

Prevalence of Carpal Tunnel Syndrome Among Dairy Workers

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Background *The purpose of this study was to determine the prevalence of carpal tunnel syndrome (CTS) among dairy workers.*

Methods *Sixty-six dairy parlor workers and 58 non-parlor workers at dairies in Texas, New Mexico, and Colorado participated in structured interviews regarding demographics, work history, and hand symptoms. All participants had nerve conduction studies performed on both hands across the carpal tunnel. A CTS case definition was based on the presence of characteristic CTS symptoms and an abnormal median mononeuropathy across the carpal tunnel.*

Results *The prevalence of CTS among the dairy parlor workers was 16.6% and 3.6% among non-parlor workers. The difference was found to be statistically significant ($P < 0.05$) with an odds ratio of 5.3, CI (1.1–25.5).*

Conclusions *The results of this study indicate that CTS is a significant challenge for dairy parlor workers. The prevalence of CTS was found to be significantly higher among dairy workers performing tasks in the milking parlor as opposed to workers performing tasks in other areas of the dairy farm. The results emphasize the need for administrative and engineering controls to limit the exposure to physical risk factors that are associated with upper limb disorders such as CTS. Am. J. Ind. Med. 55:127–135, 2012. © 2011 Wiley Periodicals, Inc.*

KEY WORDS: *carpal tunnel syndrome; nerve conduction studies; dairy workers; occupational*

INTRODUCTION

Carpal tunnel syndrome (CTS) is a musculoskeletal disorder resulting from an ischemic response to the median nerve in the carpal canal [Clark et al., 2004] and is often associated with occupational tasks involving highly repetitive motions and forceful muscle contractions of the upper limb [Barr et al., 2004; Clark et al., 2004]. Occupational related CTS often results in restricted workdays, lost work time, and lengthy disability for workers [Manktelow et al., 2004; Daniell et al., 2009].

The prevalence of CTS among general working population has been reported to range from 0.6 to 4.9% [De Krom et al., 1992; Atroshi et al., 1999; Armstrong et al., 2008]. In France, a higher prevalence of CTS was reported among farmers as compared to white-collar workers [Roquelaure et al., 2008]. Additionally, an extremely

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high prevalence (68%) of CTS was reported among Italian sheep farmers that continued the traditional hand milking of sheep [Rosecrance et al., 2001]. The milking task performed by workers in modern mechanized dairy parlors also involves a significant amount of repetitive motion, forceful exertions, and awkward hand and wrist motions [Pinzke et al., 2001; Patil et al., 2010]. Exposure to repetitive and forceful hand and wrist motions has been suggested to increase the risk of CTS among workers from a variety of occupations [Siverstein et al., 1987; Franzblau and Werner, 1999; Stål et al., 1999; Aptel et al., 2002; Van Rijn et al., 2009].

Modern large-herd dairy operations utilize fast-paced mechanical milking systems designed for the efficient mass production of milk. In large-herd dairy parlors like those observed in the present study, milking tasks performed by workers can be divided into four hand and wrist intensive subtasks namely; (1) dipping, (2) cleaning, (3) stripping, and (4) attaching the milking cluster to the cow's udder. These dairy parlor subtasks have been characterized as rapid, repetitive, forceful and include awkward postures of the hands, wrists, and shoulders [Patil et al., 2010]. All subtasks are performed by each milker. While performing the subtask of "dipping", disinfecting solution is applied to the cow's teats. The "dipping" task is followed by "cleaning", where the cow's teats are manually wiped using a clean cloth. The subtask of "stripping" involves stimulating the udder for milk "let-down" by manually milking each of the cow's four teats. Because the area around the cow's teats is usually wet from water, milk, and cleaning fluids, workers usually wear rubber gloves during this and other subtasks. Stripping is followed by the subtask of "attaching" where a milking cluster weighing about 1.8–3.5 kg is attached to the udder of each cow. After the cows have been milked, the milking clusters detach automatically and the cows are released and the cycle is repeated. Most large-herd dairy parlors require 3–4 parlor workers per shift to perform the milking tasks. Workers assigned to tasks outside of the dairy parlor perform a number of non-repetitive tasks such as animal feeding, calf care, driving heavy equipment, and general maintenance. It was estimated that US dairy farms employ about 138,124 full-time equivalent workers, with 50% being immigrants [Rosson et al., 2009].

