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REVIEW ARTICLE

The incremental effect of psychosocial workplace factors on the development of neck and shoulder disorders: a systematic review of longitudinal studies

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Abstract
Background To systematically analyse evidence on the incremental effect of work-related psychosocial risk factors on the development of neck and shoulder disorders, as reported in longitudinal studies.
Methods A systematic literature search was conducted in three data bases (MEDLINE, EMBASE, and PsychINFO) until May 2009. The quality assessment leading to a methodological quality score of the included studies was conducted by two independent reviewers using a standardised checklist. Criteria for the evaluation of evidence were established. Heterogeneity analyses were conducted.
Results Altogether 18 prospective longitudinal studies were included in the analysis. Potential psychosocial risk factors were mainly based on the job demand control (support) model by Karasek (1998). Study results were too heterogeneous to deduce pooled risk estimates. But the weight of evidence was strong for an incremental effect of job demands, job control, social support, and job strain, on the development of neck and/or shoulder disorders.
Conclusion While we found evidence for an incremental effect of different psychosocial work factors (in addition to the effect of physical job factors), these results have to be interpreted carefully in order to support the notion that psychological factors can have an independent causal influence on the development of musculoskeletal disorders. Nevertheless, our findings are important for the development of preventive strategies, as they stress the need for preventive approaches that tackle both physical and psychosocial factors. Future research is warranted to consolidate and strengthen the results of this review.

Keywords Neck and shoulder pain · Psychosocial work factors · Longitudinal studies

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Background

Musculoskeletal disorders (MSDs) in general and disorders of the neck and shoulder, in particular, are common problems at workplaces in industrialised countries. In a recent evaluation in Germany, about 46 % of all employees older than 56 years reported neck and/or shoulder pain during or directly after work, and 82 % of those employees sought out medical advice because of these complaints (BAuA 2009). Neck and/or shoulder complaints are therefore a relevant problem at the workplace and are associated with individual suffering, sickness leaves, and (socio-) economic costs.

Work-related neck and shoulder complaints can be caused by physical workplace factors and workplace ergonomics (e.g. Walker-Bone and Cooper 2005; Ariëns et al. 2000). But other factors have also to be taken into consideration. Several researchers have argued that psychosocial factors at work might be associated with the

development of MSDs; Bernard (1997), for example, stated that psychosocial stress can play a significant role in the aetiology of musculoskeletal disorders. The hypothetical cause-effect chain was explained as follows: On the one hand, psychosocial demands can induce a higher level of muscle tension and deteriorate work-related biomechanical strain; on the other hand, the individual awareness and reporting of musculoskeletal symptoms, and/or the perception of pain can be affected by psychosocial demands.

Over the last years, work-related psychosocial factors have been the subject of many scientific studies, and positive associations were found between the psychosocial work environment and self-reported physical complaints. In particular, a recent review by Van Rijn et al. (2010) found an increased risk for specific musculoskeletal disorders in the shoulder region in workers exposed to higher job demands. Various other authors have also reported on links between psychosocial factors and neck and/or shoulder complaints (Bongers et al. 2006; Macfarlane et al. 2009; Walker-Bone et al. 2003), but until now, most of these studies are either of cross-sectional design or regard only psychosocial risk factors while neglecting physical exposures at the workplace. This implies that the cause-effect chain is still not well understood and that the role and extent of the influence of psychosocial workplace factors is still under scrutiny.

In order to respond to economic trends, companies worldwide introduced so-called high performance work organisation. This term describes a holistic organisational approach featuring flat hierarchies, job rotation, multitasking, and a higher level of decision authority in lower-level employees (Vašková 2007). The effects of this development on the psychosocial work environment might or might not have detrimental effects on employees' health; nevertheless, they demonstrate that the role of psychosocial workplace factors seems to be steadily increasing at modern workplaces.

In 1995, research priorities on work-related upper limb pain syndromes were identified (Harrington et al. 1998), and it was postulated that especially studies of longitudinal prospective design should be used to establish cause-effect relations in order to generate preventive strategies. Since then, countless, but still in most cases cross-sectional studies have been conducted to find evidence for a link between psychosocial work factors and neck and shoulder symptoms. However, the obvious differences in the methods and quality of these studies still pose a problem, as methodological inconsistencies might interfere with the much needed pooling of data and gathering of evidence.

This situation is the starting point of the current systematic review. The review focuses on longitudinal studies that examine the influence of physical and psychosocial workplace factors on neck and/or shoulder complaints in study populations of working age in industrialised countries. Specifically, it addresses the question whether psychosocial workplace factors have an independent, incremental effect on the development of neck and/or shoulder complaints, as described in studies of a longitudinal design.

Materials and methods

The methodological approach of this systematic review bases on the ideas and proceedings recommended in the PRISMA statement (Moher et al. 2009).

Literature research

In order to identify relevant longitudinal studies, a multistep literature search was conducted in the databases MEDLINE via PubMed (1966–05/2009), PsychINFO (1872–05/2009) and EMBASE (1973–05/2009).

First search strategy:

(a) search (musculoskeletal disorders) OR (musculoskeletal disease),
(b) search (psychosocial) OR (psychological)
(c) search (work) OR (occupation).

Combine a AND b; combine a AND c; combine b AND c; combine all.

Second search strategy:

(d) search (occupational disease) AND (musculoskeletal disease) AND (prevalence OR incidence OR risk)
(e) search for specific psychosocial factors (e.g. stress, monotonous, social support, work control, conflicting demands, job security, job strain, commitment, feedback, decision latitude).

Combine d AND e.

Limits: language English or German.

This search strategy was chosen for its ability to identify as many relevant studies as possible at the cost of reproducibility. It led to an initial number of 8,664 citations (including duplicates). The majority of the publications was found in PubMed ($n = 7{,}384$), 531 were detected in PsychINFO and 749 in EMBASE.

All citations were exported to the reference program EndNote®, duplicates were removed, and the remaining citations were screened by two reviewers, independently, to assure the same treatment for references from different databases. The first screening run took into account the title of the article and whether the study population originated from industrialised countries.

The next screening step identified studies which

1. were primary research articles (exclusion of editorials, letters, opinions, reviews, etc.),
2. had a longitudinal, prospective design (exclusion of case referent studies, case reports),
3. examined (employed) persons of working age (exclusion of children and patients), and
4. reported about neck and/or shoulder complaints or disorders (exclusion of injuries or malign diseases). This screening step resulted in 103 relevant articles, which were retrieved as full-text articles.

The final step identified eligible articles for inclusion in the review. Articles were regarded as relevant, if all of the three following criteria were fulfilled

5. The study provided exposure assessments of psychosocial factors at baseline and at follow-up (exclusion of studies with exposure assessment at only one point).
6. The study provided exposure assessments of physical factors at least at baseline (exclusion of studies without information about physical exposure).
7. The studies reported about the influence of psychosocial risk factors adjusted for physical risk factors (exclusion of studies that did not consider physical factors in the statistical analysis). Disagreements between the two reviewers were discussed in meetings.

Altogether 16 articles were identified to fulfil the inclusion criteria. Two more studies were found by checking references of eligible studies. A flow chart of the selection process is depicted in Fig. 1.

Quality assessment of the selected studies

We rated the methodological quality of the selected studies by using a methodological quality assessment list (MQA list; see Appendix), which was comprised of four already

