett and colleagues [National Research Council, 1999] and a systematic review between work-related psychosocial factors and shoulder disorders [Windt et al., 2000]. In the review of Faucett, 12 exemplar studies were selected. Of these 12 studies 6 were included in the present study

TABLE VIII. Number of Studies With a Null and Positive Association Between Certain Psychosocial Factors and Symptoms and Signs of the Shoulder and/or Elbow and/or Wrist Hand Region

	Null association[a,b] (Risk estimate)		Positive association (Risk estimate)		Attributable fraction (%)	
Work-related risk factor	n	Range of effect estimate	n	Range of effect estimate	n	Range
High job demands	6	1.1–1.4	10	1.5–2.4	6	33–58
Low decision latitude; low control and low stimulus from work	10	1.1–1.7	6	1.6–2.8	4	37–64
Low social support	7	1.2	7	1.4–2.1	3	28–52
Low job satisfaction	4	1.1–1.4	0	—	—	—
High perceived stress	2	1.4	5	2.0	1	50
Few rest break opportunities	3	1.4–1.5	3	1.5–3.3	2	33–70
Low support not work related	3	—	0	—	—	—
Worry, psychological distress, stress reaction not work related	1	—	3	1.4–4.8	3	28–79

n, number of associations presented in epidemiological studies.
[a]Confidence intervals of the risk estimates included the null estimate (1.0).
[b]Magnitude of the risk estimate was often not presented.

[Bernard et al., 1994; Johansson and Rubenowitz, 1994; Bergqvist et al., 1995; Lagerström et al., 1995; Hales et al., 1994; Leclerc et al., 1998]. The other six were excluded because they did not meet the inclusion criteria of this review. More specifically, this was because the study dealt with low back pain [Bigos et al., 1991], not specified musculoskeletal disorders [Leino and Hänninen, 1995], combined neck/shoulder disorders [Holmström et al., 1992; Ekberg et al., 1994, 1995; Ohlsson et al., 1994] or the response was below 70% [Skov et al., 1996].

Nine of the nineteen studies dealing with work-related psychosocial factors and shoulder problems included in this study (Table IV) were also included in the review of Windt et al. [2000] [Dimberg et al., 1989; Kamwendo et al., 1991; Bernard et al., 1994; Johansson and Rubenowitz, 1994; Lagerström et al., 1995; Burdorf et al., 1997; Lemasters et al., 1998]. In addition, they included six studies that did not meet the inclusion criteria of this review because they had a response below 70% [Bergenudd et al., 1988; Bergenudd and Nilsson, 1994; Silverstein and Hughes, 1996; Skov et al., 1996; Hughes et al., 1997; Pope et al., 1997]. The criterion that studies have to have a response of more than 70% seems to be rather strict. The threat of more than 30% non-response, if it is not very selective, to the validity of the study results seems to be less severe than the methodological flaws and very limited power of some of studies that did meet the inclusion criteria of this study. We, therefore, conducted a sensitivity analysis in which we did additionally include all studies with a response between 60 and 70% that otherwise met the inclusion criteria. The aim of this analysis was to assess if slightly changing this inclusion criterion would alter the conclusions of this review.

Inclusion of Studies Less Than 70%, But More Than 60% Response

Five studies with a response between 60 and 70% met the inclusion criteria [Bergenudd et al., 1988; Bergenudd and Nilsson, 1994; Silverstein and Hughes, 1996; Skov et al., 1996; Fredriksson et al., 1999]. Four of these were also included in Windt et al. [2000], Hughes et al. [1997], and Pope et al. [1997], also included in the review by Windt, had a response below 60% and were not included in this version. The first two studies are related to each other. These five additional studies attained 45, 30, 90, 55, and 55% of the maximal attainable score, respectively. Two were prospective cohort studies [Bergenudd and Nilsson, 1994; Fredriksson et al., 1999], although the latter study had a very long time lag between assessment of exposure and health effect. Only Fredriksson, Silverstein and Hughes analyzed the effect of several psychosocial factors on hand/wrist problems. They reported no positive associations for any of the factors studied. Two out of three studies that reported on the association between high demands and shoulder problems [Silverstein and Hughes, 1996; Skov et al., 1996; Fredriksson et al., 1999] reported a positive association [Skov et al., 1996; Fredriksson et al., 1999] thus, emphasizing the conclusion of this review that high demands seem to be related to shoulder problems. Additionally, Bergenudd et al. [1988] and Bergenudd and Nilsson [1994] reported an association between poor job satisfaction and shoulder problems, whereas, Silverstein and Hughes, [1996] did not.

Inclusion of these studies in this review would have underscored the relevance of high job demands in relation to shoulder problems, but not to the hand/wrist problems. Inclusion of these additional studies would have only slightly increased the consistency of the findings of high demands in relation to all upper extremity disorders. In addition, inclusion of these studies would have strengthened the evidence for low job satisfaction slightly and for low control, stimulus from work and support, the evidence would have been less. The main conclusions of this review would not have been altered. The role of perceived (job) stress was not analyzed in these additional studies.