As the US dairy industry continues to move to a more industrialized mass production model, dairy workers involved in milking tasks will be performing more highly specialized tasks involving high repetition, reduced rest time, and awkward upper extremity postures [Doughrati et al., 2009]. The purpose of this cross-sectional study was to determine the prevalence of CTS among dairy workers that perform work in the milking parlor and compare it to prevalence of CTS among non-

parlor dairy workers. The current study was the first to investigate the prevalence of CTS among dairy parlor workers.

PARTICIPANTS AND METHODS

Participants

Dairy parlor and non-parlor workers employed at six large-herd dairies from Colorado, New Mexico, and Texas were recruited to participate in this study. The physical layout of the six dairies represented the three most common dairy parlor configurations (1. parallel, 2. herringbone, and 3. rotary) for handling and milking cows. These configurations correspond to the physical alignment of cows as they are milked. Among the six dairies, there were three parallel, two herringbone, and one rotary style dairy. The number of cows milked on a daily basis (2–3 times per day) at these dairies ranged from 1,000 to 4,400 with a mean of 2,667.

Recruitment of workers was conducted through verbal announcements at the dairy, and by posted notices in the lunch area of the dairies. An incentive of \$20 was offered to each potential dairy participant. All workers present at each of dairies on the day of testing were included in the study resulting in a 100% participation rate. One hundred and twenty-four dairy workers participated. Parlor workers participating in the study performed milking tasks as described in the introduction while non-parlor workers performed tasks such as herding cows, animal husbandry, driving tractors, and feeding cows. The study sample consisted of both male and female participants. All participants were Latino/Latina. The participants were thoroughly informed of the procedures in the Spanish language (written and verbally if necessary) prior to signing informed consents. The research procedures were reviewed and approved by the institutional review board (Research Integrity & Compliance Review Office) at the investigator's academic institution.

Case Definition of CTS

The CTS case definition used in the present study was based on the presence of median mononeuropathy across the carpal tunnel and characteristic CTS symptoms. A median-ulnar latency difference of ≥ 0.5 ms and the presence of characteristic CTS hand symptoms qualified the participant for a CTS case status. The CTS case definition used in this study was similar to the case definitions used in other CTS related epidemiologic studies [Anton et al., 2002; Rosecrance et al., 2002; Atroshi et al., 2003; Werner et al., 2005; El Miedany et al., 2008; Rosecrance and Doughrati, 2010].

Hand Symptom Questionnaire

Participants completed a hand symptom questionnaire which included a hand symptom diagram adapted from Katz and Stirrat [1990] which has been used in previous epidemiologic studies [Bingham et al., 1996; Anton et al., 2002; Rosecrance et al., 2002; Werner et al., 2005; Hou et al., 2007]. Similar hand diagram questionnaires have been reported to produce reliable results in a diverse working population [Dale et al., 2008]. A trained Spanish translator interviewed the participants and administered the hand symptom questionnaire. The validity and reliability of using Spanish translators for the hand symptom questionnaire has not been studied; however, previous studies have used Spanish versions of different health-related outcomes and found acceptable levels of reliability and validity [González et al., 1995; Weiss and Berger, 2006]. There is evidence that an overestimation of CTS symptom prevalence can be minimized by conducting a CTS symptom interview rather than a relying on self-reported symptom questionnaires [Thomsen and Mikkelsen, 2003].

