Impacts of Differences in Epidemiological Case Definitions on Prevalence for Upper-Extremity Musculoskeletal Disorders

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What is This?

Impacts of Differences in Epidemiological Case Definitions on Prevalence for Upper-Extremity Musculoskeletal Disorders

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Objective: The aim of this study was to systematically evaluate prevalence based on variations in case definitions used for epidemiological studies of musculoskeletal disorders (MSDs).

Background: Prior studies of MSDs have mostly relied on a single case definition based on questionnaires.

Method: In a multicenter prospective cohort study, we systematically collected data to evaluate impacts of differences in case definitions of MSDs on prevalence of three common musculoskeletal disorders: (a) shoulder tendinosis, (b) lateral epicondylalgia, and (c) carpal tunnel syndrome. Production workers were from 21 employment settings in three diverse U.S. states and performed widely varying work. All workers completed laptop-administered structured interviews, two standardized physical examinations, and nerve conduction studies (NCS). Case definitions included symptoms only, and symptoms plus physical examinations and/or NCS.

Results: A total of 1,227 subjects had complete health data at baseline. The prevalence for shoulder tendinosis is 23.0% if only glenohumeral pain is used for a case definition, compared with 8.0% if a combination of pain plus a positive supraspinatus test is used. The prevalence for lateral epicondylalgia varied on the basis of lateral elbow pain (12.0%), pain plus tenderness on palpation (9.9%), or pain plus tenderness on palpation plus resisted wrist or middle finger extension (3.5%). Carpal tunnel syndrome prevalence varied on the basis of tingling or numbness in a median nerve–served digit (29.9%) or tingling or numbness plus NCS abnormalities consistent with carpal tunnel syndrome (9.0%).

Conclusion: Variations in epidemiological case definitions have major impacts on prevalence of common MSDs. Wide-ranging differences in prevalence may have impacts on purported risk factors that need to be determined.

Keywords: epidemiology, rotator cuff tendinitis, lateral epicondylitis, carpal tunnel syndrome, ergonomics

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INTRODUCTION

Musculoskeletal disorders (MSDs) are the leading cause of morbidity in working populations (U.S. Bureau of Labor Statistics, 2008; Washington State Labor and Industries, 2004). MSDs are a primary driver of workers' compensation costs (Washington State Labor and Industries, 2004). The most common and costly disorders of the upper extremity include shoulder tendinoses, lateral epicondylalgia, and carpal tunnel syndrome (CTS).

Shoulder tendinosis has been investigated in multiple occupational epidemiological studies that usually included only one case definition (Bodin et al., 2012; Descatha et al., 2009; Forde, Punnett, & Wegman, 2005; Kaergaard & Andersen, 2000; Kaerlev et al., 2008; McCormack, Inman, Wells, Berntsen, & Imbus, 1990; Miranda, Viikari-Juntura, Heistaro, Heliövaara, & Riihimäki, 2005; National Institute for Occupational Safety and Health [NIOSH], 1997; Rechardt et al., 2010; Roquelaure et al., 2002, 2006; Silverstein et al., 2006, 2008; Walker-Bone, Palmer, Reading, Coggen, & Cooper, 2004; Werner, Franzblau, Gell, Ulin, & Armstrong, 2005; Yamamoto et al., 2010). One study included both shoulder pain and tendinitis but did not include measurements of job physical factors (Bodin et al., 2012). Authors of many studies have aggregated shoulder and neck symptoms (Brandt et al., 2004; Gerr et al., 2002; NIOSH, 1997), and others have studied only shoulder pain (Frost et al., 2002; NIOSH, 1997). We are unable to identify authors of any studies who separately evaluated shoulder tendinosis and shoulder pain while also measuring job physical and psychosocial factors in a prospective cohort of at least 2 years of follow-up.

Lateral epicondylalgia (or epicondylitis) and elbow pain have been similarly evaluated in many studies (Chiang et al., 1993; Fan et al., 2009; Gold, d'Errico, Katz, Gore, & Punnett, 2009; Herquelot et al., 2012; Kurppa, Viikari-Juntura, Kuosma, Huuskonen, & Kivi, 1991; Leclerc et al., 2001; NIOSH, 1997; Ono et al., 1998; Ritz, 1995; Roquelaure et al., 2006; Salaffi, De Angelis, Grassi, & the MArche Pain Prevalence INvestigation Group Study, 2005; Shiri, Viikari-Juntura, Varonen, & Heliövaara, 2006; Viikari-Juntura et al., 1991; Wolf, Mountcastle, Burks, Sturdivant, & Owens, 2010; Zakaria, 2004). Two studies involved evaluation of risks for both lateral epicondylalgia and elbow pain, but neither included quantification of job physical factors (Gold et al., 2009; Herquelot et al., 2012).