Individual Psychosocial Factors

We have identified very few studies dealing with non-work-related psychosocial factors such as psychological distress, pain coping, and behavioral and personality characteristics in relation to development or prognosis of UEP. This either indicates that there are very few empirical epidemiological studies concerning these factors that meet the inclusion criteria of this review or that our search strategy was not sensitive enough to identify these studies. Some of the studies dealing with non-work-related risk factors were identified, but excluded because they did not meet the inclusion criteria, mainly because the outcome was not an upper extremity disorders as defined in this article [Burton et al., 1997; Glasscock et al., 1999; Grossi et al., 1999; Torp et al., 1999]. Although we did check additional sources [Cole and Hudak, 1996; Linton and Skevington, 1999] to identify this type of studies, the selected key words for the search may not have been as well on target for these studies as for the studies dealing with work-related psychosocial factors. However, it is not expected that we missed many studies.

Quality Assessment

The only prospective cohort study did not adjust for confounding [Bergqvist, 1995], therefore, none of the identified studies meets all high quality standards for design and conduct. However, given the cross-sectional design, several studies are well conducted [i.e., Burdorf et al., 1997; Hales et al., 1994; Bergqvist et al., 1995; Leclerc et al., 1998]. In the systematic review of Windt et al. [2000], the methodological quality of several studies included in this review was assessed in a similar manner as in this study

[Dimberg et al., 1989; Kamwendo et al., 1991; Johansson et al., 1993; Johansson and Rubenowitz, 1994; Bernard et al., 1994; Hales et al., 1994; Lagerström et al., 1995; Burdorf et al., 1997; Lemasters et al., 1998], which resulted in the same relatively high-, intermediate-, or low-rated studies except for study 15, which received 22% of the attainable score in the present study and 65% in the study of Windt et al. [2000]. Thus indicating that the scoring procedure is fairly reliable, but outliers may occur.

The scoring system is an attempt to address all possible methodological shortcomings that form a threat to the validity of the study results. However, some of the items in themselves have major flaws and not all shortcomings may lead to an overestimation of the findings, which makes it difficult to obtain a valuable overall score. The qualitative evaluation of the reviewers in poor, medium, and good is more or less consistent with the received quality score, which is an indication of the validity of the scoring system. Small sample size and thus inadequate power may not have been sufficiently addressed in the scoring system, and thus may reflect some of the discrepancies between the reviewers qualitative evaluation and the total scores of the studies.

For quite some time, the conclusions of reviews of the epidemiological studies reported in the literature on physical and psychosocial load and musculoskeletal disorders have been inconclusive due to the cross-sectional study design of almost all of the studies. In back pain research, the number of prospective longitudinal studies has increased [Hoogendoorn et al., 1999, 2000; National Research Council and the Institute of Medicine, 2001], but still few longitudinal studies on risk factors of neck and upper limb disorders are reported [Ariëns et al., 2001b]. Fortunately, several large-scale high quality prospective studies will reach press in the near future.

Levels of Evidence

The emphasis by the assessment of the level of evidence is on the consistency of the results across studies. Poor presentation and poor statistical analysis in some studies hampers adequate assessment of the size and precision of the effect estimates of the presented associations. Therefore, the assessment of whether there is an association or not in this review is often based on 'no significant effect was reported' or the variable was not presented in a final model implicating that there was no statistically significant risk and most likely also no increased risk. However, the conclusions would not differ when it would be based only on the higher quality studies that most often do present an effect estimate.

The applied statistical procedure may influence which of the studied variables will be included in a final model and which will be not. Thus, careful model selection procedures are called for. In case of (highly) correlated variables, which many of the work-related psychosocial variables often are, it is therefore, difficult to make strong inference on the findings of the separate variables. Thus, it is important not to focus entirely on the evidence supporting specific factors, but also assess whether the studies provide evidence that at least one of the psychosocial variables is associated with upper limb problems.

Little attention is given to the effect size, since the effect size highly depends on the way the variables are categorized. The presented effect estimates generally vary between around 1.5 and 2.5. However, with diseases that are fairly prevalent also in the low exposed, much higher estimates of relative risks would not be expected. In many studies, the relative risk was estimated with the logistic regression model, which overestimates the true relative risk in case of a prevalent outcome.

Systematic Review Procedure

The advantage of a systematic procedure is that it emphasizes the transparent and systematic process to evaluate the literature findings. The disadvantage of the method is that individual studies and differences between studies are not as much addressed. The state of the literature evaluated in this review is of such heterogeneity (both with respect to outcome and exposure) that a meta-analysis is not applicable.

Definition of Psychosocial Factors

In this review, quite a wide arrange of different concepts are grouped under one heading. This heterogeneity may dilute existing associations between well-defined concepts and health effects.

Comparison With Other Reviews

The results of Windt et al. [2000] are similar to the results of the present study indicating that the majority of the studies in both reviews reports an association between shoulder problems and one of the investigated psychosocial risk factors, but that the consistency across studies is not particularly strong. The results for the separate risk factors are quite similar except that Windt reports better evidence for an association between low job satisfaction and shoulder problems, which also was the result of this study after including additional studies with a response between 60 and 70%. She also reports that of the work related psychosocial factors job control shows the most consistent and best high quality evidence for a relationship with shoulder problems. Disregarding perceived job stress (which was not evaluated by Windt et al.) this does also apply to the present study. But this factor was not the major risk factor for the other upper extremity outcomes (elbow, hand/wrist). Also not, when all studies were evaluated together.

