Prevalence and Work-Relatedness of Carpal Tunnel Syndrome in the Working Population, United States, 2010 National Health Interview Survey

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Background *Patterns of prevalence and work-relatedness of carpal tunnel syndrome (CTS) among workers offer clues about risk factors and targets for prevention.*
Methods *Data from an occupational health supplement to the 2010 National Health Interview Survey were used to estimate the prevalence of self-reported clinician-diagnosed CTS overall and by demographic characteristics. The proportion of these cases self-reported to have been attributed to work by clinicians was also examined overall and by demographic characteristics. In addition, the distribution of industry and occupation (I&O) categories to which work-related cases of CTS were attributed was compared to the distribution of I&O categories of employment among current/recent workers.*
Results *Data were available for 27,157 adults, including 17,524 current/recent workers. The overall lifetime prevalence of clinician-diagnosed CTS among current/recent workers was 6.7%. The 12-month prevalence was 3.1%, representing approximately 4.8 million workers with current CTS; 67.1% of these cases were attributed to work by clinicians, with overrepresentation of certain I&O categories.*
Conclusions *CTS affected almost 5 million U.S. workers in 2010, with prevalence varying by demographic characteristics and I&O.* Am. J. Ind. Med.
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KEY WORDS: industry; occupations; carpal tunnel syndrome; occupational diseases

INTRODUCTION

Carpal tunnel syndrome (CTS) is characterized by numbness, tingling, weakness, or muscle atrophy in the hand and fingers resulting from compression of the median nerve at the wrist. The compression may be related to a specific traumatic injury or systemic condition (e.g., diabetes, pregnancy), or may be caused by thickening of the protective sheaths that surround the flexor tendons that run through the carpal tunnel. Established occupational risk factors for CTS include repetitive flexing and extension of the wrist, forceful grip, and use of handheld vibratory tools [Palmer et al., 2007; Barcenilla et al., 2011; Burt et al., 2011]. Although CTS is relatively uncommon among the general population, it is one of the most

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common work-related conditions. According to an analysis of data from the 1988 National Health Interview Survey (NHIS) occupational health supplement (OHS), CTS was the second most likely of 13 chronic conditions to be attributed to work, with 30.7% of reported cases among U.S. adults who had ever worked meeting the study definition of work-relatedness [Luckhaupt and Calvert, 2010].

In 2010, the NHIS included an OHS for the first time since 1988. In addition to collecting data on the prevalence of many common workplace exposures, the 2010 NHIS-OHS addressed three commonly work-related conditions: dermatitis, CTS, and asthma. The prevalence of dermatitis and CTS is not routinely measured with the NHIS, and national prevalence estimates for them are rare.

In this report, we focus on the reported prevalence and work-relatedness of CTS among civilian non-institutionalized adults who were working at the time of interview, or who had worked in the past year. The prevalence and work-relatedness of asthma and dermatitis among workers will be addressed elsewhere. Differences in overall prevalence and the proportion of cases of CTS attributed to work by health care professionals are examined by demographic characteristics. In addition, the distribution of industry and occupation (I&O) categories to which work-related cases of CTS were attributed is compared to the distribution of I&O categories of employment among current/recent workers in order to identify I&O groups that may be at an increased risk of work-related CTS.

METHODS

National Health Interview Survey

The NHIS is a cross-sectional in-person household survey conducted continuously since 1957 by the National Center for Health Statistics (NCHS), Centers for Disease Control and Prevention (CDC). Data are collected on the civilian non-institutionalized population of the United States, and thus exclude persons in long-term care facilities (e.g., nursing homes) or correctional facilities, active-duty Armed Forces personnel (although civilian family members are included), and U.S. nationals living in foreign countries [Pleis et al., 2010]. The survey uses a multi-stage clustered sample design, with oversampling of black, Hispanic, and Asian persons, and produces nationally representative data on health insurance coverage, health care access and utilization, health status, health behaviors, and other health-related topics.

The NHIS questionnaire consists of a core set of questions that remain relatively unchanged from year to year, and supplemental questions that vary from year to year to collect additional data pertaining to current health issues of national importance. The core survey instrument has four main modules: Household, Family, Sample Child, and Sample Adult. The first two modules collect health and sociodemographic information on each member of each family residing within a sampled household. Within each family, additional information is collected from one randomly selected adult (the ''sample adult'') aged 18 years or older and (if applicable) one randomly selected child (the ''sample child'') aged 17 years or younger. In rare instances when a sample adult is physically or mentally unable to respond, proxy responses are accepted (<1.5% of sample). In 2010, NHIS interviews were conducted in 34,329 households, accounting for 89,976 persons in 35,177 families. The estimates presented in this paper are based on data collected from 27,157 sample adults. The household response rate was 79.5%, the conditional sample adult response rate (i.e., the response rate for those sample adults identified as eligible) was 77.3%, and the final sample adult response rate (i.e., the response rate that takes into account both the conditional sample adult response rate and the household/family response rate) was 60.8%.