There are many epidemiological studies of CTS that have been reported (NIOSH, 1997; Armstrong, Dale, Franzblau, & Evanoff, 2008; Kaerlev et al., 2008; Maghsoudipour, Moghimi, Dehghaan, & Rahimpanah, 2008; Roquelaure et al., 2008, 2009; Mattioli et al., 2009; Nordander et al., 2009; Shiri, Miranda, Heliövaara, & Viikari-Juntura, 2009; Wolf, Mountcastle, & Owens, 2009; Silverstein et al., 2010; Burt et al., 2011; El-Bestar, El-Mitwalli, & Khashaba, 2011; Cartwright et al., 2012; Chang, Wu, Liu, & Hsu, 2012; Garg, Kapellusch, et al., 2012; Laoopugsin & Laoopugsin, 2012; Patil, Rosecrance, Douphrate, & Gilkey, 2012). We are unable to identify any study that includes detailed modeling for both case definitions based on nerve conduction study (NCS) and symptoms-only case definitions.

The purpose of this study was to quantify the impacts of differences in epidemiological case definitions on the prevalence estimates of common upper-extremity MSDs with particular emphasis on symptoms-based definitions compared with case definitions including diagnostic testing. Should prevalence differ appreciably, subsequent systematic analyses will be required to determine whether risk factors differ for symptoms-based compared with diagnosis-based case definitions. If risk factors differ appreciably, decisions will likely be required regarding preferential targeting of symptoms or disorders for ergonomics, occupational health, and health promotion programs.

METHOD

In this study, we analyzed data from the WISTAH study of MSDs (Garg, Hegmann, et al., 2012). The WISTAH study is approved by the institutional review boards of the University of Utah and the University of Wisconsin–Milwaukee (#11889 and #03.02.059, respectively). The design is a prospective cohort study. See Garg, Hegmann, et al. (2012) for details, data collection forms, and the symptoms diagram. A succinct summary of the methods for this report follows.

Workers were recruited from 15 employers with 21 diverse employment and production facilities located in Wisconsin, Utah, and Illinois. Study enrollments were targeted to include one third of workers each in low-, medium-, and high-physical-demands jobs based on a preliminary estimate of the strain index score primarily based on the force and repetition requirements (Garg, Hegmann, et al., 2012).

All workers completed computerized structured interviews at baseline that included a survey of symptoms required for diagnostic purposes (n = 483 items). The structured interview also used a hand/body diagram to help localize symptoms. Symptoms included (a) tingling and/or numbness in each digit and (b) pain, ache, burning and/or stiffness in each body part based on the hand/body diagram (e.g., lateral elbow pain, glenohumeral pain). Tingling and numbness were combined as one symptom. Similarly, pain of any type or quality (e.g., burning, stabbing) was combined as one symptom. For purposes of these analyses, pain of any intensity (rated 0 to 10) and tingling/numbness of any degree of persistence were included.

All workers underwent two independent, structured physical examinations, even if they did not have symptoms. Each examination included palpation and specific maneuvers (e.g., resisted middle finger extension, supraspinatus test). For this study, only the results of the first examination were used.

All workers underwent an NCS in accordance with the recommendations of the American Association of Electrodiagnostic Medicine (Jablecki et al., 2002; Wertsch, 1987, 1992; Wertsch & Melvin, 1982; Wertsch & Park, 1992). A minimum hand temperature of 30°C

TABLE 1: Parameters for Nerve Conduction Study Classification (in milliseconds)

Classification	Transcarpal Delta[a]	Sensory Latency	Motor Latency
Normal	≤0.85	≤3.70	≤4.50
Abnormal			
Mild	>0.85	≤3.70	≤4.50
Moderate	>0.85	>3.70	≤4.50
Severe	>0.85	>3.70	>4.50

[a]Transcarpal delta = (median nerve sensory latency – ulnar nerve sensory latency).

was assured with warming blankets. Palmar transcarpal sensory nerve action potential (SNAP) distal latency responses were recorded via the long finger at 8 cm. Median and ulnar digital SNAP distal latencies were recorded in the third and fifth digits, respectively, at 12 cm. Median and ulnar compound motor action potential onset latencies were recorded at 6 cm. NCSs were classified as normal or abnormal (mild, moderate, or severe case) according to the criteria in Table 1. In this report, we contrast epidemiological case definitions based on only normal compared with abnormal studies.