In another systematic review of neck problems [Ariëns et al., 2001a], it was concluded that there was some evidence for an association between high quantitative demands, low co-worker support, low job control, low (and high) skill discretion, and low job satisfaction. In that review, a slightly different method was used to assess the levels of evidence. But in general, it seems that the relationship between psychosocial factors at work and neck problems is probably stronger than the relationship between psychosocial factors at work and upper extremity disorders. In a recent review on low back pain that was based on longitudinal study only, eleven cohort and two case-control studies were included [Hoogendoorn et al., 2000]. In that review, it was concluded that there was evidence that low social support in the workplace and low job satisfaction were risk factors for back pain. No evidence was found for an effect of a high work pace, high qualitative demands, low job content, low job control, and psychosocial factors in the personal situation. However, the results of that review appeared to be rather sensitive to slight changes in the review methods. Therefore, the authors concluded that there seems to be evidence for an effect of psychosocial factors at work, but that the evidence for the role of specific psychosocial factors remains unclear.

In the first extensive review on this topic published in 1993 [Bongers et al., 1993], it was concluded that monotonous work, high-perceived workload, and time pressure are related to musculoskeletal symptoms. The data also suggested that also low control on the job and poor social support may be associated with musculoskeletal disease and that stress symptoms contributed to the development of the disease. Almost 10 years later and with a more systematic approach to the reviewing process, the conclusions are similar with the exception that no support was found for the role of monotonous work and that the conclusions concerning the evidence for the role of job demands (i.e., high perceived work load and time pressure) is formulated more cautiously in the present review. Thus when applying the current more stringent rigor of the review method, the evidence over the years leads to similar, but not to more firm conclusions compared to the previous review.

Implications of the Findings for Explanatory Models

Very few of the epidemiological studies tried to incorporate in their study design elements that would shed light on the possible pathways that connect the risk factors and the measured health outcomes. Although epidemiology is largely confined to a black box approach, it is possible to study the intermediary role of stress responses in the relationship between job demands and UEP or to study whether psychosocial factors are more strongly related to symptoms at multiple sites or to specific localized phenomena or address more specifically the confounding effect of physical load on the observed relationships. Additionally, most studies included in this review did not study interaction between physical and psychosocial load. It is strongly encouraged that future studies examine this interaction and incorporate explanatory analyses linked to the proposed models.

CONCLUSIONS

The large majority of the identified studies reported an association between at least one work-related psychosocial factor and adverse upper extremity symptoms or signs.

High perceived job stress was consistently associated with all assessed UEP in high and lower quality studies. These studies include studies with an effect measure based upon blind physical examination, but most studies are based on self-reported symptoms. The majority of these studies are cross-sectional in design and the risk ratios are modest (1.2–2.5).

Non-work-related stress reactions are also associated with UEP. Although this factor was not often studied, it was consistently associated across studies with all evaluated outcomes.

In addition to these factors, there was some evidence for a relationship between high job demands and UEP. While not meeting the pre-set criteria for consistency, high job demands were reported to be associated with UEP in most studies.

This also applies, but to a lesser extent, to poor control and poor social support at work. Little stimulus from work and poor job satisfaction were not associated with the evaluated health outcomes.

Although these findings are limited by the cross-sectional nature of the studies, the finding related to job stress was also supported by one prospective study.

Thus, although the data show that in most studies an association is reported, firm conclusions on the role of these factors in the etiology of UEP are still not possible due to the cross-sectional nature of most studies.

RECOMMENDATIONS

There is still a great need for high quality, prospective cohort studies that investigate the relationship between both work-related and even more non-work-related psychosocial factors and upper extremity disorders. Unlike the area of back pain, there are still very few prospective studies that combine data on physical and psychosocial load in work related upper extremity disorders. There is also a need for more consistent use of measures that assess specific psychosocial constructs. These measures should have demonstrated measurement properties that justify their use. The inclusion of various measures should also be based upon

APPENDIX A: Description of The Studies

TABLE A: Odds Ratio in Cross-Sectional Epidemiological Studies Among Occupational Populations*

