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Review Article

Prevalence of Musculoskeletal Disorders Among Farmers: A Systematic Review

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Objective *To determine the prevalence of musculoskeletal disorders (MSDs) among farmers and to establish the most common regional MSDs reported.*

Methods *Comprehensive electronic searches of Pubmed, Web of Science, CINAHL, SCOPUS, EMBASE, Agris Database, and Cochrane Library were carried out using keywords for MSDs and farmers. Pooled estimates of prevalence with 95% confidence intervals were calculated for overall MSD prevalence and the most common regional MSDs reported.*

Results *Twenty-four studies fulfilled the inclusion criteria and were incorporated into this review. From these studies, life-time prevalence of any form of MSD among farmers was 90.6% while 1-year MSD prevalence was 76.9% (95% CI 69.8–82.7). The majority of studies focused on spinal MSDs with low back pain (LBP) the most frequently investigated. Life-time LBP prevalence was 75% (95% CI 67–81.5) while 1-year LBP prevalence was 47.8% (95% CI 40.2–55.5). The next most common regional MSDs reported were upper (range 3.6–71.4%) and lower extremities (range 10.4–41%).*

Conclusions *The systematic review identified the prevalence of MSDs by body region in farmers and established that LBP was the most common MSD, followed by upper and then lower extremity MSDs. Reported trends suggest that the prevalence of MSDs in farmers is greater than in non-farmer populations. Case-definition uniformity among MSD researchers is warranted. More studies are needed regarding upper and lower extremity MSDs, gender, workplace, and task context of MSDs.* Am. J. Ind. Med. 55:143–158, 2012.

KEY WORDS: systematic review; musculoskeletal disorders; farmers; prevalence

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INTRODUCTION

Musculoskeletal disorders (MSDs) are defined as a group of disorders that affect the musculoskeletal system including the nerves, tendons, muscles, and supporting structures such as intervertebral discs [NIOSH, 1997]. MSDs affect millions of people around the world and are the most common cause of severe long-term pain and physical disability [Woolf and Pfleger, 2003]. Although MSDs can occur as a consequence of intrinsic pathological processes or as a result of acute injuries from a one-time trauma, they are most commonly a result of cumulative trauma, that is, repetitive minor traumas and biomechanical stresses [Kolstrup, 2008]. Work-related musculoskeletal disorders (WMSDs) describe disorders and diseases of the musculoskeletal system that are associated with cumulative traumas such as repetitive motion, excessive force, awkward and/or sustained postures, prolonged sitting and standing in the course of work [Da Costa and Vieira, 2010].

Due to the nature of farm work, which involves strenuous physical activities and high levels of manual labor, farmers and farm workers are at particular risk of developing WMSDs [Walker-Bone and Palmer, 2002; Rosecrance et al., 2006; Health and Safety Executive, 2007]. Examples of some of the work exposures that farmers face include lifting and carrying heavy loads, working with the trunk frequently flexed, risk of accidents caused by the unpredictable actions of livestock and exposure to vibration from farm vehicles and powered hand tools [Walker-Bone and Palmer, 2002]. A number of studies have reported that MSDs are the most common of all occupational non-fatal injuries and illnesses for farm workers [Hartman et al., 2006, Whelan et al., 2009]. The UK Health and Safety Executive [2007] established that workers in skilled agricultural trades had a higher prevalence of MSDs compared to all other industries, with back problems being the most common MSD. Other studies have reported an association between farming and the development of MSDs, while several highlight the association between the occupation and the prevalence of MSDs [Walker-Bone and Palmer, 2002; Hartman et al., 2006; Rosecrance et al., 2006].

Farmers are vulnerable to a range of MSDs including: osteoarthritis of the hip and knee, low back pain (LBP), upper limb disorders, and hand/arm vibration syndrome, as well as to the consequences of trauma such as sprains, fractures, and dislocations [Walker-Bone and Palmer, 2002]. Almost 60% of Southeast Kansas farmers reported that they experienced a farm work-related MSD symptom during the previous 12 months [Rosecrance et al., 2006]. A survey of self-reported work-related illness in Britain during 1995 found that 43,000 agricultural workers ascribed musculoskeletal symptoms to their occupation [Walker-Bone and Palmer, 2002].

MSDs can result in severe long-term pain and suffering for individuals. In addition to their physical effects, they can also lead to further negative consequences such as reduced work ability, lower farm income, poor quality of life, and the onset of other health problems such as stress or depression. In the Netherlands MSDs were found to be the main reason for sick leave among self-employed farmers [Hartman et al., 2006]. A study investigating disability among farmers in the Republic of Ireland found arthritis (31.4%) and back problems (17%) to be the most frequent illness/disease reported and farm income was lower on farms where the operator had a MSD-related disability [Whelan et al., 2009].

Although a number of epidemiological studies reporting on the prevalence of MSDs among farmers have been published, there has been no systematic review of the prevalence literature. A systematic review is required as study methods vary greatly across nation and in terms of type of farming, methodological quality, case definitions, or data extraction and analysis. Heterogeneity of this nature gives rise to a wide range of prevalence results and makes it difficult to identify a single prevalence for a specific body region. This review will be an important resource document for future researchers who study MSDs among farmers. The primary aim of this review was to systematically appraise peer-reviewed publications conducted with farmers to establish MSD prevalence trends among farmers for different body regions.

METHODOLOGY

Overview

The review comprised three phases. Phase 1 involved a systematic search of the literature using devised criteria and a search strategy based on key words. Phase 2 involved the initial screening of appropriate abstracts and subsequently, of full articles by two reviewers. Phase 3 involved classifying the internal validity of the included articles, and grading the strength of the evidence using established and validated tools.

Phase 1: Search Strategy

Comprehensive electronic searches of Pubmed, Web of Science, CINAHL, SCOPUS, EMBASE, Agris Database, and Cochrane Library were carried out covering the period January 1990 to February 2009. Relevant keywords were chosen with advice from two librarians, one in Health Sciences and the second in Veterinary Medicine and Agriculture. Two concepts of search terms (MeSH

TABLE I. Inclusion Criteria

Initial inclusion criteria	Detailed inclusion criteria
Titles relating to MSDs or farmers	Subjects aged 16 years plus (to capture those who undertake farm work on a regular basis)
Papers published 1990–2009	Studies establishing prevalence for MSDs
Studies written in English	Studies had to investigate farmers
	Studies had to provide own findings

headings and text words) were combined describing MSDs and farmers. This review took a broad definition of both MSDs and farmers in order to capture all relevant information within the electronic databases. The MSD keywords included: shoulder pain, elbow pain, hand pain, wrist pain, back pain, neck pain, cervical spine pain, hip pain, knee pain, ankle pain, foot pain, arthritis, bone/joint/muscle problem problems/pain pains/dysfunction dysfunctions, musculoskeletal problem problems/pain pains/dysfunction dysfunctions, orthopedic problem problems/pain pains/dysfunction dysfunctions, muscle strain, MSDs. Farmer keywords included: farmers, farmer, agriculture worker, farm worker, farming, breeder, cultivator, grower, harvester, plowman, sower, tiller, agronomist, stockman, granger, herdsman, agriculturalists, and shepherd. The farmer keywords focused on those who carry out similar work practices, that is, livestock and tillage farmers. Therefore, farmers such as aquaculture and forestry workers were excluded. All titles identified were merged into the reference management software package, Endnote (Version X1, Thomson Reuters, New York, NY).

