Applied Ergonomics 43 (2012) 455–467

Contents lists available at ScienceDirect

Applied Ergonomics

journal homepage: www.elsevier.com/locate/apergo

Work-related upper quadrant musculoskeletal disorders in midwives, nurses and physicians: A systematic review of risk factors and functional consequences

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ARTICLE INFO

Article history:
Received 20 October 2010
Accepted 12 July 2011

Keywords:
Musculoskeletal system/injuries
Health personnel
Risk factors

ABSTRACT

Background: Given a worldwide shortage of primary health care workers predicted to worsen, it is vital to address sources of attrition among these professionals. One such source may be work-related musculoskeletal disorders. We aimed to identify risk factors for and functional consequences of work-related upper quadrant musculoskeletal disorders in midwives, nurses and physicians.
Methods: Eighteen of 87 studies identified from an electronic database search met the inclusion and quality criteria.
Results: Job demands, demanding work schedules and physical exposures have the strongest associations with work-related upper quadrant musculoskeletal disorders. Functional consequences included widespread use of prescription and over-the-counter medications and major negative impact on activities of daily living. No studies of midwives were located.
Conclusion: High-quality studies of midwives as well as better-designed prospective studies of nurses and physicians are needed. Results of such studies could inform preventive strategies and reduce the contribution of work-related musculoskeletal disorders to attrition.

1. Introduction

1.1. The international midwifery shortage

In industrialized countries, the nursing and midwifery workforces are aging. Estimates indicate that in 2007, 56% of Australian midwives were aged ≥45 years, while only 17% were <35 years of age. Of the latter only 3% were younger than 25 years (Australian Institute of Health and Welfare, 2009). These percentages roughly parallel those for nurses in Australia (Australian Institute of Health and Welfare, 2009), and lead to the obvious conclusion that younger people are not entering these professions in sufficient numbers to replenish the workforce.

A similar situation exists in Canada. Data from the Canadian Institute for Health Information indicate that the largest group of employed nurses is in the 50–54 year age range (Cameron et al., 2008; Canadian Institute for Health Information, 2007b). Moreover, the percentage of nurses aged over 55 years grew from 21 to 24% between 2005 and 2007, while the percentage of nurses aged <30 years increased minimally from 10 to 10.5% in the same time period (Canadian Institute for Health Information, 2007b). The number of Canadian midwives is growing (Canadian Association of Midwives, 2008) and available data suggest they are younger on average than nurses in Canada (Canadian Institute for Health Information, 2008), however their numbers are still few (2 per 100,000 population in 2007) (Canadian Institute for Health Information, 2007a).

In the United Kingdom, where nurses' and midwives' data are reported collectively, the workforce profile is much the same. Over 31% of nurses and midwives registered in 2008 were aged over 50 years (Nursing and Midwifery Council, 2008). Alarmingly, the percentage of nurses and midwives over 40 years of age is >65%, while those aged <30 years represent just over 9% of the 2008 total (Nursing and Midwifery Council, 2008).

Data from the United States on certified nurse-midwives tell a similar story. The 2009 membership survey of the American College of Nurse-Midwives showed that of respondents who attend births, 32% were in the age group ≥55 years. Nearly 19% were 45–54 years of age, while only about 17% were aged between 25 and 44 years (K. Schuiling, personal communication, 2010).

It is clear that health care systems can ill afford to lose nurses and midwives to other employment or premature retirement. Consequently, governments, health authorities and professional

Abbreviations: MSD, musculoskeletal disorder; WRUQMSD, work-related upper quadrant musculoskeletal disorder; NMQ, Standardized Nordic Musculoskeletal Questionnaire; OR, odds ratio; CI, confidence interval.

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doi:10.1016/j.apergo.2011.07.002

organizations need to investigate causes of attrition and implement strategies to retain nurses and midwives in the workforce. Attrition from nursing and midwifery can be a result of workplace conditions, family situation or health status (Curtis et al., 2006b; Estryn-Behar et al., 2010; Gerein et al., 2006). Nurses change jobs or leave nursing because of musculoskeletal disorders (Fochsen et al., 2006; Geiger-Brown et al., 2004; Owen, 2000), and this may be true of midwives as well.

1.2. Aim

The original purpose of this systematic review was to determine associations between risk factors and work-related upper quadrant musculoskeletal disorders (WRUQMSDs) in midwives. Repeated searches of the literature yielded no studies published in English of midwife samples. Hence, the aim was revised and the search expanded to studies of nurses and physicians as these groups were considered to have practice characteristics similar to those of midwives and may therefore have similar exposures. Because the midwife's scope of practice encompasses both nursing and medical functions, limiting the review to studies of either group risked overlooking possible associations that could be relevant to midwives in their practice. A secondary aim was to elucidate the functional consequences of WRUQMSDs on the populations studied. The PRISMA statement guided the process (Moher et al., 2009).

1.3. Why are midwives at risk?

No English-language studies have estimated prevalence of WRUQMSDs in midwives (Long et al., submitted for publication). Although most midwifery care is directed at healthy young women and their newborns, physical and psychosocial stressors abound. In hospital settings, midwives move beds and other heavy equipment. They may assume awkward positions when assisting with breast-feeding or attending a birth, in particular a waterbirth (Hignett, 1996). Physical support of a laboring woman often involves extended periods of massage for comfort and firm, sustained pressure to the sacrum for the relief of back pain. The birthing room is a place of intense emotions, ranging from anxiety and sometimes frustration to elation for all present, while outside the birthing room midwives may face hostility, unwarranted questioning of clinical judgment and skills, or other manifestations of horizontal violence from coworkers (Curtis et al., 2006a).

After a full, busy workday, the physiological patterns of labor and birth and the desirability of continuity of care may dictate that this workday extend far into the night with fatigue, sleep deprivation and the potential for work-family conflict (Grzywacz et al., 2006) adding to the pressures. Working under these conditions may result in injury (Knardahl, 2005) and subsequent workforce attrition (Fochsen et al., 2006).

2. Methods

2.1. Definition of terms

Many terms are used in the literature to describe musculoskeletal concerns, for example, symptom, disease, injury, disorder, complaint, discomfort, pain, numbness, and tingling. For the purposes of this review, a work-related upper quadrant musculoskeletal disorder was defined as the occurrence of symptoms in the neck, shoulder, or upper back, caused or exacerbated by work activities or the work environment. These anatomical areas are closely related and discomfort in one may actually originate in another (Bogduk, 2003).

The term "functional consequences" in this review refers to effects on the individual resulting from a WRUQMSD. These consequences include use of medication, the need for diagnostic or therapeutic measures, absence from work, reduction or change in work, domestic, and recreational activities, interference with sleep, and job change or retirement from the workforce due to disability.

2.2. Search and selection of papers for review

Between March and November 2009 MHL searched PubMed, Medline, CINAHL, Health Source: Nursing/Academic, and Embase. The search was updated in May 2011. Occupational diseases, occupational injury, musculoskeletal diseases, musculoskeletal disorders, upper limb, upper extremity, neck, shoulder, and upper back were the search terms for outcomes of interest and nurs*, midwi*, midwife, midwives, nurse-midwives, physicians, surgeons, doctors and obstetricians for the desired populations. A secondary search of the reference lists of retrieved articles yielded additional papers for evaluation. No limits were applied on publication dates or study design.