The questionnaire was also designed to elicit general information on demographics, self-reported pre-existing medical conditions (co-morbidities), employment history, and duration and intensity of specific hand symptoms. The participants were instructed to rate hand symptoms such as numbness, tingling, or aching, on a 0–10 scale and shade the appropriate symptoms as per their location on a hand diagram. Hands were classified as having characteristic CTS symptoms if participants rated their symptom intensity at least 2 on the 0–10 scale and had numbness or tingling localized in two or more of the first four fingers corresponding to median nerve distribution. Additionally, the symptoms must have occurred sometime in the past 12 months, have been present for at least 2 weeks, and have occurred while working in their respective dairy position. The median distribution consisted of the ventral aspect of the digits 1, 2, 3, ventral-radial aspect of the 4th finger, as well as the dorsal aspect of the distal phalanx of each of these digits. This symptom classification was similar to that used in other epidemiological studies of CTS [Katz and Stirrat, 1990; Franzblau et al., 1993; Rempel et al., 1998; Werner et al., 2005; Armstrong et al., 2008]. The hand symptom questionnaire further included questions regarding the duration of hand symptoms, nocturnal symptoms, and pain-aggravating activities.

Nerve Conduction Studies

After completing the hand symptom questionnaire, nerve conduction studies (NCS) were performed on both hands of each participant. NCS were conducted using the Cadwell Sierra II Wedge nerve conduction equipment

(Cadwell Labs, Kennewick, WA). The NCS were performed by two physical therapists experienced in conducting electrophysiologic exams for CTS. The choice of electrophysiologic studies were based on the recommendations set forth by the American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM) [Jablecki et al., 1993; Jablecki et al., 2002].

Orthodromic, 8 cm midpalmar to wrist sensory nerve latencies were determined for median and ulnar nerves by performing supramaximal stimulation in the palm with a handheld bipolar stimulator. The specific procedures for the NCS can be found in previously published studies [Bingham et al., 1996; Rosecrance et al., 2001, 2002; Anton et al., 2002]. The sensory latency was defined as the time interval between the stimulus artifact and the peak of the negative aspect of the mixed nerve action potential. Additionally, median motor latencies were obtained by supramaximal stimulation of the median nerve for the abductor pollicis brevis among all the participants. Median and ulnar latency measurements were recorded and the median–ulnar latency difference (MULD) was calculated for each participant. Median mononeuropathy across the carpal tunnel was defined as a median and ulnar sensory latency difference equal to 0.5 ms or greater. Other occupational studies reporting CTS prevalence have used the 0.5 ms MULD for the 8 cm palm to wrist segment [Bingham et al., 1996; Rosecrance et al., 2001, 2002; Anton et al., 2002]. The 0.5 ms MULD has been considered to be a conservative criterion for determining median neuropathy across the carpal tunnel [Redmond and Rivner, 1988]. If a median sensory latency could not be obtained an 8 cm temperature adjusted antidromic median motor latency of greater than 4.4 ms was used as the criterion for median mononeuropathy. Hand temperature was measured in the first web space of all hands. Hands with surface temperatures below 30°C were warmed using warm water. The ulnar nerve was also evaluated in this study and it served as an internal control for the influences of hand temperature, age, and systemic disease [Jablecki et al., 1993; Jablecki et al., 2002].

Statistical Analyses

All descriptive data for the demographic and occupational variables were reported as means and standard deviations, or frequencies and percentiles. Prevalence ratios were determined for parlor and non-parlor dairy workers with only median mononeuropathy, only symptoms of CTS and for those with a case definition of CTS (both neuropathy and symptoms). The prevalence ratios for these three types of cases were compared between parlor and non-parlor workers using a χ^2 test for proportions and odds ratios (OR) with their 95% confidence interval (CI) determined. Student's *t*-tests were performed to determine

the demographic factor differences between parlor and non-parlor workers.

Additionally, analyses were performed univariately to assess the association of CTS prevalence with demographic and occupational variables. A maximum likelihood ratio test was used to determine the significance of associations. The relatively small sample size used in the present study limited the usefulness of a logistic regression analysis to assess the association of CTS with demographic and job variables. All data in this study was analyzed using per SAS, Version 9.2 for PC software (SAS Institute, Cary, NC).