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI	AF[a]
1. Ahlberg et al. [1995] (44-M)[b]	90 female health care personnel	Symptoms of the shoulder: pain during the last month (self reported questionnaire alternatives from no to almost daily) Prevalence total population: 26%. Prevalence unexposed not presented	Poor support i.e., low positive factors index: 5 item factor on relationships at work, which was the result of a factor analysis of a 16 item index of relationships at work; items: calm and pleasant atmosphere, good sense of fellowship, support workmates, bad days accepted by workmates	Positive association, ordinal logistic regression estimate (0.18)	—	—
2. See Table B			High job strain (JCQ) i.e., sum score for skill utilization (4 items) and authority over decisions (2 items) (combined often called control) divided by job demands scale (5 items)	No association ordinal logistic regression estimate (0.94)	—	—
3. Bergqvist [1995] (100 G)[b]	260 VDU workers	Shoulder/neck discomfort during the last 12 months (self reported Nordic Q)	Limited rest break opportunities	2.7	1.2–5.9	63%
		Prevalence total pop: 61.5%	High perceived stress: stomach-related stress reaction	3.5	1.5–8.2	71%
			Worry/distress; Negative affectivity: sum score containing items on anger, disgust, scorn, guilt, fearfulness, depression	2.0	1.0–4.2	50%
		Shoulder/neck symptoms during the last 7 days that interfered with work activities (self reported Q)	High perceived stress: stomach-related stress reaction	5.4	1.6–7.6	81%
		Prevalence total pop: 7.3%				
		Any diagnosis in the shoulder region established in a physiotherapy examination based on tests and anamneses over the previous 12 months	Limited work task flexibility	3.2	1.2–8.5	69%
			Limited rest break opportunities	3.3	1.4–7.9	70%
		Prevalence total pop: 11.9%	High perceived stress: stomach-related stress reaction	4.8	2.1–10.7	79%
		Arm/hand discomfort during the last 12 months (self reported Nordic Q)	Poor social support: limited or excessive peer contacts	2.1	1.1–4.1	52%
		Prevalence total pop: 29.9%	High demands: frequent overtime	2.2	1.2–4.1	55%
			High perceived stress: stomach-related stress reaction	3.8	2.0–7.3	74%
		Any diagnosis in the arm/hand region established in a physiotherapy examination examination based on tests and anamneses over the previous 12 months	Poor support: Limited or excessive peer contacts	4.5	1.3–15.5	78%
			Limited rest break opportunities			
			High perceived stress: stress reaction	2.7	0.8–9.1	63%
				3.4	1.3–8.4	70%
		Prevalence total pop: 8.7%				

APPENDIX A. (*Continued*)

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI	AF[a]
4. Bernard et al. [1994] (88 G)[b]	973 newspaper workers	NIOSH case-definition (self reported Q): pain, numbness, tingling, aching, stiffness, or burning in the shoulder area within the preceding year and • no previous non work-related accident/injury • symptoms began after current job • lasted > 1 week or at least once a week • intensity > moderate (midpoint 5 point scale) Prevalence total pop: 17%	Poor control: perceived lack of participation in job-decision making (very little vs. moderate upper quartile vs. lower quartile); NIOSH general job stress instrument (multi-item scale with adequate internal consistency)	1.6	1.2–2.1	37%
			High demands: perceived increased job pressure (moderately disagree vs. moderately agree: upper quartile vs. lower quartile); NIOSH general job stress instrument (multi-item scale with adequate internal consistency)	1.5	1.0–2.2	33%
		Same case-definition in the elbow-region; prevalence total pop: 10%	—	—	—	—
		Same case-definition in hand or wrist region Prevalence total pop: 22%	High demands: number of hours spent under a deadline per week (30–39 hr vs. 0–10 hr)	1.6	1.2–2.3	37%
			Poor support: Perceived lack of support from an immediate supervisor (very much vs. a little, upper quartile vs. lower quartile)	1.4	1.2–2.5	28%
5. Bru and Mykletun, [1996] (44 M)[b]	492 female hospital staff	Self-reported pain in the shoulder in the last 12 months; self reported, Nordic Questionnaire with adjusted answering categories Scale reflects 'maximum intensity of pain during the last 12 months as well as the level of pain during the more recent days'	Poor support: social relations; multi-item factor based on Cooper stress check (relations with colleagues, subordinates, and boss)	Positive association (multiple linear regression)	Change in Tscore?	—
			Low skill discretion/monotony: work content multi-item factor based on self-designed questionnaire: distribution, cooperation, variation, new competence, and challenge in tasks	Positive association (multiple linear regression)	Change in Tscore?	—
			High demands: work overload-multi-item factor based on Cooper stress check (mistakes, time pressure, overwork, work-home, feeling undervalues, managing people)	Positive association (multiple linear regression)	Change in Tscore?	—
6. Burdorf et al. [1997] (88 G)[b]	144 Tank terminal workers; no musculoskeletal complaints before current job	Self reported pain that lasted at least a few hours during the past 12 months in the shoulder (adapted Nordic Q) Prevalence 14%	High demands: working under pressure (self report, one question yes/no?)	NS	—	—
			Poor support: lack of social support (self report, one question yes/no?)	NS	—	—

APPENDIX A. (*Continued*)

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI	AF[a]
		Self reported pain that lasted at least a few hours during the past 12 months in the elbow (adapted Nordic Q) Prevalence 11%	High demands: working under pressure (self report, one question yes/no?)	NS	—	—
			Poor support: lack of social support (self report, one question yes/no?)	NS	—	—
		Self reported pain that lasted at least a few hours during the past 12 months in the wrist (adapted Nordic Q) Prevalence 9%	High demands: working under pressure (self report, one question yes/no?)	NS	—	—
			Poor support: lack of social support (self report, one question yes/no?)	NS	—	—
7. Dimberg et al. [1989] (33 P)[b]	2814 industrial workers	Many signs and symptoms established during physical examination; i.e.	High perceived job stress: mental stress at the time symptoms started (0–10 indication of level)	Correlation with trapeziums myalgia, lateral epicondylitis	—	—
8–9. Engström et al. [1999] (55 M)[b]	67 assembly operators	Symptoms (ache, pain, discomfort) experienced during the previous 12 months (self reported Nordic questionnaire) in the upper extremities (i.e., elbow, forearm, wrists, hands, and fingers)	Poor control: decision latitude (influence and control over work and stimulus from the work itself; both 5 item scales with adequate internal consistency)	Partial correlation 21 ($P < 0.10$)	—	—
			Poor support: social support at work (co-worker and supervisor support, both 5 item scales; with adequate internal consistency)	NS	—	—
			High perceived job-stress: psychological load (stress at work, work load, extent of feeling tired, exhausted after work, rest break opportunities, mental strain)	NS	—	—
10. (see Table B)						
11. Hales et al. [1994] (88 G)[b]	518 telecommunication employees (VDU work)	Very well specified case definition: self reported symptoms in shoulder confirmed by physical examination according to strict criteria (see 4). Pain, numbness, tingling, aching, stiffness, or burning within the preceding year and • no previous not work-related accident/injury • symptoms began after current job • lasted > 1 week or at least once a week • positive physical findings in the body region specified. Prevalence 22%	Extensive questionnaire (job characteristics inventory and job diagnostic survey included) 21 multi-item scales (i.e., job control, work pressure, work load) Job insecurity: i.e., fear of being replaced by computer (single item)	2.7	1.3–5.8	63%