Information regarding employment status and the current I&O of those currently employed was obtained from survey questions included in the Sample Adult core module. Demographic characteristics were obtained from questions asked in the Household and Family core modules.

Occupational Health Supplement

The National Institute for Occupational Safety and Health (NIOSH) sponsored an OHS to the 2010 NHIS to collect information on the prevalence and correlates of work-related health conditions and exposures to potential psychological and physical occupational hazards in the U.S. working population. The OHS questions were embedded within the Sample Adult questionnaire. The 2010 NHIS sample included 17,524 sample adults who had worked at least part of the 12 months preceding their interviews; most of the OHS questions focused on these respondents. Information regarding the most recent I&O of employment for those sample adults not currently employed but employed in the past 12 months, information regarding the longest-held job for those current/recent workers whose current/recent job was not their longest-held job, and information about CTS was obtained from supplemental questions on the OHS.

Ethics Board Approval and Consent

The 2010 NHIS was approved by the Research Ethics Review Board of the NCHS (Protocol #2009-16) and the U.S. Office of Management and Budget (Control #0920-0214). Written consent for participation in the 2010

NHIS was not received, but instead all 2010 NHIS respondents provided oral consent prior to participation.

Study Definitions

The questions used to assess the lifetime and 12-month prevalence of CTS were: ''Have you ever been told by a doctor or other health professional that you have a condition affecting the wrist and hand called carpal tunnel syndrome?'' and ''During the past 12 months have you had carpal tunnel syndrome?'' Those who reported having CTS in the past 12 months were considered ''current'' cases of CTS.

For this study, we classified sample adults into three categories according to their employment history: employed in the past 12 months (current/recent workers), not employed in the past 12 months, but employed at some time in the past (former workers), and never employed. Follow-up questions about the work-relatedness of CTS were asked of current/recent workers with current CTS. For this paper, we defined cases of work-related CTS as current/recent workers who reported current CTS (i.e., past 12 months), and who answered ''yes'' to the follow-up question: ''Have you ever been told by a doctor or other health professional that your carpal tunnel syndrome was probably work-related?'' For those respondents who stated that they had been told by a health professional that their CTS was probably work-related, additional questions were asked to ascertain whether the condition was related to their current/most recent job or to a previous job (either their longest-held job or another job). For cases attributed to jobs other than the current/most recent job or longest-held job, information was collected to determine the I&O of the job to which CTS was attributed.

We also classified current/recent workers according to several demographic characteristics: sex, age group, race/ethnicity, marital status, education, place of residence, and region. Analysis by educational status was limited to workers aged 25 years and over. Geographic classification was based on the location of a respondent's home, and included region and place of residence. For place of residence, a metropolitan statistical area (MSA) is defined by the U.S. Office of Management and Budget and is typically centered around a single large city that wields substantial influence over the region included in the MSA. Large MSAs have a population size of 1,000,000 or more, small MSAs have a population size of $<$1,000,000, and ''not in MSA'' consists of persons not living in a MSA.

For I&O classification, the NHIS obtains open-ended responses from each sample adult respondent (age 18 years and over) regarding the industry (employer's type of business) and occupation (employee's type of work) of each job for which information is collected. These responses were reviewed by U.S. Census Bureau coding specialists who assigned four-digit I&O codes based on the 2007 North American Industrial Classification System (NAICS) and 2010 Standard Occupational Classification (SOC) system. To allow for more reliable estimates, we used less detailed two-digit I&O recodes in this paper. The industry recodes include 21 simple categories (based on NAICS sectors; see Table III), and the occupation recodes include 23 simple categories (based on SOC major groups; see Table IV).

Data Analyses

To account for the complex sampling design of the NHIS, analyses were completed using SAS-callable SUDAAN software version 10.0 [RTI, 2008]. To represent the U.S. civilian, non-institutionalized population aged 18 years and over, and to estimate the total number of employed U.S. civilian workers represented by each individual in the sample, all estimates were weighted using the NHIS sample adult record weight. Point estimates with a relative standard error (RSE) such that $30\% < \text{RSE} \leq 50\%$ are noted in the text and marked with an ''*'' in the tables, and estimates with a RSE $>$ 50% and estimates based on cell sizes $\leq$10 are not reported.

Two sample z-tests were used to compare the prevalence rates of current CTS and the proportions of current cases of CTS attributed to work by health professionals among current/recent workers by demographic characteristics. Each of the current CTS cases that were attributed to work by a health professional were classified according to the I&O categories of the specific job to which the case was attributed, regardless of whether that job was the current/most recent job, longest-held job, or another job. We then calculated ratios of the proportion of work-related cases of CTS that were attributed to each major I&O category compared to the proportion of current/recent workers employed in each category. Ratios of $>$1.0 indicate an overrepresentation of a specific I&O category among work-related CTS cases compared to what would be expected if workers from all I&O categories had the same risk of work-related CTS.