Phase 2: Screening Process

Following elimination of duplicates, the potentially relevant studies were assessed against initial inclusion criteria (Table I). The abstracts of all studies meeting the initial inclusion criteria were then further scrutinized, by two researchers using more detailed inclusion criteria (Table I). If no abstract was available, or if it was unclear from the abstract whether a study should be included, the whole article was retrieved and read. The full text of all the remaining potentially relevant articles was evaluated by two researchers to ensure the eligibility of the article for inclusion in the review. Disagreements regarding study eligibility were resolved through focused discussions, and involvement of a third researcher until consensus was reached. A detailed pro-forma was developed and implemented by two researchers to extract and subsequently categorize the study design and results of each included article (n = 24). The search and selection results are presented in Figure 1.

Phase 3: Assessment of Methodological Quality

Methodological quality of the included prevalence studies was assessed according to the ''Guidelines for critical appraisal of the health research literature: prevalence or incidence of a health problem'' as proposed by Loney et al. [1998]. Each article was evaluated and scored according to eight criteria: (i) Study design and sampling method—this item was considered adequate if the study design was observational and if the sampling method

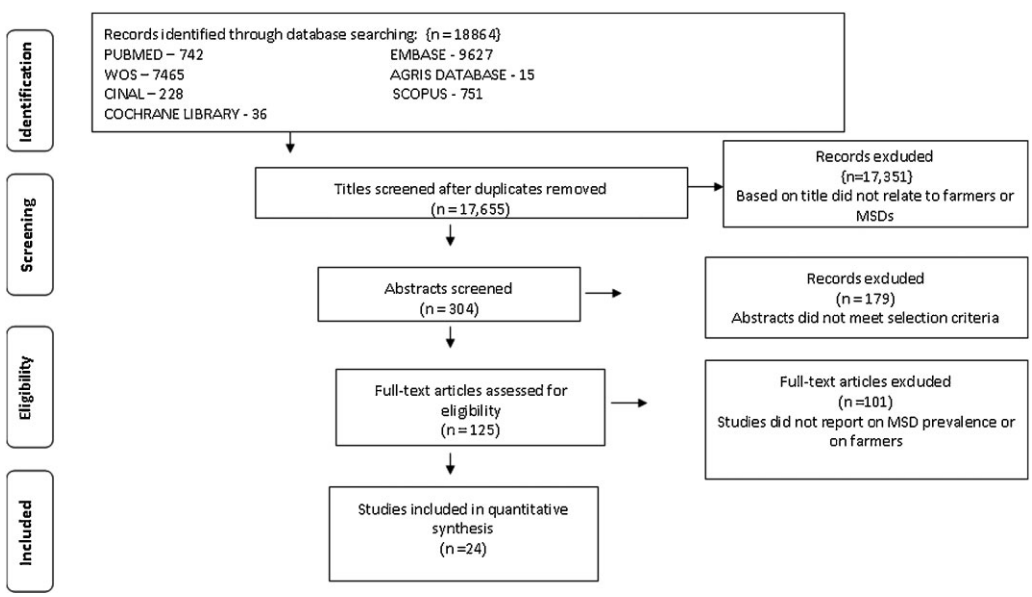

FIGURE 1. Stages of systematic review of studies investigating prevalence of musculoskeletal disorders among farmers.

included either the whole population or a random sample; (ii) sampling frame—considered adequate if the sampling frame was considered to have minimal bias (e.g., derived from census data); (iii) sample size—adequate if sample size was >300 subjects; (iv) appropriate measurement—adequate if objective was suitable and if standard criteria were used for measurement of the health outcome; (v) outcomes measured by independent assessors—considered adequate when the health outcome was measured objectively in an unbiased fashion, that the trained assessors were independent and not aware of the subjects' clinical status and that the farmers under assessment included those with and without the health problem; (vi) response rate—accepted if the response rate was 70% or greater and if an attempt was made to obtain information about reasons for non-participation and characteristics of the group of non-responders; (vii) results—accepted if the estimates of prevalence were given with confidence intervals and in detail by subgroup, if appropriate; and (viii) study subjects—accepted if the study subjects and the setting described in detail are similar to those of interest to this review.

Having applied these criteria, the findings were classified according to main body regions reported. Meta-analysis was carried out to statistically pool MSD and LBP prevalence results using standardized prevalence estimates from the studies. The analysis was performed using Meta-Analyst software [Wallace et al., 2009]. A random effects model was used as it makes the assumption that there is heterogeneity present among the studies that cannot be readily explained [Higgins and Green, 2011]. The number of cases of LBP/MSD, and total sample size were entered for individual studies and a pooled prevalence was calculated. Where the number of LBP/MSD cases was presented in relation to specific subgroups (e.g., gender) data were combined to provide total number of cases in the overall sample. This was necessary in the case of three studies [Manninen et al., 1996; Xiang et al., 1999; Park et al., 2001]. Forest plots were constructed for 1-year MSD prevalence and both lifetime and 1-year LBP prevalence for all studies.

RESULTS

Given the combined health science and agriculture theme, the electronic search resulted in the identification of a large number of titles (n = 18,864). The search functions of several of the databases, in particular Web of Science (n = 7,465) and EMBASE (n = 9,627) did not allow advanced search strings, thus these searches returned a high volume of titles. Following elimination of duplicates (n = 1,209), the potentially relevant articles (n = 17,655) were assessed against initial inclusion and exclusion criteria. Over-representation of irrelevant agricultural and health terms in titles resulted in many of the articles being excluded (n = 17,351). The abstracts of all studies meeting the initial inclusion criteria (n = 304) were then further scrutinized and the full text of all potentially relevant articles (n = 125) was evaluated, resulting in the final articles for inclusion (n = 24). The search and selection results are presented in Figure 1.

In total, 24 articles using four distinctive methodologies were included in the review (Table II): cross-sectional (n = 17), case-controlled (n = 3), prospective cohort (n = 2), and retrospective cohort (n = 2) studies. All studies dealt with the prevalence of MSDs among farmers. The studies yielded a range of prevalence estimates: point (n = 3), period (n = 7), 1-year (n = 21), and lifetime (n = 4). MSDs were classified using a range of validated measures: modified version of the Standardized Nordic Questionnaire (n = 10) [Bovenzi and Betta, 1994; Gustafsson et al., 1994; Hildebrandt, 1995; Stal et al., 1996; Toren et al., 2002; Gomez et al., 2003; Stål and Englund, 2005; Kolstrup et al., 2006; Rosecrance et al., 2006; Nonnenmann et al., 2008], the International Classification of Diseases code (n = 4) [Holmberg et al., 2002; Greenlee et al., 2005; Thelin and Holmberg, 2007; Thelin et al., 2009], 1988 National Health Interview Survey (n = 3) [Xiang et al., 1999; Park et al., 2001; Shipp et al., 2009], non-validated definitions (n = 4) [Croft et al., 1992; Manninen et al., 1996; Firth et al., 2002; Cameron et al., 2006]. A small number did not provide any definition (n = 3) [Scutter et al., 1997; McNeill and O'Neill, 1998; O'Sullivan et al., 2009]. The study sample sizes ranged from 79 to 11,368 farmers. The response rate varied from 41.9% to 96%.