Epidemiological Case Definitions

Epidemiological case definitions used in this study rely on data from the structured interview, physical examination, and/or NCS (see Table 2). Analyses reported herein were performed for the right upper extremity only, regardless of hand dominance. The most restrictive epidemiological case definition (presumably most specific, least sensitive) for rotator cuff tendinosis in this report is pain in the glenohumeral joint area plus glenohumeral pain on the supraspinatus test. The most restrictive case definition for lateral epicondylalgia in this report is pain in the lateral elbow, plus pain on palpation of at least one of the six standardized tender points (Garg, Hegmann, et al., 2012), plus pain on at least one of two resisted maneuvers. The most restrictive case definition for CTS is tingling/numbness in at least two median nerve–served digits (thumb; index, middle, and ring fingers) present for at least 25% of the days in the month prior to study enrollment plus an abnormal NCS consistent with CTS.

Statistical Analyses

Prevalences were calculated for each case definition for each MSD in Table 2. Wilcoxon rank-sum tests for continuous data and chi-square tests for continuous data were performed to assess statistical differences between genders. Analyses were performed for the right upper extremity only. Data were analyzed in SAS 9.2 (SAS Institute, Cary, North Carolina, USA).

RESULTS

Descriptive statistics for the population of 1,227 production workers in this report are provided in Table 3. These subjects were enrolled from 15 employers in 21 plants and/or employment settings. They performed a wide range of tasks, mostly in manufacturing (Garg, Hegmann, et al., 2012). The population was 65.8% female. The mean age was 42.1 ± 11.4 (range = 18.3 to 68.5) years. The mean body mass index was close to obese (≥30 kg/m^2), 29.5 ± 6.7 kg/m^2. A majority of workers (72%) did not smoke, with a plurality (48%) being lifelong nonsmokers. Consistent with employed populations, diabetes mellitus (5%) was not surprisingly relatively infrequent. Previously diagnosed hypertension (17%) and high cholesterol (18%) were more frequent. The mean incumbency in their current position was 9.8 ± 9.3 years. There were statistically significant ($p < .05$) differences between genders for age, thyroid disease, high cholesterol, tobacco use, and employer.

Glenohumeral joint pain of any intensity in the month prior to enrollment was common and reported by 282 workers (23.0%; see Table 2). When we use an epidemiological case definition requiring a combination of glenohumeral

TABLE 2: Epidemiological Case Definitions and Baseline Prevalence of Musculoskeletal Disorders (*N* = 1,227) for the Right Upper Extremity Only, Regardless of Hand Dominance

Case Definition	Female	Male	Total
Rotator cuff tendinosis (symptoms only)	199 (24.7%)	83 (19.8%)	282 (23.0%)
1. Glenohumeral pain present on ≥25% of days			
Rotator cuff tendinosis (symptoms and resisted maneuver):	70 (5.7%)	28 (6.7%)	98 (8.0%)
1. Glenohumeral pain present on ≥25% of days and			
2. Glenohumeral pain on supraspinatus testing (aka "empty can test")			
Lateral epicondylalgia (symptoms only)	122 (15.1%)	25 (6.0%)	147 (12.0%)
1. Lateral elbow pain present on ≥25% of days			
Lateral epicondylalgia (symptoms and tenderness)	100 (12.4%)	21 (5.0%)	121 (9.9%)
1. Lateral elbow pain present on ≥25% of days and			
2. "Pain" upon palpation of 1 or more of 6 lateral elbow tender points			
Lateral epicondylalgia (symptoms, tenderness, and resisted maneuver)	35 (2.9%)	8 (1.9%)	43 (3.5%)
1. Lateral elbow pain present on ≥25% of days and			
2. "Pain" upon palpation of 1 or more of 6 lateral elbow tender points and			
3. Lateral elbow pain on resisted wrist and/or middle finger extension			
Carpal tunnel syndrome (symptoms only): N/T in median nerve–served digits (thumb, index finger, middle finger, and/or ring finger) for ≥25% of days and/or nights			
0 digits	533 (66.0%)	340 (81.0%)	873 (71.1%)
1 digit	36 (4.5%)	9 (2.1%)	45 (3.7%)
2 digits	42 (5.2%)	14 (3.3%)	56 (4.6%)
3 digits	57 (7.1%)	15 (3.6%)	72 (5.9%)
4 digits	138 (17.1%)	40 (9.5%)	178 (14.5%)
Carpal tunnel syndrome (NCS)	147 (18.2%)	59 (14.0%)	207 (16.9%)
1. Abnormal NCS consistent with median mononeuropathy at the wrist			
Carpal tunnel syndrome (symptoms and NCS)	86 (10.7%)	25 (6.0%)	111 (9.0%)
1. N/T in 2 or more median nerve–served digits (thumb, index finger, middle finger, and/or ring finger) for ≥25% of days and/or nights and			
2. Abnormal NCS consistent with median mononeuropathy at the wrist			