Inclusion criteria were:

- *Population*: midwives, nurse-midwives, registered nurses, registered nurse students, physicians, or medical students
- *Exposures*: individual, psychosocial workplace, and/or physical workplace exposures
- *Outcomes*:
  - musculoskeletal symptoms, incident or prevalent in the previous 12 months, in the neck, shoulder and/or upper back, and/or
  - functional consequences of these symptoms on the affected individual in relation to work and personal life
  - symptoms attributable to the individual's work activities or environment and not to trauma or leisure activities
- *Reporting of associations*: risk factors related to musculoskeletal disorders (MSDs) of any of the three body areas
- *Language*: English
- *Source*: peer-reviewed or professional journals

Exclusion criteria were:

- Intervention studies
- Studies of "nursing personnel" or "nursing staff," unless the article stated explicitly, or queries to corresponding authors ($n = 7$) revealed, that there were registered nurses in the sample

MHL screened the results. VJ and FB then confirmed inclusion using a blind review process and any dissent was resolved through discussion by all authors.

2.3. Methodological quality assessment

To assess study quality, we chose the tool described by Sherehiy et al. (2004) for its clarity and comprehensive approach to epidemiologic studies. MHL modified the tool by deleting items relevant only to case-control studies as these were superfluous (Table 1). Studies were rated based on the number of positive attributes ("+") identified. We then calculated the percentage of positive attributes out of the total number possible. As recommended by Kennedy et al. (2010), studies achieving >85% were considered to be high quality and <85% but ≥50%, moderate quality. As our goal was synthesis based on best evidence, we excluded studies scoring <50% from further analysis.

Table 1
Criteria for study quality assessment, adapted with permission from Sherehiy et al. (2004).

Item	Item definition	Design
Study objective	1. Positive, if the study had (a) clearly defined objective(s)	All
Study population	2. Positive, if the main features of the study population are described (sampling frame and distribution by age and sex)	All
	3. Positive, if participation rate is at least 80% or if participation rate is 60–80% and non-response is not selective (data shown)	All
	4. Positive, if participation rate at moment of main follow-up is at least 80% or if the non-response is not selective (data shown)	PC[a]
Exposure assessment, physical load at work	5. Positive if data are collected and presented about physical load at work	All
	6. Method for measuring physical load at work: direct measurement and observation (+), interview or questionnaire only (--)	All
	7. Positive if more than one dimension of physical load assessed: duration, frequency, amplitude	All
Exposure assessment, psychosocial factors at work	8. Positive if data are collected and presented about psychosocial factors at work	All
	9. Positive if more than one aspect of psychosocial factors is assessed	All
Exposure, individual factors	10. Positive if data are collected and presented about individual factors	All
	11. Positive if more than one aspect of individual factors is assessed	All
Exposure measurements, other	12. Positive, if data on history of the musculoskeletal disease/symptom is collected and included in the statistical analysis	All
	13. Positive, if the exposure assessment is blinded with respect to disease status	All
Assessment of the outcome	14. Positive if the time period on which the assessment was based was at least 1 year	PC
	15. Method for assessing outcome: physical exam blinded to exposure status (?[b]); self-reported based on specific questions relating to symptoms/disease/use of mannequin (?); single question (--)	All
Analysis and data presentation	16. Positive if the measures of association estimated were presented (OR/RR), including confidence intervals and numbers in the analysis	All
	17. Positive if the analysis is controlled for confounding effect or effect modification is studied	All
	18. Positive if the number of cases in the final multivariate model is at least 10 times the number of independent variables in the analysis	All

[a] PC: prospective cohort.
[b] ?: Unclear.

2.4. Assessment of level of evidence and strength of association

We developed our rubric for level of evidence based on work by Hartvigsen et al. (2004) and Kennedy et al. (2010):

- *Strong evidence*: consistent findings in more than one high-quality study
- *Moderate evidence*: consistent findings in one high-quality study plus one or more moderate quality studies OR in multiple moderate quality studies
- *Limited evidence*: consistent findings in two moderate quality studies
- *Insufficient evidence*: one moderate quality study or inconsistent findings across multiple studies.

We further adopted Hartvigsen et al.'s (2004) categorization for strength of association:

- *Moderate association*: OR or risk ratio between 1.01 and 2.00, or $\leq$.50 for protective effects, or $.01 < p < .05$
- *Strong association*: OR or risk ratio >2.00, or $p < .01$.

2.5. Data extraction

MHL extracted exposure and outcome data from each included study. Individual, psychosocial workplace, and physical workplace exposures were aggregated in a spreadsheet. These exposures are discussed further in Section 3. In the absence of explicit reference to measurement of work-relatedness, we determined from study objectives that the MSDs being investigated were work-related.

3. Theory

Recent reviews suggest the etiology of WRUQMSDs in workers from various occupational groups is multifactorial with individual characteristics as well as workplace psychosocial and physical exposures all playing a role (Bongers et al., 2002; Sherehiy et al., 2004; Staal et al., 2007). Several models have been proposed to demonstrate the association between work exposures and musculoskeletal disorders (Bongers et al., 1993, 2002; Côté et al., 2008; Feuerstein et al., 2004; Panel on Musculoskeletal Disorders and the Workplace, 2001c; Punnett and Bergqvist, 1999). The explanatory model developed by the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and its Associated Disorders (Côté et al., 2008), hereafter referred to as the Bone and Joint Decade model, was selected as the conceptual framework for this review. We chose this model for its recency, broad evidence base, recognition of the possible roles of coping with stress at work and individual risk factors, biological plausibility, and ease of comprehension. The model proposes a causal pathway followed by workers from an asymptomatic to a symptomatic state of neck pain. Although it was developed to explain associations between various risk factors and neck pain, it may be applicable to upper quadrant musculoskeletal disorders.

In the model, foundational influences including demographic factors and ethnicity/country of origin are placed first in recognition that many of these precede entry into the workforce. Demographic variables, few of which are modifiable, include age, gender, marital status, responsibility for care of children or dependent adults, and education. They affect the model's second group of risk factors, which we have called developmental factors.

Developmental factors have the potential to interact with each other and some are modifiable. Health behaviors can be positive (regular exercise, healthy diet, adequate sleep) or negative (smoking, excessive alcohol consumption). The category of general health, prior pain and comorbidities incorporates characteristics such as body mass index (BMI), upper body strength, and history of MSD or headache, all of which have been explored for association with WRUQMSDs (Panel on Musculoskeletal Disorders and the Workplace, 2001b). The concept of occupation may be interpreted in a variety of ways, as intended by the Bone and Joint

Decade Model Task Force (P. Côté, personal communication, 2010). It may refer simply to job title or, depending on the purpose of the study, include characteristics of employment such as career length, type of institution or shift work. Individual psychological factors such as depression complete this group of risk factors.

The next step in this pathway encompasses psychosocial and physical exposures in the workplace. Psychosocial workplace exposures have been implicated in the development of MSDs, including those of the upper extremities (Bongers et al., 2006). These exposures include high job demands, low job control, high job stress, and low support from supervisors and coworkers. Examples of these exposures in midwifery practice given in Section 1.3 were anxiety and frustration in the birthing room, and lack of support from colleagues outside it. Physical workplace exposures can be broadly categorized as force (pushing, pulling, lifting), as with sacral pressure for the comfort of the laboring woman; repetitive manual tasks such as measurement of the uterine fundal height in antenatal clinic; and awkward or static postures that the midwife adopts to conform to the position chosen by the mother, ensuring safety for the mother and newborn during the birth (Panel on Musculoskeletal Disorders and the Workplace, 2001b).