RESULTS

Study Sample

The study sample consisted of 124 dairy workers from six dairies located in Texas, New Mexico, and Colorado. Among the workers that participated, 66 (53.2%) were dairy parlor workers and 58 (46.7%) were non-parlor workers. All of the participants were Latino/Latina. Twelve percent ($n = 15$) of the participants were females. Among the non-parlor workers 10.3% ($n = 6$) were females, whereas 13.6% ($n = 9$) of the parlor workers were female. Four participants (3.2%) were excluded from the data analyses because they had self-reported comorbidity (diabetes, hypothyroidism, and rheumatoid arthritis). Among these four participants, one was a parlor worker while the other three were non-parlor workers.

Demographic Variables

The participants ranged in age from 26 to 44 years with a mean of 36.8 (SD 8.9) years (Table I). The mean age (29.8 years, SD 7.8 years) of the parlor workers was significantly less ($P < 0.05$) than the mean age (33.6 years, SD 9.3 years) of non-parlor workers. The mean body mass index (BMI; kg/m^2) of all participants was

28.4 kg/m^2 (SD 5.5) with a range of 22.8 to 36.2 kg/m^2 . The mean BMI (25.2 kg/m^2 , SD 3.9) for parlor workers was significantly less ($P < 0.05$) than it was for non-parlor workers (28.1 kg/m^2 , SD 5.8). The dairy parlor workers performed parlor work for a mean of 4.5 years (SD 3.7), whereas the non-parlor workers had performed non-parlor tasks for a mean of 5.5 years (SD 5.4). The parlor workers worked significantly ($P < 0.05$) fewer hours (mean = 48.8 hr, SD 3.1) per week than the non-parlor workers (mean = 53.1 hr, SD 8.8). Among the parlor workers, 97% ($N = 63$) were right-handed and 3% ($N = 2$) were left-handed. Whereas among non-parlor workers 94.5% ($N = 52$) employees were right-handed and 5.5% ($N = 3$) were left-handed. Thirty four percent ($N = 19$) of the non-parlor workers used tobacco products whereas 23% ($N = 15$) of the parlor workers used tobacco products.

Nerve Conduction Variables and CTS

The mean latencies for the right and left hand median sensory, ulnar sensory, and median motor nerves as well as median ulnar latency difference (MULD) among parlor and non-parlor workers are presented in Table II. None of the differences in latencies between the two groups were statistically significant at the $P = 0.05$ level. Thirteen dairy workers who had hand symptoms characteristic of CTS were also classified as having median mononeuropathy across the carpal canal in at least one hand. The overall prevalence of CTS in at least one hand among all the dairy workers was 10.8% (13/120). The prevalence of CTS among the parlor workers was 16.9% ($n = 11$) as compared to 3.6% ($n = 2$) among non-parlor workers.

A univariate analysis that included all dairy workers indicated no significant association ($P > 0.1$) between CTS and age, BMI, number of years worked performing the dairy tasks, or number of hours worked per week. There was no significant difference between the ages of workers with CTS (35.3 years) and without CTS

TABLE I. Baseline Characteristics of Dairy Workers

Baseline characteristics	Parlor workers (N = 65)	Non-parlor workers (N = 55)	P-value
Age, years \pm SD	29.8 \pm 7.8	33.6 \pm 9.3	0.014*
Body Mass Index (kg/m^2) \pm SD	25.2 \pm 3.9	28.1 \pm 5.8	0.001*
Height (m) \pm SD	1.6 \pm 0.1	1.7 \pm 0.09	0.155
Weight (Kg) \pm SD	72.7 \pm 10.6	83.3 \pm 18.2	0.001*
Gender, n (%)			
Males	56 (86.1)	49 (89.7)	—
Females	9 (13.6)	6 (10.3)	—
Number of years worked \pm SD	4.5 \pm 3.7	5.5 \pm 5.4	0.211
Number of hours worked per week \pm SD	48.8 \pm 3.1	53.1 \pm 8.8	0.001*

*signifies difference at $P < 0.05$ level.