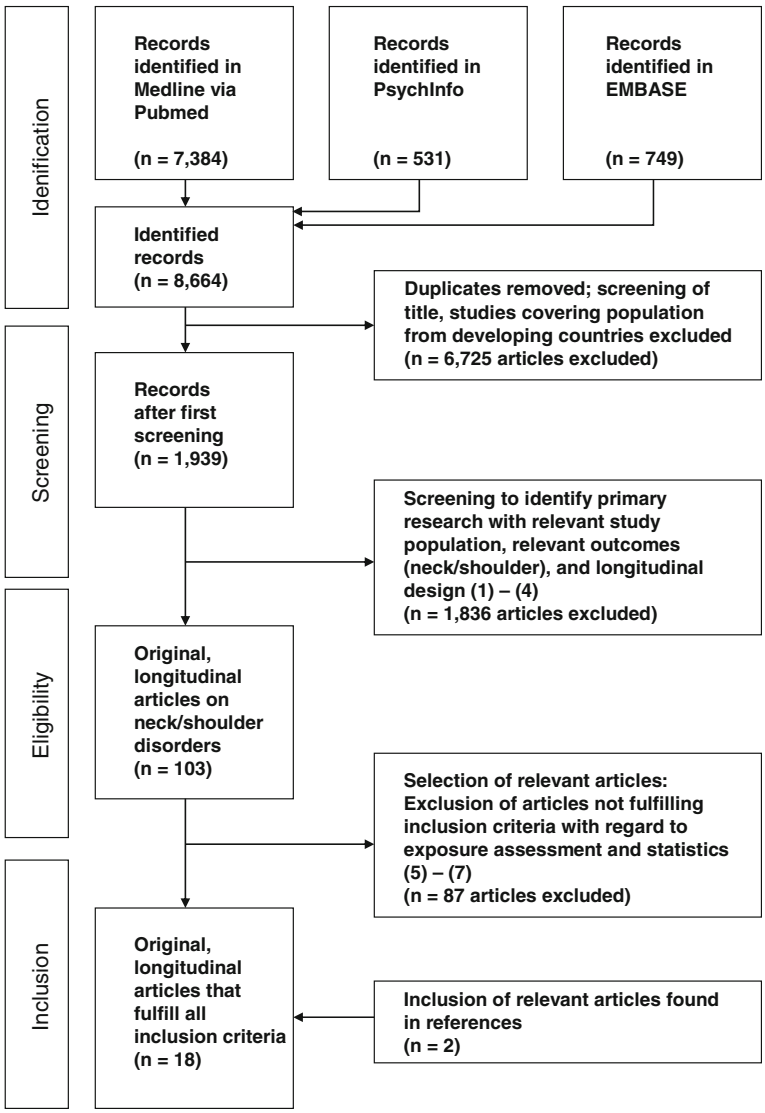

Fig. 1 Flow chart of the selection process of included longitudinal studies (literature research until May 2009)

published quality lists (Ariëns et al. 2001; Kuijpers et al. 2004; Linton 2000; Van der Windt et al. 2000). Two reviewers evaluated the quality of each study, respectively. Each item of the MQA was scored as positive (+), negative (−), or unclear (?). Differences between the two reviewers were addressed in a consensus session. All positive items were then added and divided by the total number of items in order to create a methodological quality score (MQS) of each article. The cut-off point between high-quality and low-quality studies was a priori set at 50 % of the total sum score. Studies with a MQS > 50 % were considered as high-quality studies. Table 1 shows the MQS of all included articles.

Heterogeneity of the selected studies

To identify heterogeneity across the included studies, we subsumed items with strong evidence and performed a *I*2 Test, which quantifies the effect of heterogeneity, providing a measure of the degree of inconsistency in the studies' results (Harkness et al. 2003). Additionally, we calculated Cochrane Q and created a forest plot for each risk variable (Figs. 2, 3, 4, 5). With regard to job demands ($Q = 34{,}6$, $p = 0.00$, I2 = 77 %), job support ($Q = 15.1$, $p = 0.01$, I2 = 67 %), job strain ($Q = 133{,}87$, $p = 0.00$, I2 = 98 %), and job control ($Q = 6.92$, $p = 0.07$, I2 = 57 %), we found considerable heterogeneity between the study results, as p was considerably lower than 0.1 and I^2 more than 50 %. Variation of the results has to be considered when interpreting the validity of the results.

Evaluation of evidence in the examined studies

Given the large heterogeneities of the included studies, a statistical pooling of risk estimates was not possible. Nevertheless, results from these studies can contribute to the weight of evidence regarding the presence or absence of an incremental effect of psychosocial factors on the development of neck and/or shoulder complaints. In order to summarise the evidence contained in the included studies, best evidence synthesis (see also Hoogendoorn et al. 2000) was performed according to the following scheme:

- *Strong evidence*: generally consistent findings in several high-quality studies
- *Reasonable evidence*: generally consistent findings in one high-quality study and at least one low-quality study or multiple low-quality studies
- *Insufficient evidence*: only one study available or inconsistent findings in multiple studies

Consistent findings were assumed when at least 75 % of all studies reported the same finding. A positive or negative risk estimate was considered notwithstanding the statistical significance. This approach is based on the fact that automatic use of a binary significant vs. non-significant

Table 1 Prospective studies on psychosocial risk factors for neck and shoulder disorders and corresponding methodological quality score

Author	A	B	C	D	E	F	G	H	I	J	K	L	M	Score total	Score (%)
Andersen et al. (2003)	+	+	−	−	+	+	+	+	+	−	+	+	+	10	77
Andersen et al. (2007)	+	+	+	+	+	−	−	−	+	−	+	+	+	9	69
Ariëns et al. (2001)	+	+	+	+	+	−	+	−	+	+	+	+	+	11	85
Brandt et al. (2004)	+	−	+	+	+	+	+	+	+	−	−	+	+	10	77
Cassou et al. (2002)	+	−	+	−	+	−	−	+	−	−	−	+	+	6	46
Eltayeb et al. (2009)	−	−	+	−	+	−	+	−	+	+	−	+	+	7	54
Feveile et al. (2002)	+	+	+	−	+	−	+	−	?	−	−	+	+	7	54
Grooten et al. (2004)	+	+	+	+	+	−	−	−	+	+	+	+	+	10	77
Harkness et al. (2003)	+	+	+	−	+	−	−	−	+	+	−	+	+	8	62
Juul-Kristensen and Jensen (2005)	+	+	+	+	+	−	+	−	−	−	+	+	+	9	69
Korhonen et al. (2003)	+	+	+	+	+	−	−	−	−	−	+	+	+	8	62
Leclerc et al. (2004)	+	+	+	+	+	+	−	+	−	−	−	+	+	9	69
Miranda et al. (2001)	+	+	+	+	+	−	−	−	−	−	+	+	+	8	62
Östergren et al. (2005)	+	+	+	−	+	−	+	−	+	+	−	+	+	9	69
Smith et al. (2009)	+	+	+	−	+	−	−	−	+	−	+	+	+	8	62
Trinkoff et al. (2006)	+	+	+	−	+	−	+	−	+	+	−	+	+	9	69
Van den Heuvel et al. (2005)	+	+	+	+	+	−	+	−	+	+	+	+	+	11	85
Wahlström et al. (2008)	+	−	−	+	+	−	−	−	−	−	+	+	+	6	46

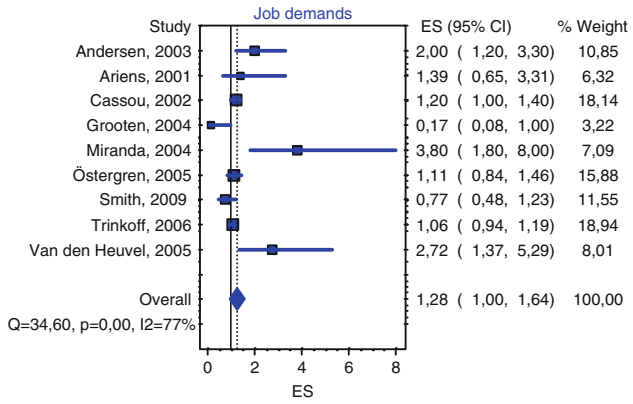

Fig. 2 Heterogeneity: Forest Plot with regard to job demands [odds ratios (ORs), 95 % confidence intervals (95 % CI)]

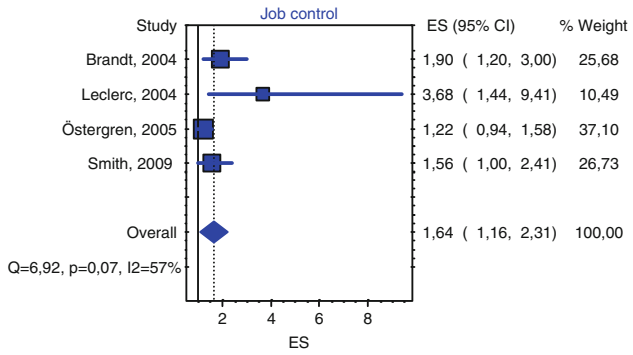

Fig. 3 Heterogeneity: with regard to job control [odds ratios (ORs), 95 % confidence intervals (95 % CI)]

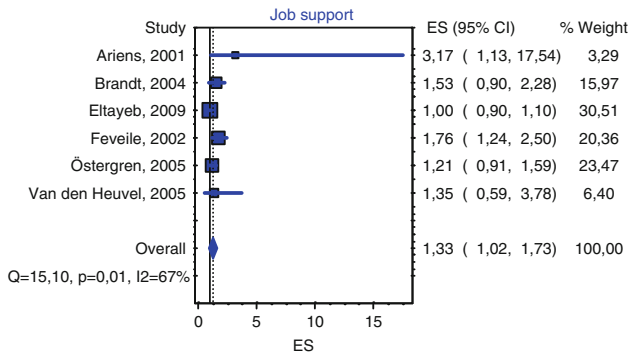

Fig. 4 Heterogeneity: Forest Plot with regard to job support [odds ratios (ORs), 95 % confidence intervals (95 % CI)]

decision rule encourages raters to ignore potentially important observed differences (Gelman and Stern 2006). Inclusion of non-significant findings, that is, findings with odds, different from 1.0 but still not significant, therefore allows for a more nuanced evaluation. Risk estimates in the region of 1 were considered to indicate no effect. Studies not presenting any effect estimates for non-significant associations were not entered in the assessment.