Note. N/T = numbness/tingling; NCS = nerve conduction study.

joint pain and either elicitation or increase in glenohumeral pain on performance of the supraspinatus test, 98 workers (8.0%) met that case definition for rotator cuff tendinosis. The stratified data by gender demonstrated relatively modest differences in rates by gender for both

TABLE 3: Descriptive Statistics Stratified by Gender

Variable	Female, n = 807 (65.8%)	Male, n = 420 (34.2%)	Total N = 1,227 (100.0%)
Age in years ($M \pm SD$)*	43.8 ± 10.7	38.9 ± 12.0	42.1 ± 11.4
Body mass index in kg/m^2 ($M \pm SD$)	29.7 ± 6.9	29.0 ± 7.1	29.5 ± 6.7
Thyroid disease, *n* (%)*	78 (6.4%)	7 (0.6%)	85 (6.9%)
High cholesterol, *n* (%)*	158 (12.9%)	61 (5.0%)	219 (17.9%)
High blood pressure, *n* (%)	137 (11.2%)	67 (5.5%)	204 (16.6%)
Diabetes mellitus, *n* (%)	49 (4.0%)	17 (1.4%)	66 (5.4%)
Tobacco use, *n* (%)*			
Lifetime never smoker	398 (49.3%)	176 (41.9%)	574 (46.8%)
Former smoker	196 (24.3%)	103 (24.5%)	299 (24.4%)
Current smoker	203 (25.2%)	137 (32.6%)	340 (27.7%)
Missing	10 (1.2%)	4 (1.0%)	14 (1.1%)
Employer/work*			
Poultry processing	44 (5.5%)	10 (2.4%)	54 (4.4%)
Manufacturing and assembly of animal laboratory testing equipment	20 (2.5%)	10 (2.4%)	30 (2.4%)
Electrical generator manufacturing and assembly	24 (3.0%)	35 (8.3%)	59 (4.8%)
Metal automotive engine parts manufacturing (three facilities)	38 (4.7%)	53 (12.6%)	91 (7.4%)
Injection molding of rubber and plastic automobile parts	23 (2.9%)	25 (6.0%)	48 (3.9%)
Modular furniture for cubicles	37 (4.6%)	11 (2.6%)	48 (3.9%)
Plastic bag manufacturing	47 (5.8%)	24 (5.7%)	71 (5.8%)
Large-scale textile printing	23 (2.9%)	12 (2.9%)	35 (2.8%)
Small electric motor manufacturing	137 (17.0%)	18 (4.3%)	155 (12.6%)
Small electronics and sensor manufacturing	26 (3.2%)	16 (3.8%)	42 (3.4%)
Commercial lighting and warehousing	104 (12.9%)	40 (9.5%)	144 (11.7%)
Small engine manufacturing and assembly	50 (6.2%)	39 (9.3%)	89 (7.2%)
Red meat processing	0 (0%)	22 (5.2%)	22 (1.8%)
Office work	18 (2.2%)	10 (2.4%)	28 (2.3%)
Apparel manufacturing	90 (11.2%)	2 (0.5%)	92 (7.5%)
Airbag manufacturing	63 (7.8%)	41 (9.8%)	104 (8.4%)
Cabinet manufacturing	1 (0.1%)	3 (0.7%)	4 (0.3%)
Distribution center	4 (0.5%)	4 (1.0%)	8 (0.6%)
Medical equipment manufacturing	52 (6.4%)	10 (2.4%)	62 (5.1%)
Garage door manufacturing	2 (0.2%)	14 (3.3%)	16 (1.3%)
Small metal parts manufacturing	4 (0.5%)	21 (5.0%)	25 (2.0%)

*$p < .05$ for difference in gender for this variable.

shoulder outcomes. The prevalence ratio (PR) for tendinitis diagnosed by joint pain alone as compared with pain with a resisted maneuver was 2.88.