APPENDIX A. (*Continued*)

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI	AF[a]
		Elbow problems according to above definition	Job insecurity: i.e., fear of being replaced by computer (single item) Job demands: surges in work load (multi-item scale)	3.0	1.5–6.1	66%
				2.4	1.2–5.0	58%
			Low job control: routine work lacking decision making opportunities (full-time scale)	2.8	1.4–5.7	64%
		Hand/wrist problems according to above definition	High qualitative demands: i.e., high information processing demands	2.3	1.4-4.3	56%
12. Hoekstra et al. [1996] (55 M)[b]	108 teleservice representatives with telephone tasks	NIOSH case-definition (self reported Q) (see also 4/11): pain, numbness, tingling, aching, stiffness, or burning in the neck, shoulder, elbow, or hand/wrist area within the preceding year and • no previous not work-related accident/injury • symptoms began after current job • lasted $>$ 1 week or at least once a week • intensity $>$ moderate (midpoint 5 point scale)	NIOSH general job stress instrument (multi item scale with adequate internal consistency)	NS in final model (applies to shoulder, elbow, and hand/wrist problems each)	—	—
			Perceived workload variability: (continuing changing workload during the day) Rubenowitz instrument (see 8/9) 5 dimensions all measured with 5 item scales with adequate internal consistency.	NS in final model		
			Poor control: Influence and control over work (influence on rate, method, tasks, technical matters, rule and regulations)			
14. Johansson and Rubenowitz [1994] (22 M)[b]	167 white and 241 blue collar workers of 8 metal companies	Self reported symptoms (discomfort, aches, pain) in the shoulder region during the last 12 months (Nordic Q); work related (WR): and yes to the following question: 'the symptoms are solely related to my present work'	Poor skill discretion: stimulus from work itself (interesting, varied, use talents and skills, learn new things, general feeling- about work)	Blue S For blue collar workers: significant For white collar workers: only work-related symptoms associated	—	—
			Poor social support: supervisor climate (can ask for advice, regards viewpoints, provides information, general communication company)	Significant association for white and blue collar workers	—	—
			Poor social support: relations with fellow workers (contacts, can talk, cheerful environment, discuss work problems, friends)	For blue collar workers only: WR complaints significantly associated For white collar workers: significant association for all complaints		—

APPENDIX A. (*Continued*)

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI	AF[a]
			High perceived job-stress: psychological load (stress at work, work load, extent of feeling tired, exhausted after work, rest break opportunities, mental strain)	Significant associated for white and blue collar worker	—	—
15. Johansson et al. [1993] (22 P)[b]	28 workers of a truck assembly system	Self reported symptoms (discomfort, aches, pain) in the shoulder region during the last 12 months (Nordic Q)	Rubenowitz instrument (see 8/9, 14) 5 dimensions all measured with 5 item scales with adequate internal consistency			
			High perceived job-stress: psychological load (stress at work, work load, extent of feeling tired, exhausted after work, rest break opportunities, mental strain)	0.39 S (newest workstation layout)	—	—
16. Kamwendo et al. [1991] (22 P)[b]	420 medical secretaries	Self reported shoulder pain during the previous year (6 point scale seldom to often, dichotomized so that the outcome is often shoulder pain).	Index of psychosocial work environment based on 10 items (4 point scale never to usually) and dichotomized in good $=<$ 20 or poor $>$ 20	1.87 (prevalence rate ratio of frequent shoulder pain)	$P < 0.05$	46%
		Prevalence 44%; prevalence non-exposed: 34%	Individual items showing a significant association with shoulder pain: poor social support: friendly cooperation with co-workers; poor control: poor influence on working conditions; high demands: given too much to do work commitment (yes very/yes rather vs. not very/not at all); poor social support: support and help from superiors (always/mostly vs. mostly not/never)			
17. Lagerström et al. [1995] (67 G)[b]	688 female nursing employees	Self reported symptoms of shoulder during the last 12 months (Nordic Q) supplemented with 10 point answer scale (not at all—very much).	High demands scale JCQ	1.65 (SS)	1.05–2.59	39%
		Symptoms $>$ 0 (prev: 53%)	Poor stimulation at work: skill discretion scale JCQ	—	—	—
		Severe symptoms (SS) $>$ 5 (prev: 18%)	Poor control: authority over decisions scale JCQ	1.73	1.13–2.67	42%
			Work commitment (yes very/yes rather vs. not very/not at all)	—	—	—
		Self reported symptoms of hand during the last 12 months (Nordic Q) supplemented with 10 point answering scale (not at all—very much)	Poor social support: Support and help from superiors (always/mostly vs. mostly not/never)	—	—	—
			High demands scale JCQ	—	—	
		Symptoms $>$ 0 (prev: 22%)	Poor stimulation at work: skill discretion scale JCQ	1.62	1.09–2.39	38%
		Severe symptoms $>$ 5 (SS) (prev: 4%)				