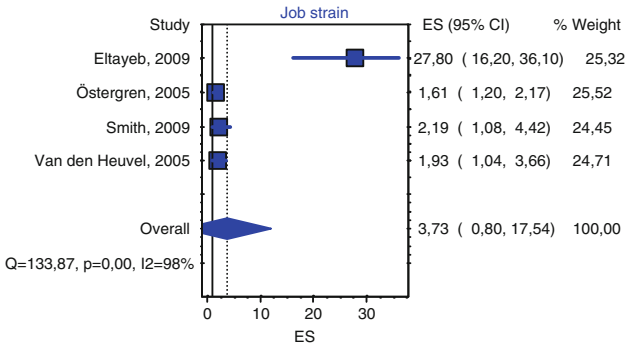

Fig. 5 Heterogeneity: Forest Plot with regard to job strain [odds ratios (ORs), 95 % confidence intervals (95 % CI)]

Results

Study characteristics with regard to psychosocial and physical workplace factors

Altogether 18 studies, 16 of them high-quality studies, met the inclusion criteria (Table 2). All studies examined working populations or populations of working age in a longitudinal, prospective approach. The time span of follow-up ranged between 6 months and 3 years. Assessment and definition of the health outcome variables varied between the different studies (see Table 2). Usually, questionnaires were used for outcome assessment; only two studies (Andersen et al. 2003; Brandt et al. 2004) also used physical examinations.

Most psychosocial factors examined in the selected studies based on the job demand control (support) model of Karasek and co-workers (Karasek 1979; Karasek and Theorell 1990). Other relevant factors, which are not associated with the job demand control model, were as follows: "job satisfaction" (one study), "mental stress" (three studies), and "organisational factors" (three studies) (see Tables 2, 3, 4).

In order to report on the incremental effect of psychosocial factors on the development and reporting of neck/shoulder complaints, we only included studies that adjusted for at least one physical factor (see "Materials and methods"). The spectrum of physical factors ranged from specific physical exposures like neck flexion $> 20°$ (Andersen et al. 2003) to very general variables like high physical demands (Trinkoff et al. 2006) (see Table 2).

Incremental effect of different psychosocial workplace factors on the development of neck and/or shoulder disorders

Job demands

Altogether nine high-quality studies (Andersen et al. 2003; Ariëns et al. 2001; Brandt et al. 2004; Cassou et al. 2002;

Table 2 Descriptive characteristics of all included longitudinal studies

Study	Study population[a]	Outcome measures (duration of follow-up)	Outcome incidence-prevalence-recurrence	Psychosocial factors examined in the study	Physical factors examined in the study	Adjustment/physical variables in multivariate model
Andersen et al. (2003)	Workers from industrial and service companies ($n = 3123$; sex na; age na)	New onset neck/shoulder pain (symptom case or clinical case) (4 years)	1-year incidence symptom case: 14.1 % 1-year incidence clinical case: 1.7 %	JDC-model: job demands; job control; social support; level of distress. Additional comments on the interaction between job demand and job control	Repetition; force requirements; neck flexion >20°; lack of recovery time	*Multivariate model* sex; job demands, pain pressure threshold; level of distress; *physical factor in multivariate model* combined physical exposure (shoulder repetition, force requirements, percentage with neck flexion >20°, percentage of time with lack of physical recovery)
Andersen et al. (2007)	Workers from industrial and service companies ($n = 3276$; at follow-up 36.3 % men; at follow-up 44.9 ± 9.9)	New onset neck/shoulder pain (2 years)	30 % prevalence of neck/shoulder pain	JDC-model: job demands (work loads, sensory demands, cognitive demands); job control (decision latitude, freedom at work); social support (social support from supervisors, social support from colleagues); additional comments on the interaction between job demand and job control; quality of leadership; job satisfaction	*Frequency and duration of manual handling activities; postures; and repetitive movements* (lifting with the hands, lifting weight at or above shoulder height, pulling or pushing weights, squatting, standing, and repetitive movements with the hands); estimation of lifted weights	*Multivariate model* age; sex; occupational group; intervention group; education level; other chronic diseases; *physical factors in multivariate model* lifting at or above shoulder level; squatting <5 min per hour
Ariëns et al. (2001)	Workers from 34 companies including various industrial and service branches ($n = 1789$; 75.4 % men; 35.7 ± 8.5)	New onset neck pain for at least 1 day (1 year, 3 years)	1-year incidence 5.7 % 3-year incidence 14.4 %	JDC-model: quantitative job demands; skill discretion; decision authority; co-worker support; supervisor support; conflicting job demands; job security	Percentage of working time with neck flexion ≥45°; percentage of working time with neck rotation ≥45°; percentage of working time sitting; number of times 25 kg or more was lifted per 8-h working day; working time with ≥60° upper arm elevation; working time repeated movements were performed ≥4 times/min; video display terminal work; working with the hands above shoulder level; working with vibrating tools; driving a vehicle; frequent flexion/rotation of the upper part of the body	**Co-worker support** *multivariate model* age; sex; coping; *physical factor in multivariate model* driving a vehicle at work **supervisor support** *multivariate model* age; sex; quantitative job demands; decision authority; co-worker support; *physical factor in multivariate model* percentage of time in a sitting position **conflicting job demands** *multivariate model* age; sex; hands above shoulder level (leisure time); *physical factor in multivariate model* driving a vehicle at work

Table 2 continued

Study	Study population[a]	Outcome measures (duration of follow-up)	Outcome incidence-prevalence-recurrence	Psychosocial factors examined in the study	Physical factors examined in the study	Adjustment/physical variables in multivariate model
Brandt et al. (2004)	Technical assistants and machine technicians [$n = 5658$; 36.1 % men; age 41.7 (8.9)]	New onset of neck or shoulder symptom cases; new onset of neck or shoulder clinical cases (12 months)	Incident symptom case neck 1.5 % incident Symptom case shoulder 1.9 % incident clinical Case neck 0.2 % Incident clinical case shoulder 0.3 %	JDC-model: job demand (work load, sensory demands, cognitive demands); job control (decision latitude, freedom at work); social support (support from supervisors, support from colleagues)	Keyboard position; mouse position; forearm and wrist support; computer screen position; adjusted chair; adjusted desk; duration of computer time	**Neck** *multivariate model* sex; pain started after accident; high demands; low social support; *physical factors in multivariate model* duration of work with mouse; duration of work with keyboard **right shoulder** *multivariate model* sex; poor social network; pain started after accident; low control; *physical factors in multivariate model* duration of work with mouse; duration of work with keyboard
Cassou et al. (2002)	Random sample of male and female workers born in 1938, 1943, 1948, and 1953 from the occupational physicians' files [$n = 14995$; 59.7 % men; age (37–57)]	Chronic neck and shoulder pain (5 years)	Incidence of chronic neck and shoulder pain: Men 7.3 %; Women 12.5 %	JDC-model: high job demand (hurry, to do several things at the same time, many interruptions); low job control (no means available to carry out high-quality work, no possibility of choosing the way in which the work will be carried out, no diversification of work, no learning new things at work)	Awkward work (awkward posture, carrying heavy loads, vibrations, work exertion required to operate tools or machines)	**Men** *multivariate model* age; depressive symptoms; MSD in the past; sporting activities; smoking; *physical factors in multivariate model* repetitive work; awkward work **women** *multivariate model* age; depressive symptoms; MSD in the past; *physical factors in multivariate model* repetitive work
Eltayeb et al. (2009)	Computer office workers ($n = 264$; ~50 % men; age na)	New onset neck, shoulder and forearm/hands complaints (12 and 24 months)	Prevalence (95 %CI) at 12-month follow-up: neck 0.33 (0.27–0.39); shoulder: 0.31 (0.28–0.37) Prevalence (95 %CI) at 24-month follow-up: neck 0.31 (0.28–0.37); shoulder: 0.33 (0.27–0.39)	JDC-model: job demand (task difficulty; job pressure); job control (decision authority; skills discretion); social support (relationship with co-workers; relationship with supervisors; work flow); job strain (calculated by dividing the task difficulty over decision authority)	Computer position (keyboard, screen); use of arm/wrist support; adjustable chair; awkward body posture; irregular head and body posture; computer work h/day	*Adjustment* age; sex; history of complaints; *physical factors in multivariate model* computer working h/day; equipment position; personal computer placement; awkward body posture; irregular head and body posture