Organizational factors at work such as shift work (Sveinsdóttir et al., 2006), long working hours (Lipscomb et al., 2002), and organizational climate (Gershon et al., 2007; Stone et al., 2007; Stone and Gershon, 2006) have also been evaluated for their contribution to MSDs in nurses and have been categorized in some studies as psychosocial workplace exposures. However, depending on the study aim, they may fit best under occupation or alternatively assume a unique place between occupation and workplace exposures due to their effect on the amount and type of these exposures (A. Trinkoff, personal communication, 2010).

Finally, the Bone and Joint Decade model considers how a worker copes with stress at work can mediate the effects of workplace exposures. Coping strategies may be problem-focused, whereby the cause of the stress is identified and dealt with; or emotion-focused, where the stressed individual acts to manage the troubling feelings rather than confront the stressor (Lim et al., 2010).

4. Results

4.1. Study design, populations investigated, study quality

Fig. 1 summarizes the results of the search process. Following exclusion of studies that were irrelevant to the study aim and removal of duplicates, 100 studies published between 1993 and 2010 were screened for possible inclusion. Thirteen of these were excluded based on title and abstract. After reading the remaining

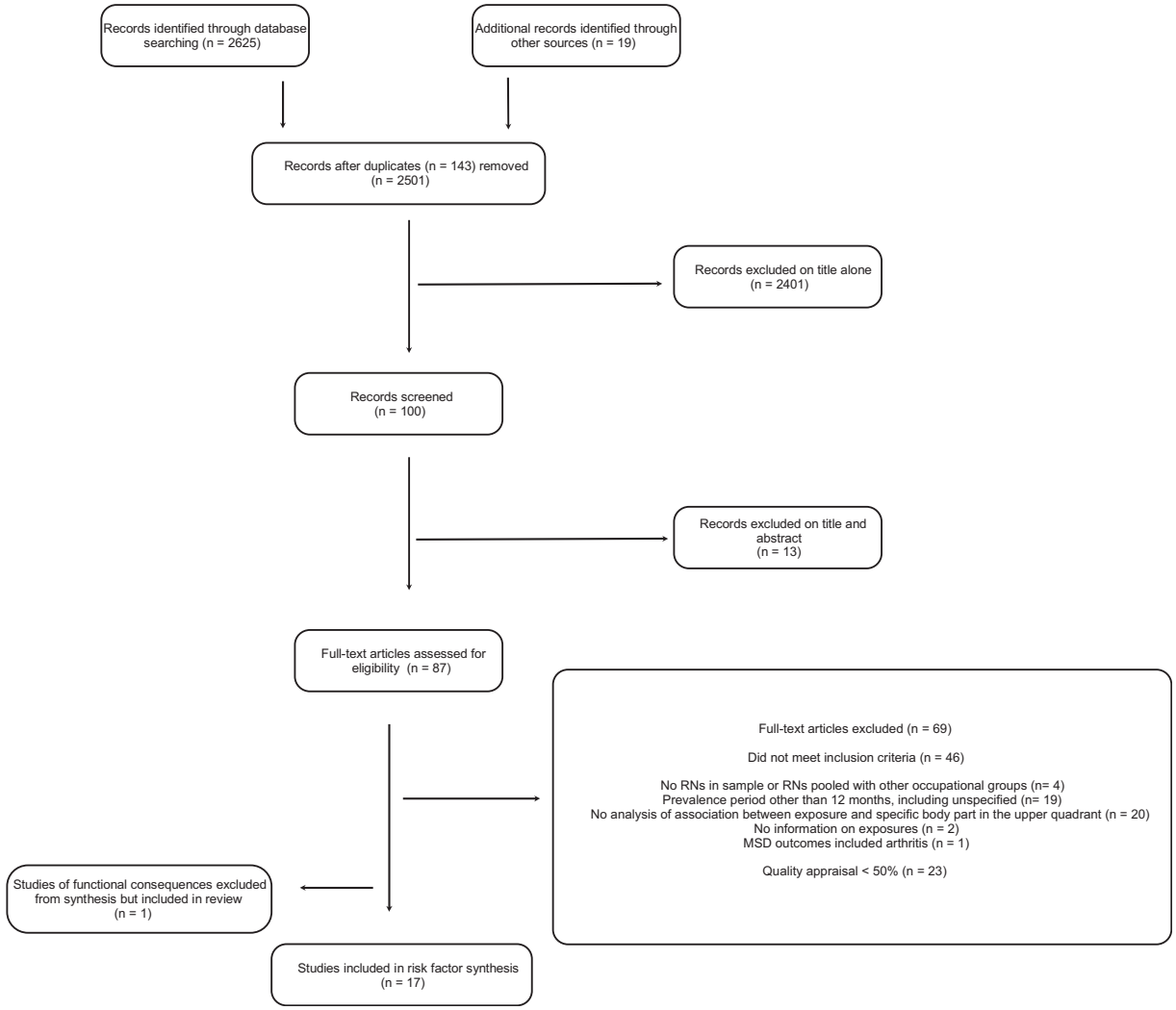

Fig. 1. Flow diagram of study selection process.

87 full text articles, 46 studies were excluded because they did not meet the inclusion criteria. This left 41 studies that underwent the quality appraisal process, of which 23 failed to achieve 50% in the quality appraisal. Of the remaining studies ($n = 18$), published between 1996 and 2010, there were 15 cross-sectional surveys and two longitudinal studies that underwent data extraction and synthesis. One study was omitted from the synthesis but included in the review for its unique focus on functional consequences (Trinkoff et al., 2002). Four other papers reported functional consequences of WRUQMSDs on study participants (Camerino et al., 2001; Choobineh et al., 2006; Smith et al., 2006b; Szeto et al., 2009).

Nurses or nursing personnel were subjects in 16 studies. Studies of nursing personnel ($n = 2$) comprised occupationally heterogeneous samples with one consisting of registered nurses (29.7%), nurse technicians (32.8%) and nurse auxiliaries (37.5%) (Magnago et al., 2010) and one involving a variety of hospital staff including nurses (40% of sample), midwives (8%) and physicians (3%) (Bru et al., 1996). Physicians were the focus of the remaining two studies. Interestingly, Smedley et al. (2003) excluded midwives from their sample of nurses, characterizing midwifery as a "non-nursing" job.

Only one retrieved study differentiated midwives as a subgroup but they were few in number and that study was ultimately excluded based on the quality appraisal (Bru et al., 1993). One included study (Smith et al., 2006b) observed physicians in five specialties including gynecology, but the researchers did not report whether the gynecologists also practiced obstetrics. No study reported an analysis of maternity nurses as a distinct subgroup.

The outcome of the quality appraisal is shown in Table 2. As no study achieved a score of 85%, all were rated moderate in quality.

4.2. Exposure assessment, outcome measures, outcomes

All of the studies assessed exposures and outcomes or functional consequences by self-report. Outcome measurement tools included the Standardized Nordic Musculoskeletal Questionnaire (NMQ) (Kuorinka et al., 1987) in 15 studies, the Dutch Musculoskeletal Questionnaire, which contains items from the NMQ, in one study (Bos et al., 2007), and an instrument constructed and validated by the Italian Ergonomic Research Unit on Posture and Movement in one study (Camerino et al., 2001). Reported annual prevalence of any WRUQMSD in these samples ranged from 24 to 83% at the neck, 35 to 72% at the shoulder, and 14 to 62% at the upper back.

Table 3 presents the details and significant associations reported in the 17 studies of risk factors included in the review, listed alphabetically. All of these studies collected data on a range of risk factors inherent to the worker although one study (Bru et al., 1996) reported only age and another only age and gender (Trinkoff et al., 2006). Table 4 synthesizes cross-sectional study findings with respect to consistency and strength of association.