APPENDIX A. (*Continued*)

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI	AF[a]
			Poor control: authority over decisions scale JCQ	—	—	—
18. Leclerc et al. [1998] (88 G)[b]	1,006 workers with industrial repetitive work (assembly, clothing, food, and packaging)	Diagnosis of CTS based on positive (defined criteria) Tinel's sign or Phalen's test at a medical examination or a diagnosis based on nerve condition velocity was already established. Prevalence: 11.8% workers with repetitive work (range from 7.2 in food industry to 16 in packaging). 2.4% non exposed control group (with comparable educational level in jobs such as maintenance, cleaning, or catering)	Poor work satisfaction: satisfaction with 7 items: work station, workload, variety of work and relations at work dichotomized (high $>=5$ and low <5)	1.42	0.95–2.11	29%
			Poor job control: score 0–5 based on influence on time of break, additional breaks, pace, quantity of work, dichotomized in low and high score	1.43; 1.59 (adjusted for organizational factors)	0.92–2.23; 1.04–2.34	37%
		Work organization (group level):	—	—	—	
		autonomy at work station; just in time production; external constraints (i.e., high competitiveness, subcontractor, seasonal goods, perishable foodstuff)	2.24	1.40–3.57	55%	
		Poor psychological and psychosomatic well being (8 item scale)	2.32	1.40–3.82	57%	
19. Lemasters et al. [1998] (67 G)[b]	522 union carpenters with different types of carpentry work	Telephone interview (data on reliability and validity against physical exam): within the past 12 months have you experienced any recurring symptoms such as pain, aching, numbness in your shoulder?	Poor job control (reliability Q referenced 0: Control over amount of work, availability of materials, policies and procedures, pace, quality and scheduled hours	1.9	1.1–3.2	47%
		Plus (see also 4/11/12): • Onset after start carpenter • Symptoms at least once a week or lasting 1 week • No history of injury	High demands: exhausted at end of day	1.5	0.9–2.4	33% (NS)
		Same question in for elbow	High demands: exhausted at end of day	1.4	0.9–2.2	29% (NS)
			Poor job control (reliability Q referenced 0: Control over amount of work, availability of materials, policies and procedures, pace, quality, and scheduled hours	1.6	0.9–2.6	37% (NS)
		Same question for hand or wrist	High demands: exhausted end of day	1.5	0.9–2.5	33% (NS)
			Poor job control (reliability Q referenced 0: Control over amount of work, availability of materials, policies and procedures, pace, quality and scheduled hours	1.6	1.0–2.7	37%

APPENDIX A. (*Continued*)

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI	AF[a]
20. Marcus and Gerr [1996] (55 M)[b]	449 female office workers of 40 years or younger	Pain or soreness of the neck or shoulder at least once per week of at least moderate intensity during the month preceding completion of the questionnaire. Prevalence neck or shoulder symptoms is 63%	Low job security (likely to lose job)	2.23	1.3–3.7	54%
			High perceived job stress: high job stress previous 2 weeks	2.47	1.2–5.1	60%
		Pain or soreness in the finger, hands, wrists, forearms or elbows, or numbness or tingling of the fingers at least moderate intensity during the month preceding completion of the questionnaire. Prevalence arm symptoms is 34%	High perceived job stress: high job stress previous 2 weeks	2.04	1.0–4.0	43%
21. Pickett and Lees [1991] (11 P)[b]	79 data entry office workers in five different offices of the same company	Self reported work related symptoms of shoulder, arm or hand/wrist; Precise question not presented; Shoulder symptoms prev 76%	Rest breaks in task	Not presented	—	—
			Perceived stress: Occupational stress: single item, portion of time at work operators perceived themselves to be under emotional or mental stress at work (rarely, sometimes, almost, always)	Not presented	—	—
		Hand wrist symptoms: prev 52%	Occupational stress	Not presented	—	—
		Arm symptoms: prev 53%	Occupational stress	Not presented	—	—
22. Pocekay et al. [1995] (44 P)[b]	3,175 semiconductor workers from eight manufacturing companies	Several health outcomes; relationships with risk factors not separately presented	Perceived stress: Job stress index: job is very demanding; job is very tiring; job is very stressful	Range 1.1–1.5	—	9–33%
		• Any distal upper-extremity symptom = physician diagnosed carpal tunnel syndrome within the past year, questionnaire (self-) diagnosed CTS, hand/wrist pain daily $\geq$ 1 week within past year; elbow/forearm pain daily for $\geq$ week within the past year	Non-work stress: Somatization index (symptoms over the most recent four weeks: feeling tired, tingling in fingers or toes, heart palpitations, feeling irritable, light headedness, lack of muscle strength, chest tightness)	Range 1.4–1.8	—	28–44%
		• Medical diagnosed CTS in past year		1.4	—	28%
		• Hand/wrist pain daily $\geq$ 1 week within past year				
		• Elbow/forearm pain daily for $\geq$ week within the past year				
		• Epidemiological CTS in past year				
		• Daily shoulder pain $\geq$ 1 week in past year				
		• Medical diagnosed tendonitis in past year				