Methodological Quality

The 24 eligible studies were assessed using guidelines for critical appraisal described by Loney et al. [1998]. The quality scores ranged from 2 to 8 points. Studies were classified as high quality (>6 points), moderated quality (>4 points), or low quality (<4 points). The critical appraisal results and overall methodological quality scores are summarized in Table II. In total 10 studies were rated as high quality [Croft et al., 1992; Bovenzi and Betta, 1994; Xiang et al., 1999; Holmberg et al., 2002; Gomez et al., 2003; Greenlee et al., 2005; Stål and Englund, 2005; Cameron et al., 2006; Thelin and Holmberg, 2007; Thelin et al., 2009], 11 studies as moderate quality [Gustafsson et al., 1994; Hildebrandt, 1995; Manninen et al., 1996; Stal et al., 1996; Park et al., 2001; Firth et al., 2002; Toren et al., 2002; Kolstrup et al., 2006; Rosecrance et al., 2006; Nonnenmann et al., 2008; Shipp et al., 2009], and three recorded low methodological quality [Scutter et al., 1997; McNeill and O'Neill, 1998; O'Sullivan et al., 2009]. Articles generally scored well in areas of clearly

TABLE II. Summary of Included Studies

Study	Participant	Type	Results—prevalence of MSDs					Quality score range 1–8
			Any MSD	Spinal	Upper extremity	Lower extremity	Other	
Bovenzi and Betta [1994] Northern Italy	Tractor drivers: n = 1,155 (M) Office workers: n = 220 (M)	CC Q&I		Back pain—*Lifetime prevalence*: Tractor drivers: n = 995 (86.1%); Office workers: n = 126 (57.3%); OR 1.83, 95% CI 1.13–2.97 LBP—*Lifetime prevalence*: Tractor drivers: n = 939 (81.3%); Office workers: n = 93 (42.3%); OR 3.22, 95% CI 2.09–5.17 *1 year prevalence*: Tractor drivers: n = 828 (71.7%); Office workers: n = 8 (36.8%); OR 2.39, 95% CI 1.57–3.66 *1 month prevalence*: Tractor drivers: n = 453 (39.2%); Office workers: n = 4 (18.6%); OR 1.62, 95% CI 1.01–2.59				6.5
Cameron et al. [2006] USA	Homestead: n = 214 (M) (F) Kankakee: n = 211 (M) (F)	C/S Q&I		Back pain—*1 year prevalence*: Homestead: n = 39.4%, SE = 3.9; Kankakee: n = 24.2%, SE = 3.0				6
Croft et al. [1992] England	Farmers: n = 179 (M) Office workers: n = 71 (M)	CC Q&I				Hip osteoarthritis—*Farmed for at least* 1 year: 60–65 years: n = 8 (13.8%); 66–70 years: n = 7 (13.0%); 71–76 years: n = 13 (23.6%) Office workers: 60–65 years: n = 1 (2.7%); 66–70 years: n = 0 (0%); 71–76 years: n = 1 (5.0%)		6
Firth et al. [2002] New Zealand	Farmers: n = 586 (M) (F)	C/S MQ		LBP—*Lifetime prevalence*: n = 442 (75.4%) *1 year prevalence*: n = 320 (54.6%); Dairy: n = 50/270 (55.6%); Pastoral: n = 138/239 (57.7%); Arable: n = 5/14 (35.7%); Horticulture: n = 12/24 (50%); Other: n = 15/39 (38.5%)				4.5
Gomez et al. [2003] USA	Farmers: n = 1,706 (M) (F)	C/S TI		Neck and shoulder—*1 year prevalence*: n = 593 (35%) *7 day prevalence*: n = 768 (45%) LBP—*1 year prevalence*: n = 692 (41%) *7 day prevalence*: n = 631 (37%)	Hand and wrist—*1 year prevalence*: n = 457 (28%) *7 day prevalence*: n = 835 (49%)	Hip—*1 year prevalence*: n = 255 (15%) *7 day prevalence*: n = 818 (48%) Knee—*1 year prevalence*: n = 498 (29%) *7 day prevalence*: n = 750 (44%)	One or more joint areas—*1 year prevalence*: n = 1,240 (73%) *7 day prevalence*: n = 870 (51%)	6

(*Continued*)

TABLE II. (*Continued*)