4.3. Risk factors inherent to the worker

This group of risk factors includes the foundational factors of country of origin, ethnicity and demographic characteristics and the developmental factors of health behaviors, occupation, general health/prior pain/comorbidities and individual psychological factors.

4.3.1. Foundational factors

The only study to report on ethnicity suggested a protective effect of race (Trinkoff et al., 2003). This was an incidental finding that the authors did not analyze further (A. Trinkoff, personal communication, 2010). It is unclear why other studies did not consider ethnicity, although this may be related to presumed ethnic homogeneity in the source populations.

Demographic factors studied included age, gender, marital status, presence and ages of children in the home, carer responsibility for dependent adults, and education. In contrast to the findings in nurses, neither of the two studies of physicians demonstrated a relationship between any risk factor in this category and WRUQMSD (Smith et al., 2006b; Szeto et al., 2009).

In two cross-sectional studies of nurses (Alexopoulos et al., 2003; Trinkoff et al., 2003) there was a significant positive association between age and shoulder complaint. Likewise, two cross-sectional studies of nurses found a gender difference, with females being more affected (Camerino et al., 2001; Trinkoff et al.,

Table 2
Results[a] of study quality appraisal. Prospective studies in bold; all others are cross-sectional.

Study reference	*n*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total	%
1. Alexopoulos et al., 2003	351	+	+	+	N	+	--	+	+	+	+	+	--	--	N	?	+	+	+	12/16	75
2. Bos et al., 2007	3169	+	+	--	N	+	--	?	+	+	+	+	--	--	N	?	+	+	+	10/16	63
3. Bru et al., 1996	492	+	+	+	N	+	--	+	+	+	+	--	--	--	N	?	--	+	--	9/16	56
4. Camerino et al., 2001	1008	+	+	+	N	+	--	--	+	+	+	+	--	--	N	?	--	+	--	9/16	56
5. Choobineh et al., 2006	641	+	+	+	N	+	--	+	+	+	+	+	--	--	N	?	+	+	+	12/16	75
6. Lipscomb et al., 2002	1163	+	+	--	N	+	--	+	+	+	+	+	--	--	N	?	+	+	+	11/16	69
7. Lipscomb et al., 2004	1163	+	+	--	N	+	--	+	+	+	+	+	--	--	N	?	+	+	+	11/16	69
8. Magnago et al., 2010	491	+	+	+	N	+	--	--	+	+	+	+	--	--	N	?	+	+	--	10/16	63
9. Mehrdad et al., 2010	347	+	+	+	N	--	--	--	+	+	+	+	--	--	N	?	+	+	--	9/16	56
10. Smedley et al., 2003	**190**	**+**	**+**	--	--	**+**	--	--	**+**	**+**	**+**	**+**	**+**	**N**	**+**	**?**	**+**	**+**	**+**	**12/17**	**71**
11. Smith et al., 2006a	844	+	+	--	N	+	--	--	+	+	+	+	--	--	N	?	+	+	+	10/16	63
12. Smith et al., 2004	282	+	+	+	N	+	--	--	+	+	+	+	--	--	N	?	+	+	+	11/16	69
13. Smith et al., 2006b	286	+	+	--	N	--	--	--	+	+	+	+	--	--	N	?	+	+	--	8/16	50
14. Szeto et al., 2009	135	+	+	--	N	+	--	--	+	+	+	+	?	--	N	?	--	+	+	9/16	56
15. Trinkoff et al., 2002	1163	+	+	--	N	Not a study of risk factors; studied functional consequences only					+	+	--	--	N	+	--	+	?	8/16	50
16. Trinkoff et al., 2003	1163	+	+	--	N	+	--	+	--	--	+	+	--	--	N	?	--	+	?	9/16	56
17. Trinkoff et al., 2006	**2624**	**+**	**+**	--	**+**	**+**	--	--	**+**	**+**	**+**	**+**	--	**N**	**+**	**?**	**+**	**+**	**+**	**12/17**	**71**
18. Yeung et al., 2005	97	+	+	+	N	+	--	+	+	+	+	+	--	--	N	?	+	+	?	11/16	69

[a] +, positive; --, negative; ?, unclear; N, not applicable.

Table 3
Summary of 17 studies of risk factors for work-related upper quadrant musculoskeletal disorders in nurses and physicians.

Author, year	Study design	Population Sample size	Outcome(s) measured	Significant risk factors observed	Body area	Odds ratio or other measure of effect/ significance	95% confidence interval
Setting	*Control for confounding*	Response rate *% female*					
Alexopoulos et al., 2003	Cross-sectional	RNs	Musculoskeletal pain lasting for at least a few hours	Age >40	Shoulder	3.58	1.86–6.89
		$n = 351$		Perceived moderate/bad	Neck	2.76	1.72–4.44
6 large hospitals in Athens, Greece	*Adjusted for age and gender*	90%		general health	Shoulder	2.89	1.70–4.82
		81%		Manual materials handling	Shoulder	1.95	1.06–3.60
				Strenuous shoulder movement	Shoulder	1.87	1.06–3.30
				Awkward back postures	Neck	1.88	1.17–3.02
Bos et al., 2007	Cross-sectional	RNs	Musculoskeletal complaints	None significant in multivariate analysis	Neck/shoulder	-	-
		Non-specialized					
8 university hospitals in the Netherlands	*Logistic regression*	$n = 1977$					
		Intensive care					
		$n = 525$					
		Operating room					
		$n = 381$					
		63%					
		82%					
Bru et al., 1996	Cross-sectional	Hospital staff	Musculoskeletal pain	Full-time work	Neck	$p = .03$	---
		40% RNs					
1 regional hospital in Norway	*Logistic regression*	$n = 492$		Full-time work +high ergonomic load	Neck	$p = .04$	---
		85%					
		100%					
Camerino et al., 2001	Cross-sectional	RNs	Musculoskeletal symptoms meeting threshold criteria	Gender (female)	Neck	$p = .000003$	---
		$n = 1159$		"Job seniority"	Upper back	$p = .0005$	
3 large hospitals in Milan, Italy	*Logistic regression*	87%		In males	Neck	$p = .004$	
		69%		In females	Neck	$p = .006$	
Choobineh et al., 2006	Cross-sectional	RNs	Musculoskeletal disorder	Job tenure	Neck	2.12	1.46–3.08
		$n = 641$		Move/lift heavy loads	Neck	2.09	1.15–3.80
12 university hospitals in Tehran, Iran	*Age-adjusted; multiple logistic regression*	Unknown		Awkward head/arm posture	Neck	2.20	1.09–4.45
		85%		Awkward body posture	Shoulder	2.01	1.20–3.38
					Upper back	2.14	1.24–3.70
				Work bent/twisted at waist	Upper back	1.74	1.06–2.85
Lipscomb et al., 2002	Cross-sectional	RNs	Musculoskeletal symptoms meeting case definition[a]	Higher score on work schedule index	Shoulder	1.14	1.01–1.29
		$n = 1163$					
New York and Illinois, USA	*Age-adjusted; multiple logistic regression*	74%		>12 h/day + > 40 h/week	Neck	2.30	1.03–5.11
		95%			Shoulder	2.48	1.07–5.77
Lipscomb et al., 2004	Cross-sectional	RNs	Musculoskeletal symptoms meeting case definition[a]	4–6 health care system changes	Neck	2.18	1.12–4.22
New York and Illinois, USA	*Age-adjusted; multiple logistic regression*	$n = 1163$		>6 health care system changes	Neck	4.45	1.97–10.08
		74%			Shoulder	2.63	1.17–5.91
		95%					
Magnago et al., 2010	Cross-sectional	Nursing workers	Musculoskeletal disorder	High job strain	Shoulder	1.97	1.07–3.64
		30% RNs			Upper back	1.83	1.02–3.35
1 university hospital in Rio Grande do Sul, Brazil	*Logistic regression*	$n = 491$					
		93%					
		88%					
Mehrdad et al., 2010	Cross-sectional	RNs	Musculoskeletal symptoms or complaints	Workplace psychosocial stress	Neck	2.18	1.16–4.08
		$n = 317$		Moderate	Neck	2.36	1.01–5.57
1 large hospital in Tehran, Iran	*Logistic regression*	91%		High	Upper back	2.51	1.06–5.94
		87%					
Smedley et al., 2003	Longitudinal; surveys 3-monthly for	RNs	Musculoskeletal pain	Previous history of neck pain: Interval since last episode	Neck/shoulder	Hazard ratio	
		$n = 587$ at baseline		>1 yr at baseline		1.6	1.1–2.3
2 acute care hospitals in the south of England	2 years	$n = 190$ at final survey		Within 1 yr at baseline		2.8	2.0–3.9
	Adjusted for age, BMI, "frequently feeling tired, low, tense or under stress"			Total duration of previous neck pain	Neck/shoulder		
				<1 week		1.7	1.1–2.5
				1–4 weeks		2.3	1.5–3.3
		56%		>4 weeks		2.6	1.7–4.0
		95%		>4 weeks & pain in past yr			