RESULTS

Employment status data were available for 27,157 sample adults in the 2010 NHIS, who represented approximately 229 million civilian non-institutionalized U.S. adults (Table I). The sample included 17,524 adults (weighted proportion = 67.7%) who were employed in the past 12 months (current/recent workers); 7,915 (26.7%) who were not employed in the past 12 months,

TABLE I. Lifetime and 12-Month Prevalence of CTS Among U.S. Adults, by Employment Status

			Lifetime Prevalence			12-Month Prevalence		
Employment status	Sample[a]	Est. population (in thousands)	Cases[a]	Unadjusted % (95% CI)	Adjusted[b] % (95% CI)	Cases[a]	Unadjusted % (95% CI)	Adjusted[b] % (95% CI)
Employed in past 12 months	17,524	155,262	1,185	6.7 (6.3–7.2)	7.8 (7.2–8.4)	561	3.1 (2.8–3.5)	3.4 (3.0–3.8)
Not employed in past 12 months, but employed some time in past	7,915	61,189	946	12.2 (11.3–13.1)	10.8 (9.7–12.0)	402	5.2 (4.6–5.9)	5.2 (4.3–6.1)
Never employed	1,704	12,979	81	3.6 (2.7–4.8)	4.0 (2.7–5.7)	51	2.0 (1.5–2.8)	2.7 (1.6–4.4)
Total	27,143	229,430	2,212	8.0 (7.6–8.4)	7.9 (7.5–8.3)	1,014	3.6 (3.4–3.9)	3.6 (3.3–3.9)

Data includes U.S. adults who are part of the civilian non-institutionalized population. All estimates weighted unless otherwise noted.
Est., estimated; CI, confidence interval.
[a]Unweighted.
[b]Estimates adjusted by age, sex, and race/ethnicity using the projected 2000 U.S. population as the standard population.

but were employed at some time in the past (former workers); and 1,704 (5.7%) who were never employed (Table I).

Prevalence of Carpal Tunnel Syndrome (CTS)

The overall lifetime prevalence rate of self-reported clinician-diagnosed CTS among sample adults was 8.0% (95% CI 7.6–8.4), ranging from 3.6% (95% CI 2.7–4.8) among those never employed to 12.2% (95% CI 11.3–13.1) among former workers (Table I; $P < 0.05$ for all pair-wise comparisons). The lifetime prevalence rate of CTS among current/recent workers was 6.7% (95% CI 6.3–7.2). The overall 12-month prevalence rate of CTS among sample adults was 3.6% (95% CI 3.4–3.9), ranging from 2.0% (95% CI 1.5–2.8) among those never employed to 5.2% (95% CI 4.6–5.9) among former workers ($P < 0.05$ for all pair-wise comparisons). The 12-month prevalence rate of CTS among current/recent workers was 3.1% (95% CI 2.8–3.5), representing approximately 4.8 million workers with current CTS.

As shown in Table II, among current/recent workers, prevalence rates for current CTS were higher among females (4.5%; 95% CI 4.0–5.0) than among males (1.9%; 95% CI 1.6–2.3); among workers aged 45–64 (4.7%; 95% CI 4.1–5.4) than among those aged 18–29 (0.9%; 95% CI 0.6–1.2) and those aged 30–44 (3.0%; 95% CI 2.5–3.6); and among non-Hispanic blacks (3.6%; 95% CI 2.8–4.6) and non-Hispanic whites (3.5%; 95% CI 3.1–3.9) compared to Hispanic workers (1.9%; 95% CI 1.5–2.5). Workers with a high school diploma or GED (4.5%; 95% CI 3.8–5.5) had a higher prevalence rate of CTS than workers with college degrees (2.5%; 95% CI 2.0–3.0); and those who were divorced or separated (4.9%; 95% CI 4.1–5.9) had a higher prevalence rate of CTS than workers who were currently married (3.3%; 95% CI 2.9–3.8) or never married (1.8%; 95% CI 1.4–2.3; Table II). All the differences mentioned here were statistically significant ($P < 0.05$).