Study	Participant	Type	Results—prevalence of MSDs					Quality score range 1–8
			Any MSD	Spinal	Upper extremity	Lower extremity	Other	
Greenlee et al. [2005] USA	Farm residents: n = 6,269 (M) (F) Non-farm residents: n = 75,354 (M) (F)	RC MESA		Back pain—*Lifetime prevalence*: Farm residents: n = 334.5/1,000 persons (33.5%); Non-farm residents: n = 329.2/1,000 persons (33%) SR 1.04, 95% CI 1.00–1.08 (age adjusted to general population)			Osteoarthritis—*Lifetime prevalence*: Farm residents: n = 152/1,000 persons (15.2%); Non-farm residents: n = 139.6/1,000 persons (14%) SR 1.12, 95% CI 1.05–1.19 (Age adjusted to general population)	6
Gustafsson et al. [1994] Sweden	Dairy farmers: n = 2,087 (M); n = 920 (F)	C/S MQ	MSD—*1 year prevalence*: M: n = 1,711 (82%); F: n = 791 (86%)	Neck—*1 year prevalence*: M: n = 521 (25%); F: n = 322 (35%) Upper back—*1 year prevalence*: M: n = 250 (12%); F: n = 165 (18%) LBP—*1 year prevalence*: M: n = 1,147 (55%); F: n = 460 (50%)	Shoulder—*1 year prevalence*: M: n = 772 (37%); F: n = 450 (49%) Elbow—*1 year prevalence*: M: n = 375 (18%); F: n = 202 (22%) Hand and wrist—*1 year prevalence*: M: n = 375 (18%); F: n = 322 (35%)	Hip—*1 year prevalence*: M: n = 480 (23%); F: n = 248 (27%) Knee—*1 year prevalence*: M: n = 855 (41%); F: n = 340 (37%) Foot—*1 year prevalence*: M: n = 271 (13%); F: n = 147 (16%)		5.5
Hildebrandt [1995] Netherlands	Farmers: n = 2,580 (M); Employers: n = 946; Employees: n = 1,634	C/S MQ	MSD—*1 year prevalence*: Employers: n = 671 (71%); Employees: n = 1,225 (75%)	Neck and shoulder—*1 year prevalence*: Employers: n = 283 (30%); Employees: n = 571 (35%) LBP—*1 year prevalence*: Employers: n = 444 (47%); Employees: n = 833 (51%)		Knee—*1 year prevalence*: Employers: n = 160 (17%); Employees: n = 359 (22%)		4.5
Holmberg et al. [2002] Sweden	Farmers: n = 1,013 (M); Non-farmers: n = 769 (M)	C Q&I	MSD—*Lifetime prevalence*: Farmers: n = 918 (90.6%); Non-farmers: n = 665 (86.5%) OR 1.51, 95% CI 1.13–2.03	Neck and shoulder—*Lifetime prevalence*: Farmers: n = 574 (56.8%); Non-farmers: n = 408 (53.2%); OR 1.16, 95% CI 0.96–1.40 *1 year prevalence*: Farmers: n = 467 (46.5%); Non-farmers: n = 332 (43.7%); OR 1.12, 95% CI 0.93–1.35 LBP—*Lifetime prevalence*: Farmers: n = 686 (68.3%); Non-farmers: n = 445 (58.3%); OR 1.54, 95% CI 1.26–1.87 *1 year prevalence*: Farmers: n = 473 (47.2%); Non-farmers: n = 293 (38.6%); OR 1.42, 95% CI 1.17–1.72	Hands and forearms (numbness or paresthesia)—*Lifetime prevalence*: Farmers: n = 361 (35.7%); Non-farmers: n = 223 (29.2%); OR 1.35, 95% CI 1.10–1.65 Hands and forearms (nocturnal aches)—*Lifetime prevalence*: Farmers: n = 162 (16%); Non-farmers: n = 93 (12.2%); OR 1.38, 95% CI 1.05–1.81	Hip—*Lifetime prevalence*: Farmers: n = 318 (31.7%); Non-farmers: n = 160 (21%); OR 1.74, 95% CI 1.40–2.17 Hips, groin, and thighs—*1 year prevalence*: Farmers: n = 203 (20.2%); Non-farmers: n = 116 (15.2%); OR 1.41, 95% CI 1.10–1.81 Groin/thigh—*Lifetime prevalence*: Farmers: n = 139 (13.9%); Non-farmers: n = 96 (12.6%); OR 1.12, 95% CI 0.85–1.48 Knee—*Lifetime prevalence*: Farmers: n = 471 (46.7%); Non-farmers: n = 338 (44.2%); OR 1.11, 95% CI 0.98–1.48 *1 year prevalence*: Farmers: n = 305 (30.3%); Non-farmers: n = 202 (26.5%); OR 1.20, 95% CI 0.98–1.48		8

(*Continued*)

TABLE II. (*Continued*)

Study	Participant	Type	Results—prevalence of MSDs					Quality score range 1–8
			Any MSD	Spinal	Upper extremity	Lower extremity	Other	
Kolstrup et al. [2006] Sweden	Dairy farmers: n = 10 farms, 42 workers; (M: n = 28); (F: n = 14) Pig farmers: n = 10 farms, 37 workers; (M: n = 19); (F: n = 18)	C/S PQ&I	MSD—*1 year prevalence*: Dairy farmers: n = 36 (85.7%) (M) (F); n = 23 (82.1%) (M); n = 13 (92.9%) (F) Pig farmers: n = 29 (78.4%) (M) (F); n = 14 (73.7%) (M); n = 15 (83.3%) (F)	Neck—*1 year prevalence*: Dairy farmers: n = 14 (33.3%) (M) (F); n = 7 (25%) (M); n = 7 (50%) (F) Pig farmers: n = 12 (32.4%) (M) (F); n = 3 (15.8%) (M); n = 9 (50%) (F) Back—*1 year prevalence*: Dairy farmers: n = 25 (59.5%) (M) (F); n = 15 (53.6%) (M); n = 10 (71.4%) (F) Pig farmers: n = 21 (56.8%) (M) (F); n = 9 (47.4%) (M); n = 12 (66.7%) (F) Upper back—*1 year prevalence*: Dairy farmers: n = 11 (26.2%) (M) (F); n = 5 (17.9%) (M); n = 6 (42.9%) (F) Pig farmers: n = 8 (21.6%) (M) (F); n = 3 (15.8%) (M); n = 5 (27.8%) (F) LBP—*1 year prevalence*: Dairy farmers: n = 17 (40.5%) (M) (F); n = 10 (35.7%) (M); n = 7 (50%) (F) Pig farmers: n = 18 (48.6%) (M) (F); n = 8 (42.1%) (M); n = 10 (55.6%) (F)	Shoulders—*1 year prevalence*: Dairy farmers: n = 20 (47.6%) (M) (F); n = 10 (35.7%) (M); n = 10 (71.4%) (F) Pig farmers: n = 16 (43.2%) (M) (F); n = 6 (31.6%) (M); n = 10 (55.6%) (F) Elbows—*1 year prevalence*: Dairy farmers: n = 4 (9.5%) (M) (F); n = 1 (3.6%) (M); n = 3 (21.4%) (F) Pig farmers: n = 6 (16.2%) (M) (F); n = 0 (0%) (M); n = 6 (33.3%) (F) Hands and wrists—*1 year prevalence*: Dairy farmers: n = 11 (26.2%) (M) (F); n = 3 (10.7%) (M); n = 8 (57.1%) (F) Pig farmers: n = 14 (37.8%) (M) (F); n = 8 (42.1%) (M); n = 6 (33.3%) (F)	Hips—*1 year prevalence*: Dairy farmers: n = 6 (14.3%) (M) (F); n = 3 (10.7%) (M); n = 3 (21.4%) (F) Pig farmers: n = 4 (10.8%) (M) (F); n = 2 (10.5%) (M); n = 2 (11.1%) (F) Knees—*1 year prevalence*: Dairy farmers: n = 10 (23.8%) (M) (F); n = 6 (21.4%) (M); n = 4 (28.6%) (F) Pig farmers: n = 11 (29.7%) (M) (F); n = 5 (26.3%) (M); n = 6 (33.3%) (F) Feet—*1 year prevalence*: Dairy farmers: n = 6 (14.3%) (M) (F); n = 4 (14.3%) (M); n = 2 (14.3%) (F) Pig farmers: n = 5 (13.5%) (M) (F); n = 2 (10.5%) (M); n = 3 (16.7%) (F)		4.5
Manninen et al. [1996] Finland	Farmers (1979): n = 11,368 (M) (F) Farmers (1992): (M) n = 3,237 (F)	C/S 1979: PQ 1992: TI		Neck and shoulder *1 year prevalence* (1979): All (M): 62.3% — All (F): 68.4% 18–34 yrs: 42.9% — 18–34 yrs: 44.9% 35–44 yrs: 58.9% — 35–44 yrs: 64.9% 45–54 yrs: 67.9% — 45–54 yrs: 75.9% 55–64 yrs: 69.9% — 55–64 yrs: 75% Total (M) (F): 65.1%, 95% CI 67.9–71.2 *1 year prevalence* (1992): All (M): 54.7% — All (F): 66.6% 18–34 yrs: 49.6% — 18–34 yrs: 58.6% 35–44 yrs: 55.7% — 35–44 yrs: 68.6% 45–54 yrs: 54.4% — 45–54 yrs: 69.5% 55–64 yrs: 57.5% — 55–64 yrs: 69% Total (M) (F): 59.7%, 95% CI 54.3–64.2 LBP *1 year prevalence* (1979): All (M): 71.3% — All (F): 69.8% 18–34 yrs: 56.9% — 18–34 yrs: 57.9% 35–44 yrs: 68.9% — 35–44 yrs: 68.9% 45–54 yrs: 75.9% — 45–54 yrs: 74.9%				5.5