Lateral elbow pain of any intensity in the month prior to enrollment was relatively common, affecting 147 workers (12.0%; see Table 2). When we use an epidemiological case definition requiring a combination of lateral elbow pain and tenderness at one or more of the six tender points on examination, 121 workers (9.9%) met that case definition for lateral epicondylalgia. Requiring symptoms plus tenderness plus at least one of two resisted maneuvers to be positive reduced the number of workers meeting the case definition to 43 (3.5%). The stratified data by gender demonstrated more-than-twofold differences in rates by gender for all three lateral epicondylalgia outcomes. The PR for lateral epicondylalgia diagnosed by pain alone as compared with pain and tenderness was 1.21. The PR for lateral epicondylalgia defined by pain alone as compared with the definition of pain, tenderness, and a positive resisted maneuver was 3.43.

Regarding CTS, 351(28.9%) workers reported tingling/numbness in at least one median nerve–served digit in the month prior to study enrollment (see Table 2). Approximately 50% (n = 178) of those with tingling/numbness reported involvement of all four median nerve–served digits. When we use an epidemiological case definition that included an abnormal NCS, the number of workers meeting the case definition was reduced to 111(9.0%). The stratified data by gender demonstrated considerable differences in rates by gender for all three CTS outcomes. The PR for a CTS case definition of tingling/numbness in two or more median nerve–served digits alone as compared with a CTS definition of an abnormal NCS was 1.48. The PR for a CTS case definition of tingling/numbness in two or more median nerve–served digits alone as compared with a CTS definition of tingling/numbness in two or more median nerve–served digits and an abnormal NCS was 2.76.

DISCUSSION

Upper-extremity pain, dysesthesias, and MSDs were highly prevalent in this large, diverse population of production workers. These results demonstrate that prevalence for these disorders differ 1.2- to 3.4-fold depending upon the epidemiological case definition used to measure prevalence in these manufacturing-sector workers. Manufacturing currently includes approximately 9% of the U.S. workforce (U.S. Bureau of Economic Analysis, 2011).

For rotator cuff tendinosis, 23% had glenohumeral shoulder pain compared with 8.0% having both pain plus a positive supraspinatus test; thus 2.9 times as many cases would be analyzed for a symptoms-only case definition. Previously reported prevalence of rotator cuff tendinosis have ranged from 2.0% (Miranda et al., 2005) to 7.6% (Silverstein et al., 2006). This study's methods are likely most comparable to those of Silverstein et al. (2006), which involved reasonably analogous methods; thus the similar results suggest reproducible methods. Previously reported prevalences of shoulder pain have ranged from 12% (Miranda et al., 2005) to 36% (Forde et al., 2005), with a much wider range of estimates likely at least in part due to enrollment processes with greater biases toward symptomatic subjects, sole reliance on questionnaires, lack of body symptom diagrams, lack of specificity of symptoms to the shoulder joint, and/or inclusion of neck-related symptoms.

Regarding lateral epicondylalgia, 12% had pain only, 9.9% had pain plus tenderness, and 3.5% had pain, tenderness, and a resisted maneuver. Thus, for lateral epicondylalgia, there would be 3.4 times more cases for a symptoms-only definition compared with a case definition that required a resisted maneuver. These results also suggest that the addition of tenderness to the case definition of lateral elbow pain results in exclusion of relatively few cases (17.7%). Previously reported prevalence of lateral epicondylalgia have ranged from 0.74% (Salaffi et al., 2005) to 14.5% (Chiang et al., 1993), with issues affecting these widely ranging estimates similar to those noted previously for shoulder disorders.

Differences by disorder also varied markedly for measures of CTS, with 3.3 times as many workers meeting a symptoms-only definition of one digit affected as compared with those who met the epidemiological case definition of NCS plus paresthesias in two digits. The previously reported prevalence for CTS has also ranged widely, from 1.1% (McCormack et al., 1990) to 16.6% (Patil et al., 2012). Differences in these prevalences have underpinnings that also include variable NCS methods and criteria for median mononeuropathy. In this study, we used a greater difference between the median and ulnar transcarpal sensory latency responses (0.85 ms) than that of several prior studies, 0.5 ms, that reflects the concerns the criteria have been used to overdiagnose CTS; however, that criterion for this study is in keeping with more recent epidemiological publications.