Table 3 (*continued*)

Author, year	Study design	Population Sample size	Outcome(s) measured	Significant risk factors observed	Body area	Odds ratio or other measure of effect/ significance	95% confidence interval
Setting	*Control for confounding*	Response rate % *female*					
				5 or more times per shift:			
				Assisting a patient to walk using a cane, walker or crutches	Neck/shoulder	1.6	1.1–2.3
				Moving a patient in a wheelchair, bed, hoist, stretcher, commode		1.6	1.1–2.4
				Wash/dress a patient while s/he is on a chair/commode		1.7	1.1–2.8
Smith et al., 2006a	Cross-sectional	RNs $n = 844$	Musculoskeletal symptoms	Children in the home	Neck	2.53	1.32–4.91
				Smoking	Neck	2.45	1.43–4.35
1 large teaching hospital in Japan	*Logistic regression*	74% *100%*		Premenstrual tension	Upper back	1.94	1.32–2.86
				High mental pressure	Neck	1.53	1.02–2.31
					Shoulder	2.07	1.35–3.17
				Hard physical work	Shoulder	2.09	1.11–3.89
				Patient handling	Shoulder	2.07	1.08–4.32
Smith et al., 2004	Cross-sectional	RNs $n = 282$	Musculoskeletal complaints	High mental pressure	Neck	1.79	1.06–3.03
1 large teaching hospital in Shijiazhuang, China	*Adjusted for age, career length, department of employment*	92% *100%*		Not enough support	Neck	2.52	1.09–6.23
				Boring/tedious tasks	Upper back	1.97	1.16–3.35
Smith et al., 2006b	Cross-sectional	MDs $n = 286$	Musculoskeletal complaints	Work in internal medicine	Neck	1.85	1.02–3.38
					Shoulder	2.06	1.11–3.86
					Upper back	2.19	1.15–4.17
1 large teaching hospital in Shijiazhuang, China	*Logistic regression*	79% *51%*		Too much overtime	Shoulder	2.04	1.08–3.91
				Inadequate discussion (with management)	Shoulder	3.07	1.31–7.39
				Mental pressure	Upper back	2.28	1.11–4.79
Szeto et al., 2009	Cross-sectional	MDs $n = 135$	Musculoskeletal discomfort	Physical/ergonomic factors	Neck	2.03	1.29–3.19
Public hospitals in Hong Kong	*Multivariate logistic regression*	27% *17%*			Shoulder	1.81	1.34–2.44
					Upper back	1.67	1.28–2.20
Trinkoff et al., 2006	Longitudinal; 3 surveys over 15 months	RNs $n = 2624$	Musculoskeletal symptoms meeting case definition[a]	Work on time off factor	Neck	1.32	1.06–1.64
New York and Illinois, USA	*Age-adjusted; multiple logistic regression*	62% *95%*			Shoulder	1.23	1.01–1.50
				Physical demands	Shoulder	1.09	1.02–1.17
Trinkoff et al., 2003	Cross-sectional	RNs $n = 1163$	Musculoskeletal symptoms meeting case definition[a]	Race	Neck	.50	0.27–0.91
				Age	Shoulder	1.04	1.01–1.06
New York and Illinois, USA	*Age-adjusted; logistic regression*	74% *94%*		Gender (female)	Shoulder	9.36	1.15–76.35
				Carer for adult dependents	Neck	2.33	1.29–4.22
					Shoulder	2.06	1.11–3.81
				Psychosocial work demands	Neck	1.07	1.01–1.14
				Physical work demands:			
				Moderate	Neck	2.15	1.34–3.48
					Shoulder	2.40	1.43–4.01
				High	Neck	4.98	2.68–9.26
					Shoulder	6.13	3.14–11.98
Yeung et al., 2005	Cross-sectional	RNs $n = 97$	Musculoskeletal ache, pain or discomfort reported as high or very high in intensity or frequency	Mental task requirements + social-communication, organization, economic growth, & individual growth conditions	Upper back	0.43	0.20–0.95
3 acute care and 3 rehabilitation hospitals in Hong Kong	*Logistic regression*	Unknown *100%*		Physical & sensory task requirements + physical & socio-organization environment requirements, effort requirements & perceived risk requirements	Upper back	2.96	1.02–8.59

[a] Case definition for these studies was a relevant symptom lasting at least 1 week or occurring at least monthly in the past year, and of at least 3/5 pain intensity.

2003). For age and gender, therefore, there is limited evidence from these studies for at least a moderate positive association with the occurrence of WRUQMSDs in nurses. There is insufficient evidence of association with other foundational risk factors.

4.3.2. Developmental factors

Smoking, alcohol consumption, and exercise were the health behaviors evaluated. Of studies that examined the effect of smoking ($n = 6$) there was a positive association (OR 2.45, 95% confidence

Table 4
Strength of evidence for association between individual, workplace psychosocial and workplace physical exposures and work-related upper quadrant musculoskeletal disorders in studies of nurses and physicians.