(*Continued*)

TABLE II. (*Continued*)

Study	Participant	Type	Results—prevalence of MSDs					Quality score range 1–8
			Any MSD	Spinal	Upper extremity	Lower extremity	Other	
				55–64 yrs: 73.9% Total (M) (F): 70.4%, 95% CI 69.1–72.2 *1 year prevalence* (1992): All (M): 60.4% 18–34 yrs: 54.8% 35–44 yrs: 61.9% 45–54 yrs: 59.8% 55–64 yrs: 62.6% Total (M) (F): 58.2%, 95% CI 56.2–61.5	55–64 yrs: 72.9% All (F): 56.9% 18–34 yrs: 50.8% 35–44 yrs: 59.9% 45–54 yrs: 58.8% 55–64 yrs: 56.8%			
McNeill and O'Neill [1998] Ghana, Africa	Farmers: n = 100 (M)	C/S Q		Back pain *1 year prevalence:* n = 76 (76%) LBP *Point prevalence:* n = 48 (48%); *1 year prevalence:* n = 77 (77%)				2
Nonnenmann et al. [2008] USA	Dairy Farmers: n = 341 (M) (F)	C/S MQ	MSD *1 year prevalence*: n = 255 (75%)	Neck *1 year prevalence:* n = 148 (43%)	Shoulder *1 year prevalence:* n = 183 (54%) Elbow *1 year prevalence:* n = 82 (24%) Hand and wrist *1 year prevalence:* n = 137 (40%)		MSD symptoms in two or more sites *1 year prevalence*: n = 155 (45%)	5
O'Sullivan et al. [2009] Ireland	Farmers: n = 104 (M) (F)	C/S Q		LBP *Lifetime prevalence:* n = 77 (74%); *1 Year prevalence:* n = 56 (54%); *Point prevalence:* n = 28 (27%); *Everyday for a week or more in the previous year:* n = 42 (40%)				3
Park et al. [2001] Iowa, USA	Iowa farmers (1995): n = 287 (M) U.S. farmers (1988): n = 408 (M)	C/S MQ		Back pain—*1 year prevalence*: Iowa farmer: n = 89 (31%); U.S. farmer: n = 81 (19.9%); OR 1.78, 95% CI 1.23–2.58 Upper and middle back—*1 year prevalence*: Iowa farmer: n = 14 (4.9%); U.S. farmer: n = 20 (4.9%); OR 0.44, 95% CI 0.18–1.11 LBP—*1 year prevalence*: Iowa farmer: n = 73 (25.4%); U.S. farmer: n = 58 (14.2%)				5.5
Rosecrance et al. [2006] Kansas, USA	Farmers: n = 266 (M) (F)	C/S MQ	MSD—*1 year prevalence*: n = 160 (60%)	Neck—*1 year prevalence:* n = 58 (22.4%) Back pain—*Every day for a week:* n = 92 (36.4%) (respondents = 253)	Shoulder—*1 year prevalence:* n = 66 (25.9%) Elbow—*1 year prevalence:* n = 15 (5.8%)	Hip/thigh—*1 year prevalence*: n = 27 (10.4%) Knee—*1 year prevalence*: n = 61 (23.6%)	Farm-related injury—*1 year prevalence*: n = 42 (15.9%)	4.5

(*Continued*)

TABLE II. (*Continued*)

Study	Participant	Type	Results—prevalence of MSDs					Quality score range 1–8
			Any MSD	Spinal	Upper extremity	Lower extremity	Other	
				Upper back—*1 year prevalence:* n = 43 (16.7%) LBP—*1 year prevalence:* n = 97 (37.5%)	Hand and wrist—*1 year prevalence:* n = 31 (12%)	Foot—*1 year prevalence:* n = 39 (15.1%)		
Scutter et al. [1997] South Australia	Farmers: n = 179 (M)	C/S Q		Neck pain—*All day, everyday:* n = 9 (5%); *At least once per day:* n = 22 (12.3%); *At least once per week:* n = 29 (16.2%); *Less than once per week:* n = 79 (44.1%); *Never:* n = 40 (22.3%)			Headache—*All day, everyday:* n = 2 (1.3%); *At least once per day:* n = 5 (2.7%); *At least once per week:* n = 31 (17.3%); *Less than once per week:* n = 104 (58.2%); *Never:* n = 37 (20.8%)	3
Shipp et al. [2009] Texas, USA	Migrant farm workers: year 1: n = 390; Year 2: n = 265 (M) (F)	C/S QI		Back pain—*1 year prevalence* (Year 1): Mother: 33.3%, 95% CI 24.9–42.6%; Father: 23.8%, 95% CI 15.9–33.3%; Oldest child: 15.7%, 95% CI 8.1–26.4%; Youngest child: 9.5%, 95% CI 1.1–30.3% *1 year prevalence* (year 2): Mother: 28.2%, 95% CI 19.7–37.9%; Father: 21.1%, 95% CI 13.4–30.6%; Oldest child: 15.6%, 95% CI 7.8–26.9%				5.5
Stal et al. [1996] Sweden	Milkers: n = 161 (F) Non-milkers: n = 108 (F) Ex-milkers: n = 62 (F) Nurse assistants: n = 166 (F)	CC MQ	MSD—*1 year prevalence:* Milkers: n = 136 (84%); Non-milkers: n = 92 (85%); Ex-milkers: n = 54 (87%); Nurse assistants: n = 125 (75%)		Neck and shoulders and elbows/wrists/hands[a]—*1 year prevalence:* Milkers: n = 35 (21%); Non-milkers: n = 22 (20%); Ex-milkers: n = 12 (19%); Nurse assistants: n = 20 (12%); Milker and Nurse assistant: OR 1.92, CI 95% 1.06–3.47 Shoulders and elbows/wrists/hands—*1 year prevalence:* Milkers: n = 54 (33%); Non-milkers: n = 33 (30%); Ex-milkers: n = 22 (34%); Nurse assistants: n = 28 (16%); Milker and Nurse assistant: OR 2.49, CI 95% 1.48–4.19			4.5
Stal et al. [2005] Sweden	Pig farmers: n = 288 (M) (F); n = 202	C/S MQ		Neck—*1 year prevalence:* <34 yrs: 50%(M) 86%(F); 34–42 yrs: 30%(M) 50%(F); 43–50 yrs: 47% (M) 43%(F); >50 yrs: 40%(M)	Shoulder—*1 year prevalence:* <34: 26%(M) 56%(F); 34–42: 38%(M) 65%(F); 43–50: 45%(M) 71%(F); >50: 52%(M)			6