Work-Relatedness of Carpal Tunnel Syndrome (CTS)

Overall, 67.1% (95% CI 62.4–71.6) of current CTS cases among current/recent workers were reportedly attributed to work by health professionals (Table II), indicating that the prevalence rate of work-related CTS among current/recent workers was 2.1% (i.e., 67.1% of 3.1%), and that there were approximately 3.1 million cases of work-related CTS among U.S. workers in 2010. The proportion of CTS cases attributed to work was higher among females (71.1%; 95% CI 65.7–76.1) than among males (58.4%; 95% CI 49.2–67.0%); among workers aged 18–29 (70.9%; 95% CI 52.8–84.2), workers aged 30–44 (74.0%; 95% CI 66.1–80.5), and workers aged 45–64 (66.8%; 95% CI 60.0–73.0) compared to workers aged $\geq$65 (32.2%; 95% CI 17.8–50.9); among non-Hispanic blacks (85.6%; 95% CI 76.1–91.8) compared to non-Hispanic whites (63.9%; 95% CI 58.0–69.4) and Hispanics (62.5%; 95% CI 47.8–75.2); and among those with less than a high school education (76.8%; 95% CI 62.4–86.8), a high school education (71.8%; 95% CI 63.2–79.1), or some college (68.5%; 95% CI 60.7–75.4) compared to those with at least a Bachelor's degree (55.3%; 95% CI 44.4–65.7; Table II). All the differences mentioned here were statistically significant ($P < 0.05$).

Work-Related Carpal Tunnel Syndrome (CTS) by Industry and Occupation

Of the 363 cases of current CTS among current/recent workers that were attributed to work by health professionals, 201 (54.4%) were attributed to the respondents' current/most recent jobs, 92 (27.1%) were attributed to longest-held jobs different than the respondents' current/

TABLE II. Prevalence and Work-Relatedness of Current CTS Among U.S. Adults who Worked in the Past 12 Months, by Demographic Characteristics

			Prevalence		Proportion related to work	
	Sample[a]	Est. population (in thousands)	Cases[a]	% (95% CI)	Cases[a]	% (95% CI)
Sex						
Male	8,500	81,412	156	1.9 (1.6–2.3)	87	58.4 (49.2–67.0)
Female	9,024	73,850	405	4.5 (4.0–5.0)	276	71.1 (65.7–76.1)
Age group (years)						
18–29	4,059	38,916	46	0.9 (0.6–1.2)	32	70.9 (52.8–84.2)
30–44	5,967	49,624	181	3.0 (2.5–3.6)	129	74.0 (66.1–80.5)
45–64	6,506	59,041	299	4.7 (4.1–5.4)	190	66.8 (60.0–73.0)
≥65	992	7,681	35	3.9 (2.7–5.5)	12	32.2 (17.8–50.9)
Race/ethnicity						
Non-Hispanic white	9,997	106,033	360	3.5 (3.1–3.9)	218	63.9 (58.0–69.4)
Non-Hispanic black	2,600	16,822	93	3.6 (2.8–4.6)	75	85.6 (76.1–91.8)
Non-Hispanic Asian	1,112	7,278	11	*1.3 (0.6–2.7)	†	†
Non-Hispanic other race	351	2,856	15	3.1 (1.7–5.5)	12	71.8 (37.4–91.5)
Hispanic	3,464	22,273	82	1.9 (1.5–2.5)	50	62.5 (47.8–75.2)
Marital status						
Married	8,105	86,431	262	3.3 (2.9–3.8)	159	65.0 (58.1–71.3)
Widowed	514	2,902	21	3.9 (2.4–6.1)	16	73.5 (48.7–89.0)
Divorced or separated	2,983	17,626	138	4.9 (4.1–5.9)	93	68.6 (58.3–77.4)
Never married	4,661	35,565	102	1.8 (1.4–2.3)	67	67.3 (56.0–76.9)
Living with partner	1,232	12,564	38	3.3 (2.4–4.7)	28	76.8 (59.9–88.1)
Education[b]						
Less than HS diploma	1,812	13,049	56	3.7 (2.7–4.9)	40	76.8 (62.4–86.8)
HS/GED diploma	3,685	32,164	159	4.5 (3.8–5.5)	110	71.8 (63.2–79.1)
Some college	4,656	39,755	196	4.1 (3.5–4.8)	132	68.5 (60.7–75.4)
BA/BS degree and higher	5,284	48,309	133	2.5 (2.0–3.0)	68	55.3 (44.4–65.7)
Place of residence						
Large MSA	9,796	84,106,619	286	2.9 (2.5–3.4)	182	67.7 (60.7–74.0)
Small MSA	5,266	48,741,054	181	3.2 (2.7–3.8)	127	69.3 (61.4–76.2)
Not in MSA	2,462	22,414,415	94	3.7 (3.0–4.6)	54	61.2 (48.4–72.6)
Region						
Northeast	2,685	27,042,810	77	2.6 (2.0–3.3)	44	56.7 (43.9–68.6)
Midwest	3,948	36,931,599	139	3.6 (2.9–4.4)	88	63.9 (53.1–73.6)
South	6,421	54,415,112	228	3.4 (2.9–4.0)	155	72.2 (65.3–78.1)
West	4,470	36,872,567	117	2.8 (2.2–3.5)	76	69.8 (59.0–78.7)
Total	17,524	155,262,088	561	3.1 (2.8–3.5)	363	67.1 (62.4–71.6)

Cases of current CTS include adults who reported having the condition in the past 12 months. Work-related CTS does not include adults who were diagnosed with CTS prior to age 15. Data includes U.S. adults who worked in the past 12 months and are part of the civilian non-institutionalized population. All estimates weighted unless otherwise noted.
Est., estimated; CI, confidence interval; HS, high school; GED, General Educational Development; BA/BS, bachelor's; MSA, metropolitan statistical area; NCHS, National Center for Health Statistics.