Risk factor category	Number of studies	Studies finding significant association	Area of UQ affected	Odds ratio or other measure of effect/significance	95% CI	Level of evidence	Study references
Foundational factors							
Demographics							
Older/increasing age	16	2	Shoulder	1.04	1.01–1.06	Limited	Trinkoff et al., 2003
				3.58	1.86–6.89		Alexopoulos et al., 2003
Female gender	13	2	Neck	$p = .000003$	--	Limited	Camerino et al., 2001[a]
			Upper back	$p = .0005$	--		
			Shoulder	9.36	1.15–76.35		Trinkoff et al., 2003
Young children	5	1	Neck	2.53	1.32–4.91	Insufficient	Smith et al., 2006a
Adult dependents	3	1	Neck	2.33	1.29–4.22	Insufficient	Trinkoff et al., 2003
			Shoulder	2.06	1.11–3.81		
Ethnicity/country of origin							
Race	4	1	Neck	0.50	0.27–0.91	Insufficient	Trinkoff et al., 2003
Developmental factors							
Health behaviors							
Smoking	6	1	Neck	2.45	1.43–4.35	Insufficient	Smith et al., 2006a
Occupation							
Work in internal medicine	1	1	Neck	1.85	1.02–3.38	Insufficient	Smith et al., 2006b
			Shoulder	2.06	1.11–3.86		
			Upper back	2.19	1.15–4.17		
Job tenure/career duration	10	2	Neck	2.12	1.46–3.08	Limited	Choobineh et al., 2006
				$p = .004$ (males)			Camerino et al., 2001[a]
				$p = .006$ (females)			
Hours worked/day or week	9	1	Neck	$p = .03$	--	Insufficient	Bru et al., 1996
General health/prior pain/comorbidities							
Moderate/poor general health	2	1	Neck	2.76	1.72–4.44	Insufficient	Alexopoulos et al., 2003
			Shoulder	2.89	1.70–4.82		
Interval since last episode of neck pain	1	1	Neck/shoulder	Hazard ratio		Insufficient	Smedley et al., 2003[b]
>1 yr ago at baseline				1.6	1.1–2.3		
Within past yr at baseline				2.8	2.0–3.9		
Developmental factors							
Total duration of previous neck pain							
<1 week				1.7	1.1–2.5		
1–4 weeks				2.3	1.5–3.3		
>4 weeks				2.6	1.7–4.0		
Individual psych factors							
Premenstrual tension	1	1	Upper back	1.94	1.32–2.86	Insufficient	Smith et al., 2006a
Psychosocial workplace factors							
Job stress/demands	14	6	Neck	2.18–2.36	1.16–5.57	Moderate	Mehrdad et al., 2010
				1.79	1.06–3.03		Smith et al., 2004
				1.07	1.01–1.14		Trinkoff et al., 2003
			Shoulder	2.07	1.35–3.17		Smith et al., 2006a
				1.97	1.07–3.64		Magnago et al., 2010
			Upper back	1.97	1.16–3.35		Smith et al., 2004
				2.28	1.11–4.79		Smith et al., 2006b
				1.83	1.02–3.35		Magnago et al., 2010
				2.51	1.06–5.94		Mehrdad et al., 2010
Poor social relations/support at work	10	2	Neck	2.52	1.09–6.23	Limited	Smith et al., 2004
			Shoulder	3.07	1.31–7.39		Smith et al., 2006b
Work organization/scheduling	10	4	Neck	2.18–4.45	1.12–10.08	Moderate	Lipscomb et al., 2004[c]
				2.30	1.03–5.11		Lipscomb et al., 2002[c]
				1.32	1.06–1.64		Trinkoff et al., 2006[b,c]
			Shoulder	2.63	1.17–5.91		Lipscomb et al., 2004[c]
				2.48	1.07–5.77		Lipscomb et al., 2002[c]
				2.04	1.08–3.91		Smith et al., 2006b
				1.23	1.01–1.50		Trinkoff et al., 2006[b,c]
Combination	1	1	Upper back	0.43	0.20–0.95	Insufficient	Yeung et al., 2005
Physical workplace factors							
Lifting, pulling, pushing, manual handling	10	4	Neck	2.09	1.15–3.80	Moderate	Choobineh et al., 2006
			Shoulder	1.95	1.06–3.60		Alexopoulos et al., 2003
				2.07	1.08–4.32		Smith et al., 2006a
			Neck/shoulder	Hazard ratio			
				1.6–1.7	1.1–2.8		Smedley et al., 2003[b]
Posture	8	2	Neck	1.88	1.17–3.02	Limited	Alexopoulos et al., 2003
				2.20	1.09–4.45		Choobineh et al., 2006
			Shoulder	1.87	1.06–3.30		Alexopoulos et al., 2003
				2.01	1.20–3.38		Choobineh et al., 2006
			Upper back	1.74–2.14	1.06–3.70		Choobineh et al., 2006

Table 4 (*continued*)

Risk factor category	Number of studies	Studies finding significant association	Area of UQ affected	Odds ratio or other measure of effect/significance	95% CI	Level of evidence	Study references
Combination	5	4	Neck	2.03	1.29–3.19	Moderate	Szeto et al., 2009
				2.15–4.98	1.34–9.26		Trinkoff et al., 2003[c]
			Shoulder	2.09	1.11–3.89		Smith et al., 2006a
				1.81	1.34–2.44		Szeto et al., 2009
				2.40–6.13	1.43–11.98		Trinkoff et al., 2003[c]
				1.09	1.02–1.17		Trinkoff et al., 2006[b,c]
			Upper back	1.67	1.28–2.20		Szeto et al., 2009
Combined categories							
Full-time work + high ergonomic load	1	1	Neck	$p = .04$	--	Insufficient	Bru et al., 1996
Factor combining physical, organizational factors, effort and perceived risk	1	1	Upper back	2.96	1.02–8.59	Insufficient	Yeung et al., 2005

[a] For symptoms above threshold level.
[b] Prospective cohort study; odds/hazard ratios reflect incidence.
[c] Case definition for these studies: relevant symptom in the past year that lasted ≥1 week, or occurred at least monthly, with at least moderate pain on average (on a 5-point pain scale).

interval [CI] 1.43–4.35, $p < .05$) in only one study of nurses (Smith et al., 2006a). No significant association was found for alcohol consumption or exercise. Poorer general health, measured by13 items covering a variety of subjective health problems, was associated with WRUQMSD in one of the two studies that included general health as a variable (Alexopoulos et al., 2003). Smedley et al. (2003) found neck pain history to be antecedent to neck/shoulder MSD, and furthermore, more recent or longer duration of previous neck pain was associated with larger hazard ratios. There is insufficient evidence from these studies for a significant association of health behaviors or general health/prior history of MSD with WRUQMSDs in nurses and physicians.

Occupational factors examined were job tenure/career duration and clinical specialty. The internal medicine specialists in Smith et al.'s (2006b) study were significantly more likely to report an MSD in any of the three body regions (ORs [95% CIs]: neck 1.85 [1.02–3.38], shoulder 2.06 [1.11–3.86], upper back 2.19[1.15–4.17], $p < .05$) compared to their peers in intensive care and three surgical specialties, namely orthopedics, gynecology, and surgery. Of occupational factors, only job tenure demonstrated consistency of effect, in two studies (Camerino et al., 2001; Choobineh et al., 2006). Overall, there is limited evidence for a strong positive association of job tenure with WRUQMSDs in nurses.

4.4. Psychosocial workplace exposures

This category of risk factors includes such stressors as job demands, job control, decision authority, support from colleagues and supervisors, work schedule characteristics, workload, and work organization. Psychosocial workplace exposures were evaluated in all studies included in the synthesis. In the cross-sectional studies of nurses, significant associations with WRUQ MSDs were shown for inadequate social support (Smith et al., 2004) and mental pressure (Smith et al., 2004, 2006a); similarly, mental pressure and "inadequate discussion" were significant for physicians in Smith et al.'s (2006b) study. The term "inadequate discussion" signified the perception by the survey respondent that the amount of communication between management and staff was insufficient (D. R. Smith, personal communication, 2010) and was considered to be a manifestation of lack of supervisory support. In contrast, Szeto et al. (2009) found no effect in general surgeons for any psychosocial workplace exposure. Overall, we found moderate evidence for at least a moderate positive association between job demands and WRUQMSDs, and limited evidence for a strong negative association between social support at work and WRUQMSDs.