These data also suggest higher prevalence among females for all case definitions for all of these disorders. However, some important differences are apparent, including less difference between the genders for rotator cuff disorders, large differences for lateral epicondylalgia, and somewhat intermediate differences for the CTS outcomes. There is somewhat less of a difference between the genders for NCS abnormalities (18.2% vs. 14.0% abnormal, 30.0% higher among females) than for symptoms (34.0% vs. 19.0%, 78.9% higher among females).

These results suggest that additional studies of outcomes for MSD are needed to systematically determine whether results and purported risk factors differ on the basis of the case definition used. This recommendation is consistent with prior literature suggesting that these outcomes should be evaluated distinctly (Kryger, Lassen, & Andersen, 2007). Such analyses may also help to clarify apparent conflicts regarding purported risk factors in the published literature. Should risk factors differ appreciably, decisions will likely be required regarding preferential targeting of symptoms or disorders for ergonomics, occupational health, and health promotion programs.

Our results also suggest that additional studies are needed to further define the sensitivity and specificity of the physical examination maneuvers, as these results suggest they may not be high. (Beaudreuil et al., 2009; Dale, Descatha, et al 2011; Salaffi, Ciapetti, 2010; Hegedus et al., 2012; Lifchez, Means, Dunn, Williams, & Dellon, 2010; Walker-Bone, Palmer, Reading, & Cooper, 2003).

This study's strengths include a large sample size and enrollments from three U.S. states that include 21 diverse employment plants. Strengths also include the computerization of structured interviews, standardized physical examinations, and the performance of all physical examination and NCSs in all subjects regardless of symptoms. Last, blinding of the health outcomes team to exposures and blinding of the physiatrists measuring NCSs to the worker's symptoms provided additional study strengths. These capture methods likely have produced higher prevalence than less rigorous methods, and we believe these prevalence estimates may be higher than for service-sector workers.

The detailed study methods have likely limited its weaknesses (Garg, Hegmann, et al., 2012). This study's inclusion of primarily manufacturing workers may limit its generalizability to workers in other economic sectors. However, other studies have indicated high prevalence in other employment settings (NIOSH, 1997). Workers had to volunteer to attend enrollment processes. Thus, the overall participation rate is not known although estimated to have been at least 50% of the target population.

CONCLUSION

Prevalence estimates for common upper-extremity MSDs (shoulder tendinosis, lateral epicondylalgia, and CTS) vary widely depending on the epidemiological case definition used. In this study of a large number of manufacturing workers (N = 1,227) from a variety of workplace (N = 21), comprehensive, systematic health assessments resulted in 1.2-fold to 3.4-fold differences in prevalence of three of the most common upper-extremity MSDs. It remains to be determined whether these large variations in prevalence have impacts on purported risk factors. Differences in epidemiological case definitions used may explain some of the discrepancies in the results between previously published studies.

AUTHORS' NOTE

KTH is the WISTAH study's co–principal investigator (PI), leads the Health Outcomes Assessment Team, and drafted the manuscript. AG serves as overall study PI and heads the Job Exposure Assessment Team (JEAT). JK participated on the JEAT and helped draft the manuscript. MST analyzed the data for this report. KTH, EMW, JF, JB, and HE coordinated and accomplished the health outcomes measurements and the Health Outcomes Assessment Team's activities. JJW and RK performed the NCSs. All authors read and approved the final manuscript.

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KEY POINTS

- Prior musculoskeletal disorders studies mostly reported prevalence based on a single case definition.
- Shoulder tendinosis prevalence ranged from 8.0% if combining glenohumeral pain plus supraspinatus testing to 23% for glenohumeral pain alone.
- Lateral epicondylalgia prevalence ranged from 12% for lateral elbow pain to 9.8% for pain plus tenderness on palpation to 3.5% for pain plus tenderness on palpation plus resisted wrist or middle finger extension.
- Carpal tunnel syndrome prevalence varied from 28% based on tingling and/or numbness in a median nerve–served digit to 9.1% for tingling and/or numbness in at least two digits plus nerve conduction study abnormalities.
- Wide-ranging differences in prevalence may have impacts on purported risk factors that need to be determined.

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