Table 2 continued

Study	Study population[a]	Outcome measures (duration of follow-up)	Outcome incidence-prevalence-recurrence	Psychosocial factors examined in the study	Physical factors examined in the study	Adjustment/physical variables in multivariate model
Feveile et al. (2002)	Employees drawn from the Central Population Register [$n = 1895$; sex: na age (18–59)]	Development of neck/shoulder symptoms during the past 12 months (5 years)	Men 28 %; women 39 %	JDC-model: psychological job demands; skill discretion; decision authority; social support	Repetitive work tasks; physically hard work; working with hands raised; twisting or bending; sedentary work; heavy lifting; use of vibrating hand tools	**Men** *multivariate model* social support; *physical factors in multivariate model* twisting or bending; heavy lifting and sedentary work **women** *multivariate model* smoking habits
Grooten et al. (2004)	Healthy population, referents of the MUSIC-Norrtalje study ($n = 1213$; 42.5 % men; age 42)	Seeking care for neck/shoulder pain (4–6 years)	Cumulative incidence for seeking care for a new incidence of NSP women 29 %; men 18 %	JDC-model: demands in relation to competence; opportunities to learn and develop at work; mental demands; decision latitude; general support; low meaningfulness; job strain time pressure; degree of hindrances at work; non-fixed salary; working hours/week; night work/shift work; solitary work	Manual handling ≥50 N ≥1 h/day; hands above shoulder level ≥1 h/day; repetitive hand and finger movements ≥2day/week; vibrating tools ≥1 h/day; sitting (% of time); high-energy expenditure	**Men** *adjustment* age; previously sought care for neck/shoulder pain; *physical variables in multivariate model* manual handling <50 N>1 h/day **women** *no physical factors in the multivariate model*
Harkness et al. (2003)	Newly employed workers from 12 different occupational settings ($n = 638$ at 12-month follow-up and $n = 476$ at 24-month follow-up; 65 % men; age 23 [interquartile range 20–27)]	New onset shoulder pain (24 months)	Prevalence of new onset shoulder pain after 12 months and after 24 months: 15 %;	JDC-model: job satisfaction; monotonous work; boring work; work pace; stress/worry; control over work; ability to learn new things; support from colleagues and supervisors; psychological distress in the General Health Questionnaire	*Manual handling activities* frequency, duration, and weights of work-related mechanical tasks performed (especially: carrying weights on one shoulder; lifting weights with one or two hands; pushing or pulling weights; lifting at or above shoulder level); *postures and repetitive movements* frequency and duration of postures, and repetitive movements (e.g. driving, stretching below knee level, working with hands at or above shoulder level, and repetitive movements of the arms or wrists)	*Multivariate model* age group; sex; occupation; monotonous work; other pain (than shoulder pain); *physical factors in multivariate model* lifting with one or two hands; carrying on one shoulder; lifting at or above shoulder level, pushing/pulling; working with hands above shoulder level

Table 2 continued

Study	Study population[a]	Outcome measures (duration of follow-up)	Outcome incidence-prevalence-recurrence	Psychosocial factors examined in the study	Physical factors examined in the study	Adjustment/physical variables in multivariate model
Juul-Kristensen and Jensen (2005)	Office workers from 11 Danish companies [$n = 2576$; sex na; age: (18–49)]	Lower frequency neck/right shoulder symptoms at follow-up (12 months)	Lower frequency of neck/right shoulder symptoms 39 %	Influence on when to take a rest pause; influence on speed of work	*General* percentage of work time at computer; *ergonomic exposure* adjusted chair; adjusted table; space to rest arms in front of keyboard; screen below eye height; work time standing at desk; disturbance by glare/reflexion on screen	*Adjustment* age; sex; % of work time at computer; glare/reflection; pauses; speed of work *adjustment for physical factors* adjusted chair; adjusted desk; space for resting the arms in front of keyboard; upper line on screen below eye height; standing work posture
Korhonen et al. (2003)	Employees in three city administrative units ($n = 180$; 56 % men; age (25–61); mean 47; median 49)	Incidence of neck pain (for at least 8 day during the preceding 12 months) (12 months)	Annual incidence of neck pain 34.4 %	Breaks during work; influence on work load; mental stress (individual factor); mental strain (individual factor); job satisfaction (individual factor)	VDU work (duration, ergonomics of the workstation; viewing distance; height of VDU screen; distance of VDU keyboard; deviance of VDU keyboard from midpoint; distance of VDU mouse); physical work environment	*Multivariate model* age; sex; smoking; frequency of physical exercise; interaction age x sex; interaction mental stress x frequency of physical exercise *physical factors in multivariate model* distance of the keyboard from the edge of the table
Leclerc et al. (2004)	Workers with repetitive work tasks ($n = 598$; 29.8 % men; age categories ≤29; 30–39; 40–49; ≥50)	Incidence of shoulder pain (3 years)	Incidence men 29 % women 21 %	JDC-model: job control; job demand; social support at work; satisfaction at work	*Repetitive work* tighten with force; work with force, other than tighten; press with the hand; hit; pull; hold in position; *other* use of a hand held tool (not studied for women); bending forward; working with arms above shoulder level; use of vibration tools (not studied for men); exposure to cold	**Men** *multivariate model* number of years on the job; depressive symptoms; *physical factor in multivariate model* repetitive use of a tool (yes/no) **women** *multivariate model* depressive symptoms; *physical factors in multivariate model* hit (yes/no); bending forward (infrequently/frequently); arm above the shoulder (infrequently/frequently); use of vibrating tool (no/yes)

Table 2 continued

Study	Study population[a]	Outcome measures (duration of follow-up)	Outcome incidence-prevalence-recurrence	Psychosocial factors examined in the study	Physical factors examined in the study	Adjustment/physical variables in multivariate model
Miranda et al. (2001)	Employees of a large forestry company ($n = 3312$; white collar worker 53 % men; age 45.3 ± 9.2; blue collar worker 82 % men; age 45.3 ± 9.1)	Incident shoulder pain persistent severe shoulder pain (12 months)	Incident shoulder pain: 14 %	Overload at work (difficulty at work, hurry at work); mental stress (individual)	Physical strenuous work; working with a hand above shoulder level (h/day); working with the trunk flexed forward (h/day); twisting movements of the trunk during a workday (probability); working in sitting position (h/day); working with rotated neck (h/day)	**Incidence of shoulder pain** *multivariate model* age; sex; body mass index; jogging, dancing; *physical factors in multivariate model* physical strenuousness of work; working with a hand above shoulder level (h/day); working with the trunk flexed forward (h/day) **persistence of shoulder pain** *multivariate model* age; sex; sports activity score; cross country skiing; *physical factor in multivariate model* working with a hand above shoulder level (h/day)
Östergren et al. (2005)	Vocationally active men and women (MCDS) [$n = 4919$; 53.9 % men; age (45–65)]	New onset shoulder–neck pain during the last 12 months (12 months)	Men 6.0 %; women 8.1 %	JDC-model: psychological job demands; decision latitude; job strain (high psychological demands and low decision latitude); job support	Mechanical Exposure Index: 24 questions regarding occupational mechanical exposure	**Men and women** *adjustment* age; *adjustment for physical factors* mechanical exposure
Smith et al. (2009)	Full-time employees in 12 health care and manufacturing sites [$n = 424$; 52.4 % men; age (18–55+)]	Shoulder symptom incidence (12 months)	20 %	JDC-model: demand control quadrants (low strain, high strain, active job, passive job); separate demand control factors (job demand; job control)	*Force measurements* power grip; lifting weights; lifting percent of time; lifting frequency; frequency of forceful exertions; duty cycle of forceful exertions; *postures* neck extension or neck flexion; neck rotation; trunk flexion; trunk lateral flexion; trunk rotation and lateral flexion; frequency of shoulder movements; upper arm extension or flexion; upper arm outward or inward rotation; upper arm abduction; usage of vibrating tools	*Adjustment* age; sex; race; neck, elbow or hand/wrist symptoms at baseline; *physical factors in multivariate model*: awkward upper arm posture (extension >5° or flexion ≥45°)