APPENDIX A. (*Continued*)

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI	AF[a]
24. Silverstein et al. [1987] (67 G)[b]	136 workers employed more than 4 years in an investment casting plant	Carefully defined and well described (additional paper) outcome assessment of hand/wrist CTD by interview and physical examination disorders, nerve entrapment, non-specific included as clear pattern shown in: Interview: Pain, numbness, tingling. Lasting >1 week or >20 times last year	Poor job satisfaction: assess by interview How often do you find your work satisfying? Very often/Fairly often/Sometimes/ Rarely Little variation in job dissatisfaction was presented; In general the workers reported to be very or fairly satisfied with their work	No association	—	—
		No acute traumatic onset. Onset not before 1983 study job: Characterize signs and endpoints. Exclude referred symptoms. Prevalence: low exposed: 5% High exposed (repetition & force): 13%	No stimulus from work, assessed by interview with the following question: How often do you find your work interesting? Very often/Fairly often/Sometimes/Rarely	No association	—	—
25. Hoekstra et al., 1995 (67 M)[b]	108 workers at two Teleservice Centers	Any symptoms (pain, numbness, tingling, aching, stiffness, or burning) within the preceding year and all of the following: (see 4/11) ● No preceding acute and non-occupational injury ● Symptoms began after starting the current job ● Symptoms lasted >1 week or occurred at least once a month within the past year ● Symptoms were reported as moderate (midpoint) or worse on 5 point intensity scale	Poor job control: Job control was measured with a multi-item scale	Not presented NS	—	—
			Variability of workload: perceived workload variability was measured with a multi-item scale Specified as continually changing workload during the day. Although not explicitly stated, it is clear that high-perceived workload variability is presumed to be the risk full exposure and not low	Not presented NS	—	—
		Shoulder: prev 35%				
		Elbow prev:20%	Poor job control	Not presented NS	—	—
			Variability of workload	Not presented NS	—	—
		Hand/wrist: prev 30%	Poor job control	Not presented NS	—	—
			Variability of workload	Not presented NS	—	—
26. Toomingas et al. [1997] (55 M)[b]	83 male furniture movers, 89 female medical secretaries, 96 men and 90 women from the working population resulting in 358 men and women in various occupations, but with large groups of males with heavy work and females with office work	In this study, the Nordic questionnaire and 24 signs recorded at the physical examination were included concerning neck/shoulder/shoulder/elbow/hand/ wrist. Signs and symptoms were combined in two relevant syndromes for the neck/upper extremities i.e., tension neck syndrome and tendalgia of the upper extremities. Thus outcome-variables in this study were ● Symptoms (Nordic) ● Signs (24 in total) ● Syndromes (combined signs and symptoms)	High job demands: multi-item scale JCQ	—	—	—

APPENDIX A. (*Continued*)

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI	AF[a]
			Low control: multi item scale: low decision latitude (low control and little stimulus from work, learning ability, etc.)	— NS	— NS	—
			Poor social support	Shoulder 3.2	1.3–7.8	68% PR
			Multi item scale	Hand/wrist 1.8	1.1–3.1	44% PR
			High job strain:	Shoulder 2.2	1.0–5.1	55% PR
			job demands	Hand/wrist 1.5	0.8–2.8	33% PR
			divided by decision latitude			
27. Westgaard et al. [1993] (55 M)[b]	52 female production workers (chocolate plant) and 34 female office workers	Symptom score for each region based on intensity and frequency of symptoms in the last 12 months and last 2 months and their whole employment period within the present function Ranged from no symptoms to daily occurrence of severe symptoms; Shoulder/neck	Perceived stress: Overall psychosocial work related stress score based on a 14 item questionnaire with items on: • Mental stress due to work task, new work tasks • Stress due to reorganization • Demands because of efficiency, work speed • Effect of redundancies • Personal development • Support by colleagues and supervisor The total score seems to be dichotomized, but the way it is dichotomized is unclear	Positive association	—	—
		Arms	Perceived stress	Positive association	—	—
28. Westgaard and Jansen et al. [1992] (67 M)[b]	210 production workers mainly sewing machine operators in several plants of a garment industry and 35 office workers employed at this industry	Symptoms score based on frequency and intensity Shoulder/neck	Non-work distress Scoring of psychological problems by the interviewer in low, intermediate, high after a worker interview (based on interviewers impression!). High indicates recurring depression or anxiety	No association	—	—
		Arms	Non-work distress	No association	—	—
30. Zetterberg et al. [1997] (44 P)[b]	564 car assembly workers (440 men and 124 women)	Symptoms: Nordic questionnaire, extensive physical examination; 114 signs established (76 hand/wrist). Included were i.e.,	Perceived stress Work satisfaction 5 item work apgar but questions taken apart in support, satisfaction and stress	Positive association	—	—
		Myalgia, impingement, epicondylitis, nerve entrapment,	Low social support	Positive association	—	—
		Tendinitis, joint signs	Poor job-satisfaction	Positive association	—	—
		Symptoms/signs shoulder				
		Symptoms/signs wrist hand	Perceived stress	Positive association	—	—
			Low social support	—	—	—
			Poor job-satisfaction	—	—	—