(*Continued*)

TABLE II. (*Continued*)

Study	Participant	Type	Results—prevalence of MSDs					Quality score range 1–8
			Any MSD	Spinal	Upper extremity	Lower extremity	Other	
	(M); n = 86 (F)			30%(F); All: 39%(M) 43%(F); RR 1.08, 95% CI 0.79–1.47	70%(F); All: 38%(M) 60%(F); RR 1.72, 95% CI 1.33–2.22 Elbow—*1 year prevalence:* <34: 22%(M) 13%(F); 34–42: 27%(M) 27%(F); 43–50: 33%(M) 21%(F); >50: 23%(M) 50%(F); All: 26%(M) 22%(F); RR 0.96, 95% CI 0.61–1.50 Wrist/hand—*1 year prevalence:* <34: 50%(M) 52%(F); 34–42: 29%(M) 65%(F); 43–50: 33%(M) 33%(F); >50: 31%(M) 90%(F); All: 33%(M) 53%(F); RR 1.61, 95% CI 1.23–2.11			
Thelin et al. [2007] Sweden	Farmers: n = 1,220 (M) Non-farmers (rural men): n = 1,130 (M) Urban controls: n = 1,087 (M)	PC R					Osteoarthritis any site—*13 year period:* Farmers: n = 72 (5.9%); Non-farmers: n = 38 (3.4%); Urban controls: n=30 (2.8%) Hip osteoarthritis—*13 year period:* Farmers: n = 51 (4.2%); Non-farmers: n = 22 (1.9%); Urban controls: n = 15 (1.4%)	6
Thelin et al. [2009] Sweden	Farmers: n = 1,220 (M) Non-farmers (rural men): n = 1,130 (M) Urban controls: n = 1,087 (M)	PC R					MSD based on hospital admissions and deaths—*13 year period:* Farmers: n = 135 rate = 111; OR 1.47, 95% CI 1.10–1.95; Own Calculation = 11%	6
Toren et al. [2002] Sweden	Tractor drivers: n = 1,075 (M) (F)	C/S MQ		LBP—*1 year prevalence:* (Total (F); n = 103); n = 75 (73%); (Total (M); n = 874); n = 517 (59%); (Total (M) (F); n = 977); n = 595 (61%)		Hips—*1 year prevalence:* (Total (F); n = 97); n = 32 (33%); (Total (M); n = 843); n = 278 (33%); (Total (M) (F); n = 940); n = 311 (33%)		5
								7.5

(*Continued*)

TABLE II. (*Continued*)

Study	Participant	Type	Results—prevalence of MSDs					Quality score range 1–8
			Any MSD	Spinal	Upper extremity	Lower extremity	Other	
Xiang et al. [1999] USA	Farmers: n = 742 (M) (F); n = 448 (M); n = 294 (F)	C/S Q&I		Back—*1 year prevalence:* n = 194 (26.2%) (M) (F); n = 128 (28.6%) (M); n = 66 (22.5%) (F); *P*-value = 0.054 Upper back—*1 year prevalence:* n = 16 (3.6%) (M) n = 9 (3.1%) (F) Middle back—*1 year prevalence:* n = 11 (2.5%) (M); n = 9 (3.1%) (F) LBP—*1 year prevalence:* n = 97 (21.7%) (M); n = 43 (14.6%) (F) Unknown back area—*1 year prevalence:* n = 4 (1%) (M); n = 5 (1.7%) (F); *P*-value = 0.390				

M, male; F, female; CC, case–control; C/S, cross-sectional; Q&I, questionnaire and interview; LBP, low back pain; SE, standard error; C, cohort; RC, retrospective cohort; MESA; observed Marshfield Epidemiologic Study Area data; MQ, mailed questionnaire; TI, telephone interview; PQ&I, postal questionnaire and interview; PQ, postal-questionnaire; Q, questionnaire; PC, prospective-cohort; R, register of hospital care and surgery; yrs, years.

[a]Neck problem could not be extracted since composite figure reported.

stating study objectives, appropriate study design and sampling methods, with study subjects and setting described of interest. Methodological limitations identified in a majority of articles were inappropriate sampling frame, inadequate sample size, bias in measurement of health outcome, and estimates of prevalence not given with confidence intervals and in detail by subgroup.

MSD Prevalence

The findings were classified into three regions: spinal, upper extremities, lower extremities, and other. The studies yielded a range of prevalence estimates including point, period, 1-year, and lifetime. Table II summarizes information regarding study characteristics and prevalence results. The majority of studies (n = 11) focused only on the prevalence of spinal MSDs [Bovenzi and Betta, 1994; Manninen et al., 1996; Scutter et al., 1997; McNeill and O'Neill, 1998; Xiang et al., 1999; Park et al., 2001; Firth et al., 2002; Greenlee et al., 2005; Cameron et al., 2006; O'Sullivan et al., 2009; Shipp et al., 2009]. Five studies [Gustafsson et al., 1994; Holmberg et al., 2002; Gomez et al., 2003; Kolstrup et al., 2006; Rosecrance et al., 2006] examined MSDs of the entire body categorized into the three body regions: spinal, upper extremities, lower extremities, and the remaining studies investigated MSDs involving a range of body part combinations [Croft et al., 1992; Hildebrandt, 1995; Stal et al., 1996; Toren et al., 2002; Stål and Englund, 2005; Thelin and Holmberg, 2007; Nonnenmann et al., 2008; Thelin et al., 2009].

Only one of the 24 studies [Holmberg et al., 2002] investigated farmers' lifetime prevalence of experiencing any MSDs (90.6%). Six studies [Gustafsson et al., 1994; Hildebrandt, 1995; Stal et al., 1996; Kolstrup et al., 2006; Rosecrance et al., 2006; Nonnenmann et al., 2008] reported 1-year prevalence of experiencing any MSDs (range 60–92.9%) with overall pooled result of 76.9% (95% CI 69.8–82.7) Figure 2. The 1-year MSD prevalence range reported for females, when considered separately ranged from 83.3% to 92.9% [Gustafsson et al., 1994; Stal et al., 1996; Kolstrup et al., 2006], approximately 10% higher than that recorded when compared to the male cohort (prevalence range 71–82.1%) [Gustafsson et al., 1994; Hildebrandt, 1995; Kolstrup, 2008].