Table 2 continued

Study	Study population[a]	Outcome measures (duration of follow-up)	Outcome incidence-prevalence-recurrence	Psychosocial factors examined in the study	Physical factors examined in the study	Adjustment/physical variables in multivariate model
Trinkoff et al. (2006)	Registered nurses (neck $n = 226$, shoulder $n = 281$; 5 % men; age 45)	Neck or shoulder disorder (about 21 months)	Cumulative neck MSD 14.0 % cumulative shoulder MSD 17.3 %	Job content questionnaire psychological demands (working very hard, very fast, excessive work, long periods of intense concentration, enough time to get the job done, tasks often interrupted, and waiting on work from other people/departments) (summed up as continuous variable)	Frequency of awkward postures, heavy lifting, and pushing and pulling heavy loads on the job (summed up as continuous variable)	*Multivariate model* age, workday factor (h/day, weekends/month, shift, 13+h days, <10 h off between shifts); week factor (h/week, full versus part-time); mandatory overtime and on-call factor, number of jobs/most days worked in a row; work on time off factor (work while sick, on a day off or vacation day, breaks taken); *physical factor in multivariate model* physical demands
van den Heuvel et al. (2005)	Working population (SMASH) ($n = 787$; sex na; age na)	Three-year cumulative incidence of neck/shoulder symptoms (3 years)	24 %	Job content questionnaire: job demands; skill discretion; decision authority; social support co-workers; social support supervisor; job strain	Flexion or rotation of the wrists; lifting; neck rotation; prolonged sitting; prolonged computer work	*Adjustment* age; sex; *adjustment for physical factors* flexion or rotation of the wrists; lifting; neck rotation; prolonged sitting; prolonged computer work; long working days
Wahlström et al. (2008)	Male working subpopulation of high school graduates [$n = 586$; 100 % men; age 20.7 (19–27)]	Neck pain during the past 7 days, neck pain during the past 12 months (8–12 months)	9.5 % during the past 7 days; 29.6 % during the past 12 months	Mental stress (single item measure of stress); perceived muscular tension	Hand–arm vibration (m/s^2); hand–arm vibration (min/day); postural stress (h/day); computer work (h/day)	*Adjustment* time of follow-up; perceived muscular tension; *physical factors in multivariate model* hand–arm vibration (m/s^2); postural stress; computer work

[a] [N; sex; age(years) (median; mean ± SD); (range)], *na* information not available

Grooten et al. 2004; Östergren et al. 2005; Smith et al. 2009; Trinkoff et al. 2006; van den Heuvel et al. 2005) examined the influence of job demands on neck and/or shoulder disorders, whereas one study (Smith et al. 2009) considered shoulder symptoms only, and another (Grooten et al. 2004) focused on seeking care for neck/shoulder pain. As the health outcomes of the latter two studies strongly differed from the outcome variable of the other studies, they were not considered when evaluating the evidence for the incremental effect of job demands on the occurrence of neck and/or shoulder symptoms. Thus, altogether seven high-quality studies (Andersen et al. 2003; Ariëns et al. 2001; Brandt et al. 2004; Cassou et al. 2002; Trinkoff et al. 2006; Östergren et al. 2005; van den Heuvel et al. 2005) were used to estimate the weight of evidence for this association, and six of them reported an incremental effect of high job demands on neck/shoulder symptoms (Andersen et al. 2003; Ariëns et al. 2001; Brandt et al. 2004; Cassou et al. 2002; Östergren et al. 2005; van den Heuvel et al. 2005). Therefore, according to our definition, there is strong evidence for an incremental effect of job demands on neck/shoulder complaints. Risk estimates for job demand ranged between odds ratio (OR) 1.11 [95 % confidence interval (95 %CI) 0.84–0.46] (Östergren et al. 2005) and OR 2.0 [1.2–3.3] (Cassou et al. 2002) and between a risk ratio (RR) of 1.32 [0.68–2.56] (Ariëns et al. 2001) and RR 2.14 [1.27–3.60] (van den Heuvel et al. 2005). Another study (Eltayeb et al. 2009) considered specific facets of job demands (i.e. job pressure and task difficulty) but found no influence of these two demand-

Table 3 Incremental effect of psychosocial workplace factors on neck and/or shoulder complaints; all outcomes adjusted for physical factors

Study	Strength of the multivariate or adjusted association (CI 95 %)	Strength of the multivariate or adjusted association (CI 95 %) for physical factors
Andersen et al. (2003)	**New onset neck/shoulder pain (symptom case or clinical case)** *Job demands* (*symptom case*) reference: OR 1.00; high job demands: OR 1.5 (1.3–1.8) *Job demands* (*clinical case*) reference: OR 1.00; high job demands: OR 2.0 (1.2–3.3)	*Combined physical exposure* (*symptom case*) reference: OR 1.00; high physical exposure: OR 1.5 (1.2–1.9) *Combined physical exposure* (*clinical case*) reference: OR 1.00; high physical exposure: OR 3.2 (1.6–6.6)
Andersen et al. (2007)	**New onset neck/shoulder pain** *Job satisfaction* high: HR 1.00; low: HR 2.1 (1.2–3.6)	*Lifting at or above shoulder level* 1–49 kg per hour: HR 1.1 (0.6–2.0) ≥50 kg per hour: HR 1.9 (1.1–3.3)
Ariëns et al. (2001)	**New onset neck pain for at least 1 day** *Co-worker support* high: RR 1.00; low: RR 2.43 (1.11–5.29) *Supervisor support* high: RR 1.00; low: RR 0.95 (0.47–1.93) *Conflicting job demands* totally disagree: RR 1.00 Totally agree: RR 1.32 (0.68–2.56)	
Brandt et al. (2004)	**Neck symptom case** *High demands* RR 1.7 (1.0–2.7) *Low social support* RR 1.5 (0.9–2.4) **Shoulder symptom case** *Low control* RR 1.9 (1.2–2.9) (no evaluation for clinical cases because of small case numbers)	*Work with mouse duration* (*h/week*) 0–9: RR 1.00; ≥30: RR 2.5 (0.9–7.1) *Work with keyboard duration* (*h/week*) 0–4: RR 1.00; ≥15: RR 1.9 (0.9–4.3) *Work with mouse duration* (*h/week*) 0–9: RR 1.00; ≥30: RR 3.0 (1.1–8.1) *Work with keyboard duration* (*h/week*) 0–4: RR 1.00; ≥15: RR 2.1 (0.9–4.6)
Cassou et al. (2002)	**Chronic neck and shoulder pain** **Men** *Job demand* high: OR 1.2 (1.0–1.4) **Women** *Job demand* high: OR 1.2 (1.0–1.4)	**Men** *Repetitive work* (*before 1990*): OR 1.3 (1.0–1.7) *Repetitive work* (*in 1990*): OR 0.9 (0.7–1.2) **Women** *Repetitive work* (*before 1990*): OR 1.2 (1.0–1.5) *Repetitive work* (*in 1990*): OR 1.3 (1.0–1.6)
Eltayeb et al. (2009)	**New onset neck, shoulder and forearm/hands complaints** **Neck** *Decision authority* OR 0.9 (0.8–1.0) *Skills discretion* OR 0.9 (0.8–1.22) *Job pressure* OR 1.0 (0.9–1.03) *Task difficulty* OR 1.2 (1.0–1.51) *Social support* OR 1.0 (0.9–1.10) *Work flow* OR 0.9 (0.7–1.10) *Job strain* OR 2.6 (0.11–16.2) **Shoulder** *Decision authority* OR 0.9 (0.8–1.00) *Skills discretion* OR 0.9 (0.8–1.21) *Job pressure* OR 1.0 (0.9–1.01) *Task difficulty* OR 1.2 (0.9–1.40) *Social support* OR 1.0 (0.9–1.10) *Work flow* OR 0.9 (0.7–1.10) *Job strain* OR 27.8 (16.2–36.1)	**Neck** *Computer working hours/day* OR 1.2 (1.0–1.41) *Awkward body posture* OR 1.0 (0.9–1.11) *Irregular head and body posture* OR 1.1 (1.0–1.21) **Shoulder** *Computer working hours/day* OR 1.2 (1.0–1.50) *Awkward body posture* OR 1.0 (0.9–1.10) *Irregular head and body posture* OR 1.1 (1.0–1.31)
Feveile et al. (2002)	**Development of neck/shoulder symptoms during the past 12 months** **Men** *Social support* high: OR 1.45 (1.00–2.09); rather high: OR 1.00; rather low: OR 1.17 (0.83–1.66); low: OR 1.76 (1.24–2.50) **Women** No information about psychosocial factors in the multivariate model	**Men** *Twisting or bending* ≥3/4 of working hours: OR 1.51 (1.01, 2.26); 1/4–1/2 of the working hours: OR 1.56 (1.10, 2.22); Seldom/never OR 1 *Heavy lifting and sedentary work* ≥3/4 of the working hours and ≥3/4 of the working hours: OR 2.36 (0.14, 39.45); 1/4–1/2 of the working hours and 1/4–1/2 of the working hours: OR 1.61 (0.80, 3.24); seldom/never and seldom/never: OR 1