APPENDIX A. (*Continued*)

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI	AF[a]
31. Magnavita et al. [1999] (55 G)[b]	2041 physician sonographers	Self-reported question with an 21-item symptom list. Divided in syndromes by factor analysis Hand/wrist concerned 6 items Three or more symptoms of the hand wrist region is the effect studied. Prevalence: 5.3% (above definition)	Limited rest-break opportunities: Long average time executing sonology activities without intermittent rest break is only a proxy for rest break opportunities. This variable measures more physical load than psychosocial load and additional measures of perceived time pressure or job demands were not included	1.50	1.1–2.1	33%

*Study numbers 2,10 and 32 are listed in Table B.
[a]Attributable fraction is calculated with the OR as estimate for the relative risk. This approximation will be fairly accurate when the prevalence of the health effect at study is below ca 20–30%. With higher prevalences, the OR is an overestimation of the relative risk and thus the attributable fraction is overestimated.
[b]Number refers to the quality score and the subjective qualitative assessment listed in Table III.

APPENDIX A

TABLE B: Relative Risk in Longitudinal Epidemiological Studies Among Occupational Populations

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI[a]	AF[b]
2. Bergqvist, [1995] (50 M)	341 visual display unit workers	Shoulder neck discomfort during the last 12 months (Nordic Q). Prev total pop end of f/u: 44%	Increased perceived monotony	—	—	—
	Prevalence unexposed not presented	Elbow–shoulder discomfort during the last 12 months (Nordic Q). Prev total pop end of f/u: 27%	Increased perceived monotony	—	—	—
		Hand/wrist discomfort during the last 12 month (Nordic Q) Prev total pop end of f/u: 16%	Increased perceived monotony	1.7:3.1	0.6–4.4:1.2–7.8	41%:68%
10. Ferreira et al. [1997] (55 M) (retrospective cohort)	106 bank employees (telephone tasks)	History in medical records of one or more periods of upper extremity symptoms with time away from work confirmed by at least two medical specialists (who based the diagnosis on recurrent pain with or without clinical evidence from physical examination of tendon or tendon sheath impairment or nerve entrapment based)	• Time pressure increase (i.e., shorter processing time task) • Change in management (new administrative procedures) • Registered overtime work • Rest break opportunities	Limited rest breaks and relatively high time pressure were associated with WRULD	—	—

APPENDIX A (*Continued*)

Author	Study population	Upper limb symptoms/disorders	Psychosocial risk factor	Risk	95% CI[a]	AF[b]
32. Roquelaure et al. [1997] (82G)	65 (55 women, 10 men) cases with CTS matched with 65 controls (55 women, 10 men). Cases and controls recruited from television manufacturing plant	Case: blue-collar worker, 18–59, with medical history of carpal tunnel syndrome (CTS) between 1-1-90 and 12-30-92. Subjects with a history of CTS or musculoskeletal problems/ diabetes, thyroid dysfunction, malignancies, rheumatic diseases (90 excl.) Referent: blue-collar, same gender, same year of birth, free of CTS or musculoskeletal disorders of the upper limb from 1984 to 1992.	Work organization factors: No job rotation between different work stations. No association for • Autonomy: i.e., possibility to choose the way the work is done • Rest break opportunities, i.e., duration and number of breaks	6.3	2.1–19.3	NA

[a]Attributable fraction is calculated with the OR as estimate for the relative risk. This approximation will be fairly accurate when the prevalence of the health effect at study is below ca 20–30%. With higher prevalences, the OR is an overestimation of the relative risk and thus the attributable fraction is overestimated.
[b]Number refers to the quality score and the subjective qualitative assessment listed in Table III.

well-conceived hypotheses based upon working models of how these factors might affect the occurrence of these symptoms and disorders. The general confusion on what is meant by psychosocial factors should be avoided in future studies by clearly defining what concepts are used and how they are measured. In addition, both factors related to work organization and the individual should be clearly distinguished and addressed separately.

The case definitions in studies should also be carefully delineated and a more consistent use of outcome measures of symptoms, function, or disorders should be implemented.

It is also important that more studies address not only the role of psychosocial factors in the occurrence of these symptoms or disorders, but also discuss the role of these factors in prognosis and the recovery process following the onset of these disorders. In addition, these factors may impact other outcomes such as functional limitation or the ability to sustain a full days work. Clearly, the role of psychosocial factors in the exacerbation and maintenance of these disorders requires further investigation.

For prevention, it seems that improvement of several aspects of work organization will reduce both job stress that eventually may lead to emotional exhaustion and possibly work absenteeism, and musculoskeletal problems, simultaneously. This implies that there is a high potential for integrated preventive approaches and although adequate interventions may not be easily accomplished, it certainly is an attractive option and a challenge to effective occupational health [Christmansson et al., 1999; Torp et al., 1999; National Research Council and the Institute of Medicine, 2001].

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