MSD Diagnosis

LBP was the most commonly studied MSD [Bovenzi and Betta, 1994; Gustafsson et al., 1994; Hildebrandt, 1995; Manninen et al., 1996; McNeill and O'Neill, 1998; Xiang et al., 1999; Park et al., 2001; Firth et al., 2002; Holmberg et al., 2002; Toren et al., 2002; Gomez et al., 2003; Kolstrup et al., 2006; Rosecrance et al., 2006; O'Sullivan et al., 2009]. Life-time LBP prevalence ranged from 68.3% to 81.3% [Bovenzi and Betta, 1994; Firth et al., 2002; Holmberg et al., 2002; O'Sullivan et al., 2009] with an overall pooled estimate of 75% (95% CI 67.0–81.5) Figure 2. One-year LBP prevalence ranged from 14.2% to 77% [Bovenzi and Betta, 1994; Gustafsson et al., 1994; Hildebrandt, 1995; Manninen et al., 1996; McNeill and O'Neill, 1998; Xiang et al., 1999; Park et al., 2001; Firth et al., 2002; Holmberg et al., 2002; Toren et al., 2002; Gomez et al., 2003; Kolstrup et al., 2006; Rosecrance et al., 2006; O'Sullivan et al., 2009] with overall pooled prevalence of 47.8% (95% CI 40.2–55.5) Figure 2. The 1-year LBP prevalence range reported for female farmers was 14.6–73% [Gustafsson et al., 1994; Manninen et al., 1996; Xiang et al., 1999; Toren et al., 2002; Kolstrup et al., 2006] while the 1-year LBP prevalence range for male farmers was 14.2–71.7% [Bovenzi and Betta, 1994; Gustafsson et al., 1994; Hildebrandt, 1995; Manninen et al., 1996; McNeill and O'Neill, 1998; Xiang et al., 1999; Park et al., 2001; Holmberg et al., 2002; Toren et al., 2002; Kolstrup et al., 2006].

DISCUSSION

This is the first systematic review of epidemiological literature considering the prevalence of MSDs among farmers. In order to ensure all relevant studies were included in this review, multiple search terms were used for the word farmer including farm workers, migrant farm workers, farm employees, farm employers, farm residents. Table II includes the descriptions of participants provided by the primary authors of the studies included in this review. While the search strategy developed for this review did not constrain itself to WMSDs, the results established that most MSD research concerning farmers and farm workers relates to WMSDs. Twenty-four research studies were identified for inclusion in this review. Using accepted critical appraisal criteria, 10 of these articles were considered of high methodological quality, 11 of moderate quality, and 3 of poor quality.

The review found substantial heterogeneity between countries, type of farming, methodological quality, case definitions, and data extraction and analysis. The high level of heterogeneity made it difficult to establish single prevalence results for specific body regions. In drawing attention to these issues, it is hoped that this review will be helpful in focusing the efforts of researchers and thereby avoiding these problems in the future.

Of the various approaches to estimating prevalence of MSDs among farmers, 1-year prevalence is the most widely applied. When reporting MSDs for the same body part, variations were noted in the range of prevalence rates. Explanation for this might be due to the varied methodological quality of the studies, particularly the difference in MSD case definition. The prevalence rates in the 10 higher

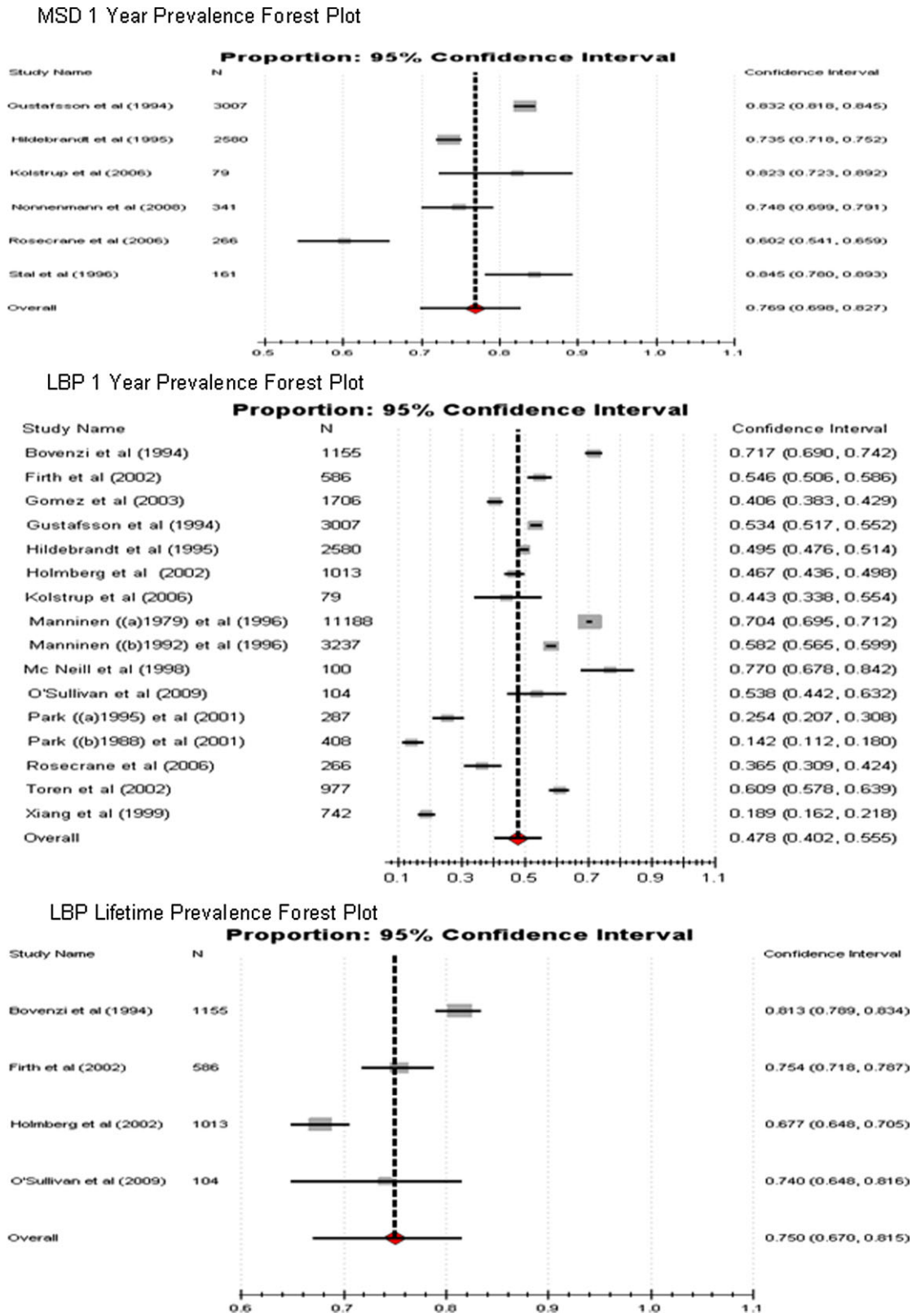

FIGURE 2. Forest plots.

methodological quality studies [Croft et al., 1992; Bovenzi and Betta, 1994; Xiang et al., 1999; Holmberg et al., 2002; Gomez et al., 2003; Greenlee et al., 2005; Stål and Englund, 2005; Cameron et al., 2006; Thelin and Holmberg, 2007; Thelin et al., 2009] should portray more accurate findings. Greater standardization of methodologies in particular case definition uniformity among MSD researchers is warranted to improve research practices and comparative analysis of findings.