Table 3 continued

Study	Strength of the multivariate or adjusted association (CI 95 %)	Strength of the multivariate or adjusted association (CI 95 %) for physical factors
Grooten et al. (2004)	**Seeking care for neck/shoulder pain** **Men** *Medium/high mental demands* RR 0.7 (0.4–1.3) *High mental demands* RR 0.2 (0.1–1.0) *High degree of hindrances at work* RR 1.5 (0.9–2.5) *Night work/shift work* RR 1.7 (1.0–2.8) *Solitary work* RR 1.6 (0.9–3.0) **Women** No association with workplace factors	**Men** *Manual handling ≥50 N≥60 min/day*: RR 1.7 (1.0–2.9)
Harkness et al. (2003)	**New onset shoulder pain** *Monotonous work* never/occasionally: OR 1.00; at least half of the time: OR 1.7 (1.1–2.8)	*Lifting with one or two hands* never: OR 1.00; ≤22 lb: OR 1.6 (0.99–2.7); >22 lb: OR 1.7 (0.9–3.0) *Pushing/pulling* never: OR 1.00; >70 lb: OR 1.1 (0.7–1.9); ≥70 lb: OR 1.9 (1.1–3.3) *Working with hands above shoulder* never: OR 1.00; <15 min: OR 1.0 (0.6–1.6); ≥15 min: OR 1.6 (0.98–2.5)
Juul-Kristensen and Jensen (2005)	**Lower frequency neck/right shoulder symptoms at follow-up** *Pauses* large influence: OR 1.00 (0.76–1.32) *Speed of work* large influence: OR 1.08 (0.84–1.38)	*% of work time at computer* 0–25%: OR 1.62 (1.05–2.52); 50 %: 1.05 (0.74–1.49); 75 %: OR 1.46 (1.08–1.96) *Standing work posture* seldom–all the time: OR 0.97 (0.75–1.26)
Korhonen et al. (2003)	**Incidence of neck pain (for at least 8 d during the preceding 12 months)** *Mental stress* none/little: OR 1.00; some/fairly/much: OR 0.5 (0.2–1.4)	*Physical work environment* mean score >3: OR 1.0; Mean score <3: OR 2.4 (1.0–6.0)
Leclerc et al. (2004)	**Incidence of shoulder pain** **Men** *Job control* high or medium level: OR 1.00; low level: OR 3.68 (1.44–9.41) **Women** *job control* high or medium level: OR 1.00; low level: OR 1.46 (0.72–2.67)	**Men** *Repetitive use of a tool* no: OR 1.00; yes: OR 4.34 (1.58–11.9) **Women** *Bending forward* infrequently: OR 1.00; frequently: OR 1.81 (0.86–3.82) *Arm above the shoulder* infrequently: OR 1.00; frequently: OR 1.84 (0.89–3.79) *Use of vibrating tool* no: OR 1.00; yes: OR 1.89 (0.86–4.15)
Miranda et al. (2001)	**Incidence of shoulder pain** *Mental stress* not at all: OR 1.00; only little: OR 1.3 (0.8–2.0); to some extent: OR 1.5 (1.0–2.4); rather much or much: OR 1.9 (1.1–3.3) **Persistence of shoulder pain** *Overload at work* not at all: OR 1.00; little: OR 2.1 (1.1–4.0); definite: OR 3.8 (1.8–8.0)	*Physical strenuousness of work* not at all or rather light: OR 1.00; somewhat strenuous: OR 1.6 (1.1–2.3); rather or very strenuous: OR 2.0 (1.3–3.1) *Working with a hand above shoulder level* (*h/day*) <1/2: OR 1.00; 1/2–1: OR 1.1 (0.8–1.6); >1: OR 1.3 (0.8–1.9) *Working with the trunk flexed forward* (*h/day*) <1/2: OR 1.00; 1/2–1: OR 1.7 (1.2–2.5); 1–2: OR 1.2 (0.7–2.0); >2: OR 1.6 (0.9–2.6) *Working with a hand above shoulder level* (*h/day*) <1/2: OR 1.00; 1/2–1: OR 1.4 (0.8–2.4); >1: OR 1.4 (0.8–2.5)
Östergren et al. (2005)	**New onset shoulder–neck pain during the last 12 months** **Men** *Psychological demands* low: OR 1.00; high: OR 1.11 (0.84–1.46) *Decision latitude* high: OR 1.00; low: OR 0.98 (0.73–1.33) *Job support* high: OR 1.00; low: OR 1.21 (0.91–1.59) *Job strain* no: OR 1.00; yes: OR 1.02 (0.69–1.50) **Women** *Psychological demands* low: OR 1.00; high: OR 1.11 (0.85–1.44) *Decision latitude* high: OR 1.00; low: OR 1.22 (0.94–1.58) *Job support* high: OR 1.00; low: OR 1.15 (0.89–1.49) *Job strain* no: OR 1.00; yes: OR 1.61 (1.20–2.17)	**Men** *Mechanical exposure* low: OR 1.00; high: OR 2.16 (1.64–2.85) **Women** *Mechanical exposure* low: OR 1.00; high: OR 1.49 (1.14–1.94)

Table 3 continued

Study	Strength of the multivariate or adjusted association (CI 95 %)	Strength of the multivariate or adjusted association (CI 95 %) for physical factors
Smith et al. (2009)	**Shoulder symptom incidence** *Demand control quadrants* low strain: HR 1.00; high strain: HR 2.19 (1.08–4.42); active job HR 1.72 (0.83–3.59); passive job: HR 2.17 (1.02–4.66) *Separate demand control factors* low demand: HR 1.00; high demand: HR 0.77 (0.48–1.23); high control: HR 1.00; low control: HR 1.56 (1.004–2.41)	*Awkward upper arm posture* (*extension >5° or flexion ≥45°*) <20 % time: HR 1.00; ≥20 % and <35 % time: HR 1.84 (1.08–3.13); ≥35 % time: HR 1.15 (0.61–2.17)
Trinkoff et al. (2006)	**Neck incident case** *Psychological demands* OR 1.06 (0.94–1.19) **Ahoulder incident case** *Psychological demands* OR 1.01 (0.90–1.13)	*Physical demands* OR 1.05 (0.97–1.12); *physical demands* OR 1.09 (1.02–1.17)
van den Heuvel et al. (2005)	**Three-year cumulative incidence of neck/shoulder symptoms** *Job demands* low: RR 1.00; medium: RR 1.21 (0.87–1.70); high: RR 2.14 (1.27–3.60) *Skill discretion* high: RR 1.00; medium: RR 1.25 (0.82–1.90); low: RR 1.01 (0.50–2.01) *Decision authority* high: RR 1.00; medium: RR 1.09 (0.73–1.64); low: RR 1.34 (0.77–2.31) *Social support co-workers* high: RR 1.00; medium: RR 1.08 (0.68–1.71); low: RR 1.25 (0.66–2.37) *Social support supervisor* high: RR 1.00; medium: RR 1.06 (0.63–1.80); low: RR 1.06 (0.61–1.85) *Job strain* low: RR 1.00; active: RR 1.17 (0.73–1.90); passive: RR 1.11 (0.67–1.84); high: RR 1.62 (1.03–2.53)	
Wahlström et al. (2008)	**Neck pain during last 7 days** *Mental stress* reference (not at all): PR 1.00; medium (some): PR 1.17 (0.50–2.81); high (much or very much): PR 1.84 (0.51–5.87) **Neck pain during last 12 months** *Mental stress* reference (not at all): PR 1.00; medium (some): PR 1.14 (0.71–1.85); high (much or very much): PR 1.52 (0.65–3.19)	*Hand–arm vibration* (*m/s2*) reference (0–0.5): PR 1.00; medium (0.5–1.7): PR 1.07 (0.33–2.96); high (≥1.7): PR 2.53 (1.03–6.08) *Postural stress* (*h/day*) reference (0–1): PR 1.00; medium (1–3): PR 1.32 (0.53–3.48); high (≥3): PR 0.63 (0.20–1.90) *Perceived muscular tension* reference (never): PR 1.00; medium (a few times): PR 0.99 (0.34–2.56); high (a few times per week, one or several times per day): PR 2.63 (0.89–7.14) *Computer work* (*h/day*) reference (0–1): PR 1.00; medium (1–4): PR 0.90 (0.31–2.63); high (≥4): PR 1.08 (0.42–2.98) *Hand–arm vibration* (*m/s2*) reference (0–0.5): PR 1.00; medium (0.5–1.7): PR 1.12 (0.60–1.99); high (≥1.7): PR 1.93 (1.12–3.24) *Postural stress* (*h/day*) reference (0–1): PR 1.00; medium (1–3): PR 1.03 (0.61–1.76); high (≥3): PR 0.69 (0.37–1.26) *Perceived muscular tension* reference (never): PR 1.00; medium (a few times): PR 0.85 (0.48–1.45); high (a few times per week, one or several times per day): PR 1.12 (0.51–2.23) *Computer work* (*h/day*) reference (0–1): PR 1.00; medium (1–4): PR 1.19 (0.67–2.16); high (≥4): PR 1.02 (0.57–1.84)

scales on complaints of the neck/shoulder area. Miranda et al. (2001) examined overload at work—another facet of job demands—and reported an association between overload and persistence of shoulder pain (OR 3.8 [1.8–8.0]) (Tables 3, 4).