TABLE II. Descriptive Statistics of the Nerve Conduction Latencies

Job description	Median sensory latency (ms)		Ulnar sensory latency (ms)		Median motor latency (ms)		MULD (ms)	
	Right	Left	Right	Left	Right	Left	Right	Left
Parlor-worker (Mean ± SD)	2.12 ± 0.41	2.04 ± 0.31	1.80 ± 0.15	1.88 ± 0.19	4.0 ± 0.84	3.86 ± 0.64	0.32 ± 0.41	0.16 ± 0.51
Non-parlor worker (Mean ± SD)	2.07 ± 0.28	2.08 ± 0.25	1.83 ± 0.17	1.88 ± 0.15	3.87 ± 0.78	3.81 ± 0.57	0.23 ± 0.27	0.19 ± 0.24

(31.1years) ($P > 0.1$). Also, no significant difference was found between the BMI of workers with CTS (26.3 kg/m^2) and workers without CTS (28.09 kg/m^2) ($P > 0.1$). Additionally, no significant difference was found in the number of hours worked between workers with CTS (50 hr) and workers without CTS (51 hr) ($P > 0.1$) and between number of years worked in the dairy industry for workers with CTS (5.8 years) and workers without CTS (4.9 years) ($P > 0.1$).

The difference in prevalence of CTS between the parlor workers and non-parlor workers was found to be statistically significant ($\chi^2 = 5.444$, $P = 0.01$) in the univariate analysis. The risk of having CTS among parlor worker was five times greater (OR = 5.3; 95% CI = 1.14–25.52) as compared to non-parlor workers. Abnormal NCS indicating median mononeuropathy across the carpal tunnel were found in 24.6% ($n = 16$) parlor workers and 18% ($n = 10$) non-parlor workers ($P = 0.394$). The prevalence of CTS symptoms was 27% ($n = 18$) among parlor workers and 11% ($n = 6$) among non-parlor workers ($P = 0.022$) (Fig. 1). If the criterion for defining median mononeuropathy was modified by increasing or decreasing the cutoff for median–ulnar latency difference, the prevalence of CTS would also change. This change in prevalence ratios and the association of work task and CTS prevalence is illustrated in Table III. This table indicates that with each 0.1 ms change in the cutoff criterion for

defining median mononeuropathy the CTS prevalence changes by approximately 3%. The change in CTS prevalence is most dramatic when the cut-off criterion is increased from 0.5 to 0.6 ms.

DISCUSSION

This study was the first to report the prevalence of CTS among US dairy workers. We determined that CTS prevalence was nearly 17% among dairy workers involved in milking tasks at six large-herd dairies in the Midwestern U.S.A. Only one previous study [Stål et al., 1998] has reported on median nerve entrapments (pronator syndrome and CTS) in the upper extremity among parlor workers in cow dairies. Stål et al., [1998] found a high prevalence of entrapment neuropathy in the upper extremity among female parlor workers in Sweden. The mean age of the workers was 41.6 years, which is about 11 years older than the participants of the present study. Of the 41 participants included in Swedish study, 30 were diagnosed as having a median nerve entrapment in the upper extremity. Twenty-three were diagnosed as having pronator syndrome (i.e., compression of the median nerve at the forearm) and six women (14.6%) were diagnosed as having compression of the median nerve at the carpal tunnel. The diagnosis of median nerve entrapment was based on clinical examination by a hand surgeon and self-reported symptoms. Unlike the present study, no electrophysiologic tests were performed to confirm the neuropathy.

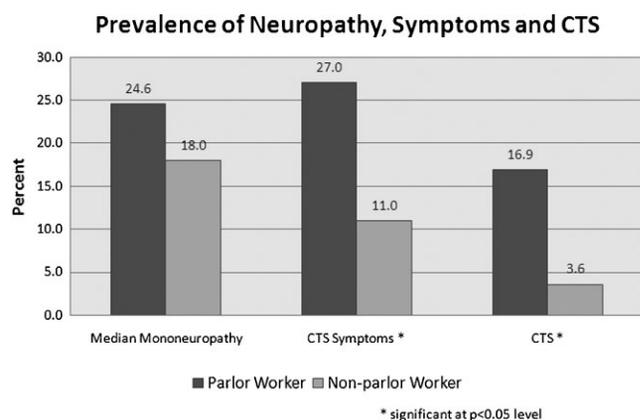


FIGURE 1. Prevalence of median nerve mononeuropathy across the carpal tunnel, characteristic CTS symptoms, and CTS (neuropathy and symptoms) for dairy parlor and non-parlor workers.