[a]Unweighted.

[b]Education only shown for persons aged 25 years and over.

†Estimates with a RSE >50% or that are based on cell sizes of ≤10 are not shown as they do not meet NCHS standards of reliability/precision.

*Estimates preceded by an asterisk have a RSE >30% and ≤50% and should be used with caution as they do not meet NCHS standards of reliability/precision.

most recent jobs, and 68 (18.6%) were attributed to jobs other than the respondents' current/most recent or longest-held jobs (weighted proportions). Two respondents who reported having work-related CTS did not report the specific job to which their CTS cases were attributed.

Among current CTS cases attributed to specific jobs, 24.0% were attributed to jobs in the manufacturing industry, a proportion 2.53 times higher than the proportion of current/recent workers employed in the manufacturing industry (9.5%; Table III), suggesting that jobs in this industry are associated with an increased risk of work-related CTS.

TABLE III. Comparison of the Distribution of Work-Related Cases of CTS by Industry Sector to the Distribution of Current/Recent U.S. Workers by Industry Sector

	Distribution of work-related cases of CTS by industry sector		Distribution of current/recent workers by industry sector		
Industry (NAICS sector)	Cases[a]	Proportion (95% CI)	Frequency[a]	Proportion (95% CI)	Ratio of % of work-related CTS cases to % of current workforce
Manufacturing (31–33)	71	24.0 (18.7–30.2)	1,590	9.5 (9.0–10.1)	2.53
Finance and insurance (52)	19	5.0 (2.9–8.3)	730	4.2 (3.8–4.5)	1.19
Public administration (92)	26	6.0 (3.7–9.4)	934	5.2 (4.8–5.7)	1.15
Other services (except public administration; 81)	21	5.8 (3.5–9.5)	919	5.1 (4.7–5.5)	1.14
Accommodation and food services (72)	23	7.8 (4.9–12.4)	1,223	7.0 (6.5–7.5)	1.11
Health care and social assistance (62)	43	12.5 (9.2–16.8)	2,444	13.2 (12.6–13.8)	0.95
Retail trade (44–45)	37	10.6 (7.5–14.6)	1,795	11.3 (10.6–11.9)	0.94
Transportation and warehousing (48–49)	12	*3.7 (1.9–7.2)	714	4.0 (3.7–4.4)	*0.93
Administrative and support and waste management and remediation services (56)	12	*4.1 (2.2–7.7)	848	4.5 (4.2–4.9)	*0.91
Education services (61)	22	5.8 (3.6–9.1)	1,694	10.0 (9.5–10.6)	0.58
Construction (23)	12	*3.8 (2.0–7.2)	1,115	7.0 (6.5–7.4)	*0.54
Professional, scientific, and technical services (54)	16	3.1 (1.7–5.4)	1,153	6.9 (6.4–7.3)	0.45
Total[b]	348	100.0 (n/a)	17,227	100.0 (n/a)	1.00

Work-related CTS does not include adults who were diagnosed with CTS prior to age 15. Data includes U.S. adults who worked in the past 12 months and are part of the civilian non-institutionalized population. Estimates are not shown for the following industries (NAICS sector) as they contained ≤10 cases and do not meet NCHS standards of reliability/precision: management of companies and enterprises (55); agriculture, forestry, fishing, and hunting (11); information (51); wholesale trade (42); utilities (22); arts, entertainment, and recreation (71); real estate and rental and leasing (53); and mining (21). Abbreviations: NAICS, North American Industry Classification System; CTS, carpal tunnel syndrome; n/a, not applicable; RSE, relative standard error; NCHS, National Center for Health Statistics.

[a]Unweighted.

[b]Total includes cases from the industry sectors noted above that each had ≤10 cases. Total excludes cases attributed to jobs in the Armed Forces and cases with missing data.

*Proportions preceded by an asterisk have a RSE >30% and ≤50% and should be used with caution as they do not meet NCHS standards of reliability/precision. Ratios preceded with an asterisk were generated using estimates with a RSE >30% and ≤50% and should be used with caution.