4.4.1. Work schedule factors

There is support for a relationship between nurses' schedule characteristics and WRUQMSDs. Trinkoff et al. (2006), in their longitudinal study, provided evidence that schedule characteristics are related to incidence of WRUQMSDs. In that study, participants were asked about aspects of work scheduling, including shift assignment (straight days or rotating), long shifts (13+ h), less than 10 h off between shifts, work while sick or on days off, mandatory overtime, on-call, most days worked without a day off, weekend work, and breaks during the workday. Several schedule characteristics was significantly associated with neck and shoulder MSDs; most striking was the nearly two and a half times greater risk of neck MSD in respondents who worked while sick (Trinkoff et al., 2006).

4.4.2. Effects of health care system changes

One survey of nurses (Lipscomb et al., 2004) measured the direct effects of the widespread adoption of managed care in the United States. These effects included heavier patient loads spread over fewer qualified staff, more part-time and temporary staff, and the need to supervise unlicensed staff in more complex patient care activities. After adjustment for demographic factors, psychosocial and physical demands, analysis showed that nurses who had experienced these changes were at greater risk for symptomatic upper quadrant MSDs than those without such experience. Of note, the risk for MSD of the neck was higher for those who had experienced more of these changes (OR [95% CI] 4.45 [1.97–10.08] for >6 changes vs. 2.18 [1.12–4.22] for 4–6 changes), suggesting a dose–response relationship (Lipscomb et al., 2004). Overall, there is moderate evidence for a moderate positive association between challenging work schedule and work organization factors and WRUQMSDs in nurses.

4.5. Physical workplace exposures

Fifteen studies explored the associations between physical risk factors – moving or lifting people or equipment, repetitive manual tasks and work in awkward (bent, twisted) postures – and WRUQMSDs. Of the studies that did not explore this category ($n = 3$), one of physicians (Smith et al., 2006b) and one of nurses (Mehrdad et al., 2010) focused only on psychosocial risk factors. The third was the paper limited to functional consequences (Trinkoff et al., 2002).

The effect of physical demands in nursing work on the development of WRUQMSDs was demonstrated by Trinkoff et al. (2003). A composite score was derived from 12 physical demand items and, after adjusting for confounding factors, there was a positive

relationship between the physical demand score and the likelihood of a WRUQMSD. Moreover, analysis of their longitudinal data examining the relationship of work schedule characteristics with WRUQMSDs revealed that physical demands partially accounted for the observed association (Trinkoff et al., 2006). This finding is supported by Szeto et al. (2009) who found only the reported physical workplace exposures were significantly associated with WRUQMSDs in their sample of general surgeons. On the whole, these studies provide at least moderate evidence for a positive association between physical workplace exposures and WRUQMSDs, except that evidence is limited for work in awkward postures.

4.6. Functional consequences of WRUQMSDs

Five cross-sectional studies discussed the functional consequences of WRUQMSDs on affected individuals. These included both studies of physicians and three studies of nurses. Findings from the two studies that reported extensively on functional consequences are shown in Table 5. Limitation of neck range of motion (Camerino et al., 2001), sleep disturbance (Camerino et al., 2001), job change (Choobineh et al., 2006; Smith et al., 2006b; Trinkoff et al., 2003) and leave of absence from work (Choobineh et al., 2006) were other noteworthy consequences.

Data on a large cohort of nurses ($n = 1163$) (Trinkoff et al., 2002) indicate that, quite apart from direct effects such as pain, WRUQMSDs lead to negative consequences for personal well-being. One measure of this is use of medications to relieve symptoms. Of those who fulfilled the case definition for neck and shoulder MSD, 32 and 31% respectively used muscle relaxants, which can cause sedation and dizziness (See and Ginzburg, 2008). Approximately half of the cases in the sample reported negative impact on domestic and recreational activities, which may create further stress on the affected individuals and their families.

5. Discussion

This review of risk factors for and functional consequences of WRUQMSDs in midwives, nurses and physicians encompassed 18 moderate quality studies published between 1996 and 2010. No studies analyzed midwives as a distinct occupational group.

Each risk factor category of the Bone and Joint Decade model was represented among the significant associations observed, supporting a multifactorial origin of WRUQMSD. Among nurses, work schedule characteristics were related to the occurrence of WRUQMSDs. Interestingly, neither study of physicians revealed any association between risk factors inherent to the worker and WRUQMSDs.

5.1. Risk factors inherent to the worker

That age was significant in only two studies is a surprising finding given its association with MSD in previous investigations (Panel on Musculoskeletal Disorders and the Workplace, 2001a). In a review of work-related musculoskeletal disorders in nurses (Sherehiy et al., 2004) older age was significantly associated with neck/shoulder MSDs. As age is often correlated with job tenure, this association may be due to the cumulative effects of long-term physical exposures. The interaction of age and job tenure or career duration is an area for further study, particularly in nurses given the increase in mature-age nursing students that has been observed in, for instance, the United States (National League for Nursing, 2011), the United Kingdom (Royal College of Nursing, 2008), and Australia (Gaynor et al., 2011).

Reviews of upper quadrant MSD in working and general populations have noted that females constitute the majority of affected

Table 5
Selected functional consequences (in %) of WRUQMSDs in nurses and physicians.

Author, year, Sample size	Body part	Medical evaluation or treatment				Medications					Effect on work	Other consequences			
		MD	Physio	Chiropractor	Other	Any	Analgesics		Steroids	Muscle relaxants	Any meds	Sick leave	↓ work hrs	↓ activities		↑discomfort at end of day	5–7days/week inadequate sleep
							OTC	Rx						Non-work	Recreational		
Szeto et al., 2009	Neck	7	7		2						40		11	31		87	
	Shoulder	8	8	7							54		8	46		77	
$n = 135$	Upper back	13	27								47		7	47		87	
Trinkoff et al., 2002[a]	Neck symptoms					16	91	8	5	14		3	15	20	27		17
$n = 1163$	cases					44	92	15	10	32		16	31	46	49		22
	Shoulder symptoms					17	91	7	7	19		35	22	26	37		17
	cases					51	93	17	14	31		46	39	57	55		21

[a] Case definition for this study: a relevant symptom with a duration of at least 1 week or occurring at least monthly in the past year; with a pain intensity of at least 3/5.

individuals (Larsson et al., 2007; Treaster and Burr, 2004) as observed in Trinkoff et al. (2003), although the wide confidence interval they determined suggests an imprecise estimation of the relationship. Studies have demonstrated that men do more heavy lifting than women in the same occupation (Messing, 2000). Since males are under-represented in nursing, gender differences may be difficult to detect with precision.

The possible confounding effect of leisure-time sports or exercise participation has not been well studied in samples of nurses and physicians. Sports such as tennis and weightlifting may predispose to the development of upper quadrant MSDs that in turn may be exacerbated by work exposures, although studies have shown a protective effect of leisure-time exercise (Hildebrandt et al., 2000; van den Heuvel et al., 2005). This question should be pursued in future research. However acquired, previous history of MSD does appear to increase future risk (Cole and Rivilis, 2004), suggesting that such a history should be routinely included as a variable in studies of WRUQMSD, particularly to examine associations between prior and prevalent or incident MSD in the same body area.

There is evidence that workstyle, a construct in the category of individual psychological factors, is associated with neck/upper extremity pain in office workers (Haufler et al., 2000; Nicholas et al., 2005). Workstyle was, however, not associated with WRUQMSD in Szeto et al.'s (2009) sample of general surgeons. This may reflect the true situation, but with a response rate of 27%, response bias is a consideration. Bru et al. (1993) posited that two personality traits, neuroticism and to a lesser extent irritability, may be associated with neck and shoulder pain in midwives. Although a small sample ($n = 37$), these results suggest individual psychological factors deserve further study to clarify their role in the development of WRUQMSDs.