TABLE III. Increment in Median–Ulnar Latency Criterion Cutoffs and Effect on CTS Prevalence

Cutoff criterion (ms)	CTS prevalence % (n)		P-value	OR	95%CI
	Parlor worker	Non-parlor worker			
0.3	20.0(13)	5.4(3)	0.01	4.3	1.6–16.1
0.4	18.4(12)	5.4(3)	0.03	3.9	1.1–14.7
0.5	16.9(11)	3.6(2)	0.01	5.3	1.1–25.5
0.6	10.7(7)	3.6(2)	0.13	3.1	0.6–16.0
0.7	9.2(6)	1.8(1)	0.08	5.4	0.6–47.0
0.8	9.2(6)	1.8(1)	0.08	5.4	0.6–47.0

The CTS prevalence among dairy parlor workers in the present study was slightly higher than those reported for other occupational groups in studies that used similar methods for determining CTS case definitions. Among fish processing workers CTS prevalence was reported at 15% [Harn-Che et al., 1993], dental hygienists at 8.4% [Anton et al., 2002], dentists at 4.8% [Hamann et al., 2001], construction workers at 8.2% [Rosecrance et al., 2002], and ski manufacturing workers at 15.4% [Barnhart et al., 1991]. The majority of occupational CTS prevalence studies associate a combination of physical risk factors (repetition and force) with the disorder [Bernard, 1997; N.R.C., 2001]. Previous studies have demonstrated that milking tasks involving mechanical milking equipment are characterized by extreme wrist postures, repetition, and high velocities in the distal upper extremity [Stål et al., 1999; Patil et al., 2010], and high hand and forearm muscle loads [Pinzke et al., 2001]. The high muscle loads combined with repetition and extreme wrist and finger positions likely contribute to the development of CTS among dairy workers involved in milking tasks.

In a previous study [Patil et al., 2010], investigators performed an assessment of physical risk factors for upper limb disorders on parlor and non-parlor dairy work tasks using the Strain Index [Moore and Garg, 1995] and the American Conference of Governmental Industrial Hygienists (ACGIH) Hand Activity Level (HAL) [ACGIH, 2003]. The non-parlor dairy tasks involved a variety of non-cyclic tasks which did not often require extensive upper extremity use. Because the Strain Index was not developed for evaluation of non-cyclic multitask jobs, the Strain Index was only conducted on the milking parlor tasks. The dominant hand mean Strain Index scores for the subtasks dip, clean, strip, and attach were 7.3, 12, 12, and 16, respectively [Patil et al., 2010]. These findings indicate that milking job tasks increase the risk (Strain Index scores > 7) of parlor workers developing upper extremity musculoskeletal disorders such as CTS.

The ACGIH threshold limit value (TLV) of the Hand Activity Level measure is based on the worker's speed of hand movements and peak hand forces during the work task. The TLV is used to determine whether the task exceeds the recommended limits [ACGIH, 2003]. Exceeding the TLV has been positively associated with diagnosed CTS in a previous study [Franzblau et al., 2005]. The ACGIH HAL scores were determined for both parlor and non-parlor workers in large-herd dairies [Patil et al., 2010]. The ACGIH HAL scores for the parlor workers exceeded the TLV for the dominant hand in all cases whereas the HAL scores for non-parlor workers were below the TLV. These findings along with findings from the Swedish milking parlor studies [Pinzke et al., 2001; Stål et al., 2003] provide evidence that physical occupational exposures of high repetition and force may be related to

the relatively high prevalence on CTS among parlor workers in dairies.