Job control

Altogether three high-quality studies (Brandt et al. 2004; Leclerc et al. 2004; Smith et al. 2009) investigated job control as a psychosocial risk factor. All studies found an association between job control and shoulder symptoms. Leclerc et al. (2004) looked at incidence of shoulder pain and found no association for women, but an association for men. The weight of evidence supports the notion of strong evidence for an incremental effect of job control on the development of shoulder symptoms.

Job control is often operationalised as skill discretion and decision authority. Three of the included studies (two high-quality) looked at these components separately (Eltayeb et al. 2009; Östergren et al. 2005; van den Heuvel et al. 2005). The results with regard to the incremental effect of decision authority point at a reasonable evidence for an incremental effect of low decision authority on neck/

Table 4 Evidence for an incremental effect of psychosocial workplace factors on the development and reporting of neck and/or shoulder complaints

	MSQ (%)	JDC	JCD(S)-model or job content model								Other psychosocial factors		
			(High or conflicting) job demands	Job pressure and task difficulty	Overload at work	Job control	Skill discretion	Decision authority	Low support (colleagues, supervisor, general)	Job strain	Low job satisfaction	Mental stress	Other[#]
Andersen et al. (2003)	77	x	(+)*							(−)			
Andersen et al. (2007)	69	x								(−)	(+)*		
Ariëns et al. (2001)	85	x	(+)						Co-worker: (+)* supervisor: (−)				
Brandt et al. (2004)	85	x	(+)*			(+)*			(+)				
Cassou et al. (2002)	62	x	(+)										
Eltayeb et al. (2009)	46	x		(−)			(−)	(−)	(−)	(+)*			Workflow (−)
Feveile et al. (2002)	54	x							(+)*				
Grooten et al. (2004)	77	x	Seeking care (−)*										Night work (+)* shift work (+)*
Harkness et al. (2003)	62	x											Monotonous work (+)*
Juul-Kristensen and Jensen (2005)	69												Influence on pauses and speed of work (−)
Korhonen et al. (2003)	62											(−)	
Leclerc et al. (2004)	69	x				(+)*							
Miranda et al. (2001)	62		Overload (−)		(+)							(+)*	
Östergren et al. (2005)	69	x	(+)			(∓)			(+)	(+)*			
Smith et al. (2009)	62	x	Only shoulder (−)			(+)*				(+)*			
Trinkoff et al. (2006)	69	JC	(−)										
Van den Heuvel et al. (2005)	85	JC	(+)				(+)	(+)	Co-worker: (+) Supervisor: (−)	(+)			

Table 4 continued

	MSQ (%)	JDC	JCD(S)-model or job content model								Other psychosocial factors		
			(High or conflicting) job demands	Job pressure and task difficulty	Overload at work	Job control	Skill discretion	Decision authority	Low support (colleagues, supervisor, general)	Job strain	Low job satisfaction	Mental stress	Other[#]
Wahlström et al. (2008)	46											(+)*	
No of studies	∑		9	1	1	4	2	2	6	4	1	3	4
Level of evidence			Strong	Insufficient	Insufficient	Strong	Insufficient	Insufficient	Strong	Strong	in-sufficient	in-sufficient	Insufficient
Reviewers' comments			Outcome: neck and shoulder complaints			Outcome: shoulder complaints			Factor: co-worker support				

MQS methodological quality score, *JDC(S)* job demand control (support)-model

(+) Positive association; (−) negative or unclear association; * Statistically significant association; [#] Other psychosocial risk factors: work flow, speed at work, shift work, pauses, hindrances, solitary work, monotonous work

shoulder complaints. The results for skill discretion are more ambiguous, so that there is currently only insufficient evidence for this association.

Another study (Juul-Kristensen and Jensen 2005) focussed on the influence of employees on pauses and speed of work, two factors which can represent job control. Nevertheless, the authors found no association between these two factors and a lower frequency of neck/shoulder pain in office workers (Tables 3, 4).

Job strain

Four of the included studies (Eltayeb et al. 2009; Östergren et al. 2005; Smith et al. 2009; van den Heuvel et al. 2005) examined the exposure to job strain, three of them were of high quality (see Table 1). Two more high-quality reports of Andersen et al. (2003, 2007) examined the interaction between job demand and job control as correlate for job strain. They did not find significant associations but did not report on the numerical results. This is why we cannot include these remarks in the evaluation of the level of evidence. The results of the included studies therefore confirm that there is strong evidence for an incremental effect of high job strain on the development of neck and/or shoulder complaints. The risk estimates vary between OR 1.02 [0.69–1.50] and OR 27.8 [16.2–36.1] (Tables 3, 4).

Social support

Authors of the included primary studies regarded social support in general, as well as social support of co-workers, and social support of supervisors, respectively. The incremental effect of low social support in general was examined in six studies (Ariëns et al. 2001; Brandt et al. 2004; Eltayeb et al. 2009; Feveile et al. 2002; Östergren et al. 2005; van den Heuvel et al. 2005), with only one study (Eltayeb et al. 2009) of low methodological quality. Consistent findings were found in five high-quality studies, especially with regard to co-worker support. There seems to be strong evidence for an incremental effect of social support at the workplace on the development of neck and/or shoulder symptoms, especially with regard to co-worker support (range of risk estimates, OR 1.15; [0.89–1.49] (Östergren et al. 2005) to OR 1.76 [1.24–2.50] (Feveile et al. 2002) and RR 1.25 [0.66–2.37] (Van den Heuvel et al. 2005) to RR 2.43 [1.11–5.29] (Ariëns et al. 2001) (Tables 3, 4)).

Other psychological/psychosocial risk factors

Only one survey (Andersen et al. 2007) examined job satisfaction and found an incremental effect of job satisfaction on the prevalence of neck/shoulder pain (hazard

ratio (HR) 2.1 [1.2–3.6]). Korhonen et al. (2003), Miranda et al. (2001) and Wahlström et al. (2008) examined mental stress (as one single item) and its relation to neck and/or shoulder complaints. Due to the only mediocre methodological quality according to our scoring system, and because of the ambiguous results of those three studies, there is currently only insufficient evidence for an incremental effect of mental stress on the development of neck and/or shoulder pain. Altogether three studies examined psychosocial/organisational aspects of work, for example, work flow, solitary work, shift work (Eltayeb et al. 2009; Grooten et al. 2004; Harkness et al. 2003). Because of the small number of studies and the heterogeneous study designs, there is currently only insufficient evidence for the associations between these factors and the development of neck and/or shoulder complaints (Tables 3, 4).

Discussion

Over the last years, different authors have suggested an independent influence of psychosocial workplace factors on the development and the occurrence of work-related musculoskeletal disorders and general health complaints, based mostly on cross-sectional studies; even so, the findings in the literature are inconsistent. While a recent prospective study by Lindeberg et al. (2011) depicts that high psychological job demands, low job control and low job support are independently associated with exhaustion in both sexes, and Leroux et al. (2006) conclude that workers experiencing high job strain are at a higher risk of developing neck–shoulder symptoms, Johnston et al. (2009) found no influence of psychosocial factors on neck pain after adjustment for individual factors, task demands, sensory measures, and measures of motor function. These inconsistencies are probably at least partially due to different methodological and statistical approaches. Also, the exclusive examination of psychosocial factors neglects the often simultaneous exposure of employees to physical workplace factors, which have to be considered as important factor for the development of neck and/or shoulder complaints, too (Mayer et al. 2012). At this point of time, it seems to be important to look at sets of carefully selected studies, to concentrate and pool information on the association between psychosocial and physical workplace factors and musculoskeletal disorders; this approach seems to be necessary to create sensible policies for preventive tools. The methodological approach of this review was specifically designed to undertake this task.

After a systematic literature research, altogether 18 prospective studies were included in the current review. The study results were evaluated according to their quality and were used to report on evidence according to previously defined criteria. According to this procedure, we found strong evidence for an incremental effect of high job demands, low job control, low social support by co-workers, as well as high job strain on the occurrence of neck and/or shoulder disorders, though the risk estimators for this incremental effect were low to medium and usually ranged between 1 and 2.

Most studies included in this review used psychosocial factors from the demand control model by Karasek (1979), which is one of the best studied job stress models in occupational health literature. It distinguishes two relevant components for employee health and well-being: job demands and job control. Specifically, the presence of high job demands combined with a low level of job control (which can be subdivided into decision authority and skill discretion) is characterised as a high strain job. Working under high strain conditions has been associated with increased job stress and negative health effects of affected workers (Karasek 1979; Karasek and Theorell 1990). Fourteen of the included longitudinal studies used the job content questionnaire by Karasek et al. (1998) comprising the categories job demand, job control, and the combined ratio of job strain. In these studies, high job demands and low job control, as well as low social support, were independently associated with the occurrence of neck and/or shoulder complaints. These findings support the theory that a high level of job demand or a low level of job control and lack of social support at the workplace can induce shoulder and/or neck complaints, or can strengthen the awareness of complaints, independent from physical exposures. The risk estimators for this incremental effect usually ranged between 1 and 2.