Only one study [Holmberg et al., 2002] reported on the lifetime prevalence of musculoskeletal symptoms (90.6%). The reported high prevalence is unsurprising, as, farming is a physically demanding job. The 1-year prevalence of MSDs ranged from 60% to 92% with an overall pooled result of 76.9%. This prevalence is similar to that recorded for other physical occupations such as veterinarians (96%) [Scuffham et al., 2010] and horse riding instructors (91%) [Lofqvist et al., 2009], where the roles or tasks are somewhat comparable to those of farmers. This suggests that similar occupational tasks and workplace contexts or environments may be contributing factors to developing MSDs. These results suggest that further research into the workplace and task contexts of MSDs is required.

In all case–control and cohort studies farmers had higher MSD prevalence rates than the non-farmer controls [Croft et al., 1992; Bovenzi and Betta, 1994; Stal et al., 1996; Holmberg et al., 2002; Greenlee et al., 2005; Thelin and Holmberg, 2007; Thelin et al., 2009] thus, suggesting that farmers are at particular risk of developing MSDs compared with other occupational groups. A study of British male farmers suggested that several physical risk factors for MSDs were present more frequently among farmers compared to blue-collar or white-collar workers [Walker-Bone and Palmer, 2002]. The European Agency for Safety and Health at Work [2010] reported skilled agricultural workers and those working in the fishing industry having the highest prevalence of both backache (59.7%) and muscular pains (57.6%) compared with nine other occupations.

Female farmers reported approximately 10% higher 1-year prevalence of ''any MSD'' (83.3–92.9%) than their male counterparts (73.7–82.1%). They also reported higher prevalence of neck, neck/shoulder, upper back, shoulder, elbow, hands/wrist, and foot MSDs. In more recent literature, females also reported higher 1-year prevalence of LBP [Taechasubamorn et al., 2011] and back pain [Liu et al., 2011] than men. The literature suggests that women experience MSDs more frequently than men. However, the accuracy of this observation may be in question as the proportion of women included in the study samples has been limited. A previous study, established that women typically report physical symptoms 50% more often than men [Kroenke and Spitzer, 1998]. Additional research is required to establish whether the physical natures of farming occupations are more detrimental to the health of female workers.

Overall the spinal region was the most commonly affected region reported in the studies (1-year prevalence ranged from 8.6% to 81.3%), followed by the upper extremity (1-year prevalence ranged from 3.6% to 71.4%) and then the lower extremity (1-year prevalence ranged from 10.4% to 41%). Of the 24 studies, 14 reported on 1-year LBP prevalence, suggesting that LBP among farmers was the most frequent body part investigated. Also, LBP had the highest prevalence figure compared with the other body parts, which is consistent with the high LBP prevalence reported in recent farmer studies [Osborne et al., 2010; Stocks et al., 2010; Taechasubamorn et al., 2011]. A systematic review [Da Costa and Vieira, 2010] investigating risk factors of WMSDs identified heavy physical work, awkward static and dynamic working postures, and lifting as the main biomechanical risk factors for the development of LBP. These findings might help explain why LBP is so common among farmers, as their work environment may expose them to these risk factors on a regular, if not daily basis. Other studies have shown that many years of farming [Xiang et al., 1999], tractor work [Toren et al., 2002; Gomez et al., 2003], and milking four or more hours per day [Park et al., 2010] are associated with greater prevalence of LBP. Unlike most occupations, farmers usually start working on farms at a young age and carry on farming well after the normal retirement age. These factors may also contribute to the higher than average MSD prevalence rates. Given this occupational context it may be useful for researchers to consider reporting both 1-year and lifetime prevalence rates of LBP.

Fewer studies exist regarding the prevalence of upper and lower extremity MSDs and, of these, most only provided 1-year prevalence results. This limited perspective fails to capture more chronic symptoms such as osteoarthritis of the hip or knee. Findings from previous studies indicate that farmers may have higher rates of hip osteoarthritis compared with other occupational groups [Holmberg et al., 2002; Walker-Bone and Palmer, 2002] especially if they have farmed for over 10 years [Croft et al., 1992]. A previous study reported, that as many as one in five farmers may eventually require hip replacement [Croft et al., 1992], highlighting the need to provide interventions to avoid this. Research on upper extremity MSDs such as the shoulder area had a 1-year prevalence range of 25.9–71.4%. Four [Gustafsson et al., 1994; Stål and Englund, 2005; Kolstrup et al., 2006; Nonnenmann et al., 2008] out of the five studies investigating shoulder problems related to pig or dairy farmers with the fifth study [Rosecrance et al., 2006] including all farmer types. Roscreance's article found that farmers had a much lower annual prevalence of shoulder disorders (25.9%),

compared with pig (43.2%), and dairy (47.6–54%) farmers. These data indicate that there may be distinctive occupational MSD profiles based on the type of farm work regularly undertaken which warrants consideration in future research.

Methodological Short Comings of Prevalence Studies

Given the combined health science and agriculture theme, the various terms for farmers, diversity of literature sources and problems with certain databases, the electronic search resulted in the identification of a very large number of articles that needed to be examined for this review. However, when screened for inclusion criteria, this left a substantially lower amount of studies available for inclusion. This review found substantial heterogeneity across the studies which made reporting single prevalence results difficult.

While undertaking this systematic review of the MSD prevalence literature several methodological limitations were identified. The most common methodological shortcomings were lack of common case definition, lack of appropriate sampling frame, inadequate sample size, and bias in the measurement of health outcome. These shortcomings have consequences for the validity of the study findings. Inappropriate sampling frames result in the possibility of under representation of certain groups such as the elderly, people who are retired or perhaps no longer working due to MSD-related disability (''healthy worker effect''). While census data provide one of the few datasets that are thought to have minimal bias these are costly and tend to be separated by a period measured in years thereby limiting their utility in monitoring and evaluation studies. Telephone interviews and self-administered questionnaires are more feasible than personal interviews, but may not be the most accurate [Loney et al., 1998]. Previous studies [Rockwood and Stadnyk, 1994; Loney et al., 1998] indicated that the sample size should be at least 300 subjects, thus, a sample size of >300 was considered satisfactory for this review. Finally, self-reported health outcomes can include recall bias as farmers may not remember or may be inaccurate in recall. On the basis of this review future researchers need to carefully consider and clearly specify their methodology.

CONCLUSION

The results from this systematic found a high prevalence of MSDs among farmers. The review established that the spinal region is the most commonly investigated region with LBP reported as the most frequent MSD, followed by the upper and then the lower extremities. Also, it confirmed that farmers have higher prevalence rates of MSDs than non-farmer controls, suggesting farmers are at a particular risk of developing MSDs compared with other occupations. The prevalence ranges for many body parts varied considerably between studies due to substantial heterogeneity across the studies. Improvements in methodological quality and homogeneity are required among researchers to improve future research practices and allow meaningful comparison of results. A number of potential avenues of research were identified including, gender, workplace, and task context of MSDs, and more research regarding upper and lower extremity MSDs.

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