Sample sizes allowed for calculation of similar ratios for 11 other major industry categories. Most of these ratios approach 1.0, but three industry groups have ratios <0.6 indicating that they account for much lower proportions of work-related CTS cases than their proportions in the workforce: education services (ratio = 0.58); construction (ratio = *0.54); and professional, scientific, and technical services (ratio = 0.45; Table III).

Three occupation categories accounted for proportions of work-related CTS cases more than 1.5 times greater than their proportions in the workforce: production (ratio = 2.52); office and administrative support (ratio = 1.66); and personal care and service (ratio = 1.53; Table IV). Several white-collar occupation groups were underrepresented among work-related CTS cases, including management (ratio = 0.53) and education, training, and library (ratio = *0.49).

DISCUSSION

This is one of the first papers to report results from the 2010 NHIS-OHS. Its focus is on the prevalence and work-relatedness of CTS. This is the first time in 22 years that information on prevalent cases of CTS among adults has been collected by the NHIS, the last time being in 1988 as part of the previous OHS.

Among all adults, we found a lifetime prevalence rate of self-reported clinician-diagnosed CTS of 8.0% and a 12-month prevalence rate of self-reported clinician-diagnosed CTS of 3.6%. The latter estimate is consistent with a recent literature review concluding that prevalence rates of electrophysiologically confirmed, symptomatic CTS, based on studies conducted outside the U.S., range from approximately 1 to 4% in men and 3 to 5% in women, increasing with age [Lawrence et al., 2008].

Methodological Considerations

For this study, cases of CTS were identified from the survey question, ''Have you ever been told by a doctor or other health professional that you have a condition affecting the wrist and hand called carpal tunnel syndrome?'' Clinical diagnosis of CTS is complex and a variety of research and/or surveillance case definitions for CTS and

TABLE IV. Comparison of the Distribution of Work-Related Cases of CTS by Occupational Category to the Distribution of Current/Recent U.S. Workers by Occupational Category

	Distribution of work-related cases of CTS by occupational category		Distribution of current/recent workers by occupational category		Ratio of % of work-related CTS cases to % of current workforce
Industry (SOC major group)	Cases[a]	Proportion (95% CI)	Frequency[a]	Proportion (95% CI)	
Production (51)	49	15.1 (10.7–20.8)	1,053	6.0 (5.5–6.4)	2.52
Office and administrative support (43)	81	22.2 (17.7–27.4)	2,400	13.4 (12.8–14.0)	1.66
Personal care and service (39)	18	5.8 (3.4–9.8)	672	3.8 (3.4–4.1)	1.53
Community and social services (21)	11	*2.3 (1.2–4.4)	333	1.8 (1.6–2.1)	*1.28
Installation, maintenance, and repair (49)	14	4.2 (2.5–6.8)	564	3.5 (3.2–3.8)	1.20
Food preparation and serving related (35)	22	6.9 (4.2–11.2)	997	5.8 (5.3–6.2)	1.19
Transportation and material moving (53)	18	5.1 (3.0–8.5)	978	5.7 (5.3–6.1)	0.89
Building and grounds cleaning and maintenance (37)	11	*3.0 (1.6–5.8)	767	3.9 (3.6–4.3)	*0.77
Healthcare practitioners and technical (29)	13	*3.3 (1.8–5.9)	855	4.8 (4.4–5.1)	*0.69
Sales and related (41)	25	7.0 (4.6–10.6)	1,743	10.6 (10.0–11.2)	0.66
Construction and extraction (47)	11	*3.6 (1.9–6.7)	906	5.7 (5.3–6.1)	*0.63
Business and financial operations (13)	12	*2.9 (1.5–5.5)	821	4.6 (4.2–5.0)	*0.63
Management (11)	19	5.0 (3.0–8.4)	1,497	9.4 (8.9–10.0)	0.53
Education, training, and library (25)	11	*3.3 (1.7–6.4)	1,125	6.8 (6.4–7.3)	*0.49
Total[b]	349	100.0 (n/a)	17,219	100.0 (n/a)	1.00

Work-related CTS does not include adults who were diagnosed with CTS prior to age 15. Data includes U.S. adults who worked in the past 12 months and are part of the civilian non-institutionalized population. Estimates are not shown for the following occupational categories (SOC major group) as they contained $\leq$10 cases and do not meet NCHS standards of reliability/precision: architecture and engineering (17); arts, design, entertainment, sports and media (27); computer and mathematical (15); farming, fishing, and forestry (45); healthcare support (31); legal (23); life, physical, and social science (19); and protective service (33). Abbreviations: SOC, Standard Occupational Classification; CTS, carpal tunnel syndrome; n/a, not applicable; RSE, relative standard error; NCHS, National Center for Health Statistics.

[a]Unweighted.

[b]Total includes cases from the industry sectors noted above that each had $\leq$10 cases. Total excludes cases attributed to jobs in the Armed Forces and cases with missing data.