Next to the job demand control model, some authors also considered other independent psychosocial risk factors at the workplace. Altogether four out of the 18 studies of this review worked with self-administered questionnaires for psychosocial exposures at the workplace and examined factors like job satisfaction, mental stress in general, and solitary work. Because of the scarcity of these studies and the inhomogeneities with regard to outcome and study design, there is currently only insufficient evidence for associations between other psychosocial risk factors and neck and/or shoulder complaints.

Although, to our knowledge, no other review of longitudinal studies on this topic exists, other authors have addressed comparable research questions. Linton (2000) critically examined literature concerning psychological risk factors in the development of neck pain. They declared that psychological factors were associated with the reported onset of neck pain in 37 prospective studies. However, they did not take into account an adjustment for physical factors. In 2000, van der Windt et al. hypothesised that major stress possibly leads to an increased muscle tone or

augments the influence of physical work load on musculoskeletal disorders. Palmer and Smedley (2007) found high psychosocial demands to be associated with the outcome of chronic neck pain after adjustment for physical risk factors (prevalence ratio PR 1.8), and weaker associations with low control and low social support (PR 1.3–1.4). Comparable results to the results of the present review on longitudinal studies were reported in the NIOSH document (Bernard 1997): High levels of perceived workload were found to be positively associated with musculoskeletal symptoms of the upper extremities (including neck and shoulder), even when adjusted for physical factors. However, the findings were extracted from cross-sectional reports. Macfarlane et al. (2009) found that both high and low work demands were associated with a higher risk for developing neck and shoulder pain. Bongers et al. (2002) came to the conclusion that 74 % of all studies that investigated the association between work-related psychosocial workplace stressors and shoulder/upper arm problems found at least one positive association.

Aside from the methodological benefits which derive from a strict selection process and from focussing on longitudinal studies as conducted in this review, several aspects and limitations have to be considered when interpreting the results. Due to the strict selection process, only 18 studies were included in the analysis. Despite the strict selection criteria, these 18 studies showed a broad methodological range. First, it has to be considered that populations examined in the included primary studies represent different occupational sectors, for example, service, industrial, and information sector. As occupational branches differ ostentatiously in psychosocial work environment, the inclusion of various sectors might lead to a potential selection bias. Further analysis might benefit from defining clear occupational settings, in order to draw comparisons in terms of the psychosocial strain specific to an occupational sector.

Second, this review focuses on neck and/or shoulder disorders. We looked at both localisations as they are sometimes difficult to separate (Linton 1995; Bongers et al. 2006; Hamberg-van Reenen et al. 2007). The majority of the primary surveys included in this review, examined both neck and shoulder pain (11 studies), whereas four looked at shoulder complaints only, and three studies at neck complaints only. Note that Harcombe et al. (2010) found differences in the association between psychosocial factors and neck and shoulder pain, respectively, thus the consideration of a combination of both localisations might have led to bias, too. This assumption might be reflected in our results when looking at job control, which seems to be associated with shoulder complaints rather than neck complaints. In fact, there seems to be a general discordance as to the clear site definition of upper-extremity musculoskeletal complaints since guidelines on diagnostic procedure are still vague (Sluiter et al. 2001). Nevertheless, research would profit from more precise definitions of examined musculoskeletal disorders.

These first two limitations are also represented in the heterogeneity analysis conducted in the setting of this review. The results of this analysis suggest that the effects of this review should not be pooled for analysis. It is debatable, if a random effect model should be used in order to overcome the heterogeneity of the given literature. Nevertheless, the model developed by DerSimonian and Laird might bias the results to the extent that it does not correct for bias or failure to control confounding (Pettiti 1999). Strictly speaking, we suggest that pooled findings of the included studies would lack validity and might induce a false-positive effect. The results, compared in terms of multivariable and adjusted risk estimates, therefore leave ample room for debate, whether or not there is a significant impact of psychosocial factors in general on the emergence of musculoskeletal disorders. One aspect of this general problem should be examined more thoroughly: As the results of this review implicate that "job demand" and "job control" of Karasek's job content questionnaire can play an independent significant role in the development or the reporting of neck/shoulder disorders, it should be mentioned that the term "job demand" itself might consist of multi-faceted aspects. High job demands were suggested to be a consequence of high work load, high sensory as well as high cognitive demands combined (Andersen et al. 2007; Brandt et al. 2004). Others depicted high quantitative demands or conflicting job demands in their studies (Ariëns et al. 2001). The initial definition of job demand by Karasek is divided into subscales (working very hard, very fast, excessive work, long periods of intense concentration, enough time to get job done, tasks often interrupted, and waiting on work from other people). Job demands therefore refer to physical, psychological, social, and organisational aspects of the work that require continuous physical and psychological skills and are therefore not only associated with certain psychological efforts, but also associated with physiological efforts (Demerouti and Bakker 2011). The distinction between physical and psychosocial job demands therefore was not as strict as we had intended it in our study design. This should be kept in mind when interpreting the results, especially with regard to the low to medium risk estimates of the incremental effect of psychosocial factors (adjusted for physical factors).

As a fourth limitation, it should be mentioned that some of the included studies used a standardised self-report questionnaire tool to assess neck and/or shoulder complaints (Nordic Questionnaire, Kuorinka et al. 1987) which might influence the outcome due to individual reporting bias (Salerno et al. 2002). Future research should focus on

distinct case definitions in order to manifest an evidence-based, consistent outcome and thus increase the validity of the results.

Fifth, due to our rather strict selection criteria (longitudinal studies, baseline assessment of psychosocial, and physical risk factors), our self-administered quality checklist was restricted to the most essential aspects. Weighting all items of our checklist equivalently might lead to a potential bias in scoring the studies.

Another limitation results from the studies themselves. In longitudinal studies, relative risks should be calculated as they are a more meaningful risk estimates than odds ratios. Nevertheless, most longitudinal studies used odds ratios as risk estimate, eventually because it is more common in medical research.

Generally, we tried to abstain from an overestimation of the results but had to deal with two problems. On the one hand, effect estimates in the original studies varied to a mentionable degree between 1 and 2. Interpretation of results of this magnitude might easily be distorted due to potential bias (Grimes and Schultz 2008). Bias can occur by selection of study samples, non-response, and comparability of follow-up. On the other hand, it was often said that the strength of an association should not only be defined by evaluating the magnitude of the statistical correlation. In fact, validity of the results is strengthened by means of the temporal association (meaning that exposure generally is measured ahead of the occurrence of a musculoskeletal disorder), the consistency of the outcome (implying that repeatedly similar effect is caused in several occupational settings and study conditions), and the dose–response relationship (higher levels of exposure result in higher risk of developing a musculoskeletal disorder) (Hill 1965; Rothman 1986). Our results represent an attempt to assess the nature of the association between risk factor and the occurrence of musculoskeletal disease in an evidence-based manner by evaluating all effects, even those without statistically significant associations.

Conclusions

According to our findings, there is evidence for an association between psychosocial workplace factors (as measured by the commonly used job demand control model) and neck/shoulder disorders. Still, doubt remains with regard to the size of the incremental effect of these associations. Future research faces manifold challenges which concern in particular the investigation of distinct occupational settings, a more precise and consistent definition and assessment of musculoskeletal disorders, and the longitudinal impact of psychosocial stressors on musculoskeletal disorders. Nevertheless, more insight into the interplay between workplace factors and the development of musculoskeletal disorders on basis of systematic reviews is needed in order to create effective preventive tools.

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Conflict of interest The authors declare that they have no competing interest.

Appendix

Explanation of the methodological criteria from Table 1

A	Positive if at least two demographic factors out of age, gender, profession are clearly defined
B	Positive if either inclusion or exclusion criteria for the baseline population are presented
C	Positive if the total number of participants was ≥60% on the last point of follow-up compared to the number of participants at baseline
D	Positive if demographic/clinical information (patient/disease characteristics such as age, sex and other potential prognostic predictors) was presented for those lost to follow-up/drop-outs
E	Positive if the follow-up period was at least 3 months
F	Positive if clinical diagnosis was assessed
G	Positive if standardised questionnaires at baseline and at follow-up were applied for outcome measurement
H	Positive if objective outcome measurements are applied (clinical examination, clinical tests, X-ray)
I	Positive if standardised questionnaires at baseline and at follow-up were applied for psychosocial risk factors
J	Positive if standardised questionnaires at baseline and follow-up were applied for physical risk factors
K	Positive if objective assessment of physical exposure is conducted (video analysis, weight definition)
L	Positive if the data presentation fits to the stated method
M	Positive if univariate/multivariate models are presented by means of relative risks, rate ratios, odds ratios or hazard ratios

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