The Bone and Joint Decade model proposes that coping strategies may mediate the effects of psychosocial or physical workplace exposures, but no study evaluated this variable. Future research should explore this potential mediator to validate its importance and determine its fit within the model.

5.2. Psychosocial workplace exposures

All studies in the synthesis investigated psychosocial workplace exposures, yet the majority failed to find significant associations. This may be due to study variables that were unable to capture all pertinent aspects of the psychosocial milieu, for example, failure to assess the impact of a new supervisor, fears over job security, or bullying. On the other hand, Yeung et al. (2005) showed a protective effect of a factor constructed from several positive psychosocial conditions. Qualitative research methods may be useful to clarify these relationships.

The possible relationship between demanding work schedule and other organizational characteristics and WRUQMSDs merits further inquiry. Three of ten cross-sectional studies and one longitudinal study examining these factors found a positive association. One of the cross-sectional studies, utilizing strict case definition criteria, found a dose–response relationship, thereby adding weight to its conclusions (Lipscomb et al., 2002).

The finding of greater than a twofold increase in risk for incident neck MSD in respondents who reported working while sick (Trinkoff et al., 2006) illustrates one of the harms of presenteeism, or the constellation of problems that can occur when employees report to work despite illness. The resulting inability to recover from illness, as well as such factors as 12-h shifts, the need to hold a second job and mandatory overtime act to reduce "downtime", the time available for rest and social interaction that can mitigate the effects of work stress (Carayon et al., 1999).

Job strain, the combination of high mental demands and low decision latitude (Karasek and Theorell, 1990), has been identified as a risk factor for MSD, the risk being greatest when job strain and high physical demands co-occur (Josephson et al., 1997). The relationship of psychosocial and physical exposures is not well explicated in the reviewed studies and requires further investigation. Testing the Bone and Joint Decade model, with coping as a mediator, may help explain the relationship.

5.3. Physical workplace exposures

Much has been written concerning the relationship between manual handling and low back pain, but the findings of this review clearly indicate the upper quadrant is also at risk. Smedley et al. (2003) observed that pushing/pulling seemed to be harder on subjects' shoulders than on their backs.

Repetition, though a significant factor in other occupational groups (Panel on Musculoskeletal Disorders and the Workplace, 2001b), was unexpectedly not associated with WRUQMSDs in nurses and physicians. Thirty-eight per cent of the sample in the study by Szeto et al. (2009) felt repetition was related to their MSDs, but as responses to this item were not all reported by body site, more investigation is required to elucidate the contribution of repetition to WRUQMSDs in these occupational groups.

Despite an apparent lack of consistency in this category, biological plausibility dictates that these exposures be considered in any study of WRUQMSDs. In the present review, analysis of study findings is made more difficult by heterogeneity in measurement of variables.

Evidence suggests that the interaction of risk factors is more likely to result in negative health outcomes compared to single risk factors (Devereux et al., 2002; Johnston et al., 2010). We noted this in particular in two studies. Bru et al. (1996) and Yeung et al. (2005) demonstrated significant associations between factors that combined exposures from different categories of the Bone and Joint Decade model and WRUQMSDs. These findings may be useful when constructing a model of causality.

5.4. Functional consequences

While one study focused solely on functional consequences, in general this appears to be an area lacking research attention. Only three papers that mentioned functional consequences included detailed information on specific consequences for study participants with WRUQMSDs. Nurses' responses to open-ended items in the Nurses' Worklife and Health Study survey suggested they had retired, changed jobs or were seriously considering these actions due to MSDs, further substantiating the idea that MSDs are important contributors to attrition in nursing (Geiger-Brown et al., 2004).

5.5. Other considerations

The Bone and Joint Decade model, while quite comprehensive, does not account for the feedback effect of a WRUQMSD on the developmental risk factors inherent to the worker, i.e. health behaviors, occupation, general health and comorbidities, and individual psychological factors. To cite just one example, a WRUQMSD could interfere with the ability to exercise, leading to a decline in physical and mental well-being. If severe enough, a WRUQMSD may even force a change of occupation.

A further challenge in studying risk factors using the Bone and Joint Decade model lies in the fact that some exposures resist easy categorization. Work organization has both physical and psychosocial components, and factors such as career duration could be viewed as occupational or demographic.

The studies reviewed here were conducted in Brazil, Canada, China, Great Britain, Greece, Hong Kong, Iran, Italy, Japan, the Netherlands, Norway, and the United States. This wide variety of settings contributes to the difficulty in synthesizing evidence as cultural, professional and organizational norms may have affected survey responses. Additionally, there are regulations aimed at protecting workers from developing MSDs in the European Union (Hignett et al., 2007) and Great Britain (The Manual Handling Operations Regulations, 1992). No included study examined the effect of protective regulations or the availability of lifting equipment in the study setting. Yassi et al. (2005) have postulated that increased workload on an aging workforce limits the effectiveness of such regulations.

Five studies (Lipscomb et al., 2002, 2004; Trinkoff et al., 2002, 2003, 2006) examined different variables from the same large sample of nurses in the American states of Illinois and New York. It is likely that there were midwives in that sample because regulations in Illinois stipulate nursing licensure as corequisite to midwifery practice, and in New York some certified nurse-midwives would maintain their nursing licensure even though it is not required for practice. Thus an opportunity to study risk factors for WRUQMSDs in midwives was missed, perhaps due in part to a widespread lack of recognition that midwifery and nursing are separate professions.

5.6. Methodological concerns

Despite the relatively high quality of the studies in the review, methodological problems were observed, including small sample size, very low or unusually high response rates, poorly defined exposure variables, failure to control for confounding, and disparate outcome measures that in some cases were not thoroughly described. Among study samples that were nearly 100% female, some researchers excluded males and others did not, which may have biased sampling. Some recruitment procedures as described raised questions of bias. As noted, the majority were cross-sectional designs, which cannot be used to impute causation. Self-report was widely employed to describe both exposures and outcomes and could have resulted in misclassification.

5.7. Strengths and limitations of the review

To our knowledge this is the first systematic review to include studies of both nurses and physicians. As midwives have already done, advanced practice nurses are increasingly assuming functions once reserved to physicians, and a review encompassing both professions is therefore timely. Additionally, this review focuses on the upper quadrant, which has been less thoroughly studied than the low back. This point is ably demonstrated in the review by Lorusso et al. (2007) who found 13 studies of low back pain that met their inclusion criteria but only four studies of upper quadrant MSDs. However, restriction of the review to English publications limited it by omission of potentially valuable foreign language articles and unpublished theses. In the search process relevant papers may have been missed inadvertently and the quality appraisal may not have correctly identified the most creditable studies.

6. Conclusions

WRUQMSDs in nurses and physicians are associated with foundational and developmental factors inherent to the worker, psychosocial and physical workplace exposures. The functional consequences of WRUQMSDs range from minor to quite serious and attrition from the professions can be expected to result.

Midwives, who thus far have not been well studied, are members of a unique profession sharing characteristics with nursing and medicine; hence, midwives may have similar WRUQMSD risk factors and functional consequences. They deserve to be studied as a discrete occupational group, using standardized tools and a variety of study designs to enhance the validity of the findings and explore causal relationships. Information thus gained may be useful in the design of strategies to prevent or minimize the occurrence of WRUQMSDs. Such strategies will have the ultimate aim of helping midwives remain professionally active to meet the future needs of childbearing women and babies.

Acknowledgment

The authors gratefully acknowledge the editorial assistance of Susan E.M. Kellett.

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