*Proportions preceded by an asterisk have a RSE $>$30% and $\leq$50% and should be used with caution as they do not meet NCHS standards of reliability/precision. Ratios preceded with an asterisk were generated using estimates with a RSE $>$30% and $\leq$50% and should be used with caution.

work-related musculoskeletal disorders in general have been proposed and evaluated, many of which are based on combinations of reported symptoms, physical exam findings, and/or electrodiagnostic studies [e.g., Silverstein et al., 1997; Rempel et al., 1998; Descatha et al., 2011]. Unfortunately, due to the nature of this study (i.e., relying on data collected from a few questions that were part of a broad health questionnaire), we were only able to use a very crude case definition for CTS: self-report of a clinician diagnosis of CTS. It is unclear how the accuracy of this case definition compares to case definitions used in research studies. Such a comparison would be difficult since epidemiological studies of CTS that include clinical evaluations generally exclude persons with previously diagnosed CTS, in contrast to our study that examined lifetime and current clinician-diagnosed CTS.

We believe that our study definition for work-related CTS, which relies on self-reported attribution of the case to work by a clinician, is conservative because there are many barriers (or filters) to recognition of a condition as work-related by a clinician [Azaroff et al., 2002]. When physicians were asked to report all cases of work-related CTS to the Massachusetts Department of Public Health, there was evidence of significant underreporting, which may at least partially reflect under-recognition of work-relatedness [Davis et al., 2001]. An evaluation of occupational disease reporting systems in the United Kingdom demonstrated that reporting from occupational physicians yielded much higher incidence estimates than reporting by clinical specialists, suggesting that under-recognition of the work-relatedness of disease varies by specialty [Cherry and McDonald, 2002]. It is unknown what proportion of NHIS respondents with CTS had seen occupational physicians, but we suspect that it would be small.

On the other hand, some epidemiologists have argued against measuring the burden of occupational disease by relying on occupational attribution of individual cases of conditions that may be influenced by many factors—including both occupational and non-occupational contributing causes—as is the case for CTS [Coggon, 2001; Palmer et al., 2008]. They suggest that calculating attributable fractions to estimate excess risk is more meaningful

[Palmer et al., 2008; Roquelaure et al., 2008]. We plan to calculate attributable fractions in future analyses.

Comparison to Estimates from the Bureau of Labor Statistics' (BLS) Annual Survey of Occupational Illness and Injury (SOII)

We found a prevalence rate of current work-related CTS among current/recent workers of 2.1% (or 210 cases per 10,000 workers) in 2010. Between 2003 and 2009, incident rate estimates from the BLS SOII for occupational CTS resulting in days away from work have ranged from a high of 2.5 per 10,000 full-time workers to 1.0 per 10,000 full-time workers. Our findings of a higher prevalence rate of CTS among females compared to males and of higher prevalence rates in the middle age groups compared to the youngest and oldest workers are consistent with patterns of reported occupational CTS according to recent SOII data. Our findings regarding the distribution of work-related CTS cases by occupation were also consistent with 2006–2009 BLS SOII data, which indicate that the three occupational groups with the highest rates of CTS cases involving days away from work were production; office and administrative support; and installation, maintenance, and repair [BLS, 2011].

Caution must be used when comparing prevalence rate estimates from the NHIS-OHS to incident rates from the BLS SOII, which is based on OSHA recordkeeping requirements for private industry. The NHIS-OHS would be expected to capture more cases of work-related illness than the BLS SOII for at least three reasons. First, prevalence estimates include chronic ongoing cases, whereas SOII incident rates are limited to incidents meeting the OSHA definition for a new case [OSHA, 2005]. Second, unlike the BLS SOII, the NHIS-OHS is designed to capture cases of any severity, not just those meeting OSHA recordkeeping criteria (i.e., moderate-to-severe cases). Third, there are several groups of workers that are not covered by OSHA: self-employed workers, public sector workers, and individuals employed on farms with 11 or fewer workers. Nevertheless, the present findings suggest that the burden of work-related CTS is underestimated by the BLS SOII.

Comparison to Estimates From the 1988 NHIS-OHS

In the 1988 NHIS-OHS, prolonged hand or wrist discomfort not due entirely to an injury was examined, as this can be a potential indicator of CTS, although it could also be an indicator for many other hand-wrist disorders besides CTS. The prevalence rate of such hand or wrist discomfort among current/recent workers in 1988 was 10.7%, but only 1.6% of current/recent workers self-reported CTS when asked about the condition by name [Behrens et al., 1994; Tanaka et al., 1994]. Fifty-three percent of medically diagnosed CTS cases among current/recent workers in 1988 were attributed to work by a health care provider [Tanaka et al., 2001]. In 2010, the proportion of CTS attributed to work ranged from 58.4% among male workers to 71.1% among female workers. Our findings suggest that CTS may be more prevalent (or at least more widely referred to by name) and more widely attributed to work by healthcare providers now than in 1988.

For medically diagnosed CTS reported in the 1988 NHIS-OHS, bending/twisting of the hands/wrists many times per hour on the job was found to be a stronger risk factor than several established non-occupational risk factors [race, age, body mass index, smoking, education, and family income; Tanaka et al., 1997]. Industries with the highest prevalence of reported CTS in 1988 were food products, repair services, transportation, and construction [Tanaka et al., 1995]. The occupation group with the highest prevalence of prolonged hand or wrist discomfort in 1988 was operators of machines that process metal, plastic, stone, and glass [Behrens et al., 1994]. The overrepresentation of work-related CTS among jobs in the manufacturing industry and production occupation categories in 2010 is consistent with the high prevalence rates of hand discomfort among workers in the food product manufacturing subsector and machine operators in 1988. Some findings from the present study were also consistent with results from a California surveillance program that evaluated 3,358 CTS cases during 1998–2000 and found that technical, sales, and administrative support occupations consistently accounted for a disproportionate number of CTS cases [NIOSH et al., 2004, see Figures 2–54].

Industry and occupation groups that account for disproportionate shares of work-related CTS cases suggest opportunities for prevention. Strategies for the prevention of work-related musculoskeletal diseases, including CTS, which have been previously identified by NIOSH include both engineering controls and administrative controls. Engineering controls include designing or selecting workstation layouts, tools, and work methods that minimize stress and strain. Administrative control strategies include changes in job rules and procedures such as scheduling more rest breaks, rotating workers through jobs that are physically tiring, and training workers to recognize and reduce ergonomic risk factors [NIOSH et al., 1997].

Study Strengths

Including occupational health questions in national population-based surveys such as the NHIS overcomes some of the limitations of traditional occupational health surveillance systems, including the BLS SOII [Lalich and

Sestito, 1997]. Unlike the BLS SOII, an NHIS-OHS is representative of all classes of workers and can collect detailed information about work-related conditions that do not result in medical treatment beyond first aid or days away from work. Some filters that lead to underreporting in the BLS SOII do not apply to an NHIS-OHS because information about work-related illnesses and injuries is collected directly from workers outside of the workplace setting [Azaroff et al., 2002].

Limitations

Despite its strengths, this study is subject to several limitations. First, all prevalence estimates of CTS are based on a self- or proxy respondent-report, which is subject to several types of error [Schenker et al., 2010]. For example, some respondents without adequate access to healthcare might have undiagnosed CTS which could lead to underestimation of the true prevalence of CTS. On the other hand, some respondents may misreport other diagnoses as CTS, leading to overestimation of the true prevalence. Second, it is difficult to assess occupational causality of health conditions through self-report, and relying on reported attribution of the condition to work by a health professional likely underestimates work-relatedness. Furthermore, the distribution of I&O categories to which work-related CTS cases were attributed may be influenced by non-random distribution of demographic groups with relatively high underlying (non-occupational) risk of CTS (e.g., females) among I&O categories rather than, or in addition to, differences in occupational exposures. There are also limitations associated with the I&O groups used in these analyses. On one hand, broad I&O categories lump together workers who likely have substantially different workplace exposures. On the other hand, small sample sizes even within some broad I&O groups, prevent the reporting of estimates. Ideally the OHS questions would be repeated over multiple years in the NHIS with minimal time lag between administrations (e.g., every 3–5 years). This would allow for sample sizes to increase by pooling data from different years, and for researchers to obtain more stable estimates. However, before this multi-year repetition could happen, funding and other limitations would first have to be overcome. Finally, the economic climate and high unemployment rates in the United States during 2010 should also be considered when interpreting our findings as these conditions could have potentially influenced the NHIS-OHS estimates.

CONCLUSIONS

We found that the overall lifetime prevalence of self-reported clinician-diagnosed CTS among current/recent workers was 6.7%, and that the 12-month prevalence of CTS among current/recent workers was 3.1%, representing approximately 4.8 million workers with current CTS. Approximately one third of current CTS cases among current/recent workers were attributed to work by health professionals, indicating that at least 3 million workers experienced work-related CTS in 2010. The proportion of current CTS cases related to work varied by demographic characteristics. Among current CTS cases attributed to specific jobs, certain I&O categories were overrepresented compared to their distribution among the workforce, suggesting that jobs in those categories are associated with an increased risk of work-related CTS. More detailed analyses of 2010 NHIS data may provide more insight into hypotheses raised by the prevalence estimates and ratios provided here. We plan to explore other methods for using these data to estimate the proportion of CTS attributable to employment among U.S. workers, and we encourage other researchers to explore this publicly available dataset also.

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