In the present study, the case definition of CTS was based on the results of characteristic hand symptoms and a median-ulnar latency difference ≥ 0.5 ms. This median-ulnar latency cut-off criterion for CTS has been previously used in several occupational health studies [Bingham et al., 1996; Anton et al., 2002; Rosecrance et al., 2002]. Using the cut-off criterion of ≥ 0.5 ms, the difference in CTS prevalence among parlor and non-parlor workers was found to be statistically significant. The difference in CTS prevalence between the groups would have remained statistically significant even if a more sensitive criterion of ≥ 0.3 ms had been used for an abnormal NCS. Twenty percent of the parlor workers and 5.4% of the non-parlor workers would have been classified with CTS if the median-ulnar sensory latency criterion was reduced to ≥ 0.3 ms (Table III). Redmond and Rivner, [1988] recommended that a median-ulnar sensory latency difference of 0.5 ms be used as an electrodiagnostic criterion for slowing of median nerve to avoid false positive tests for CTS. If a more specific but less sensitive conduction latency criterion of ≥ 0.8 ms were used, there would still be a large but statistically non-significant difference in CTS prevalence between the two groups. As indicated in Figure 1, the prevalence of median mononeuropathy in the two job categories was not that different (24.6 vs. 18.0%) as compared to the greater difference (27.0 vs. 11.0%) in prevalence of CTS symptoms only. Thus, it appears among these two groups of dairy workers that the difference in CTS prevalence (defined as symptoms and median mononeuropathy) is largely an effect of CTS symptom presentation.

Although work in modern dairy parlors with mechanized equipment may involve physical occupational exposures related to CTS, the more primitive manual milking of animals may be associated with even greater risk for the development of CTS. In a study of CTS among workers performing manual milking tasks without mechanized equipment, Rosecrance et al., [2001] reported a CTS prevalence of 68% among Italian sheep farmers. The authors used a case definition for CTS identical to that in the present study. This CTS prevalence among the sheep farmers was much higher than the CTS prevalence among dairy parlor workers in the present study. The higher prevalence of CTS among the sheep farmers was likely related to the self-selected sample of 76 farmers that volunteered for testing and their daily task of manually milking sheep for 4–5 hr. Manual milking of sheep involves more repetitive motion and greater forceful exertions than modern mechanized milking [Rosecrance et al., 2001]. The relatively older age (mean of 47.5 years) of sheep farmers compared to the parlor workers (mean age of 30 years) in the present study also likely accounted for the high CTS prevalence.

In another study of hand milking without mechanized equipment [Kutluhan et al., 2009], investigators assessed CTS among rural Turkish women employed to manually milk cows and sheep. One hundred and sixty hands of 80 women that performed manual milking and 40 hands of 20 healthy unemployed women were clinically and electrophysiologically evaluated for CTS. In the manual milking group, CTS was detected in 60 hands (37.5%). Two hands (5%) were diagnosed as CTS in the unemployed group. CTS frequency was increased with age and correlated with the age when milking tasks began. The authors concluded that manual milking may be a risk factor for CTS development.

LIMITATIONS

There were several limitations in this cross-sectional study, including a relatively small sample size. A larger sample size would have allowed an analysis of several potential risk factors, (BMI, age, years worked, gender) that have been associated with CTS in previous studies. The age, BMI, and number of hours worked were significantly greater among non-parlor workers as compared to the parlor workers. Because previous studies have associated increases in age, BMI, and number of hours worked with CTS, this finding provides greater confidence in the main result of CTS was statistically more prevalent among dairy parlor workers. Due to the limited sample size of the current study a logistic regression analysis was not performed. Since this study was cross-sectional in design, it is limited to inferring associations between work groups and CTS. Additionally, the present study provides a measure of CTS prevalence only at a single point of time. Accordingly, participants with transient hand symptoms and transient electrophysiological symptoms may not have been categorized as a CTS case on the day of the testing. It is also possible that some participants considered their symptoms too mild to be reported. Both these errors could have lead to an underestimation of the CTS prevalence ratios in either group. Individuals with co-morbidities associated with CTS were excluded from the study. However, it was still possible that participants with unreported co-morbidities may have been included resulting in overestimation of CTS prevalence. Additionally, the dairies that participated in the study were large-herd dairy operations from Colorado, Texas, and New Mexico and may not have similar work methods and practices as other dairy operations in the United States or Europe. We did not investigate the effect that parlor design, milking methods between dairies, herd size, or other operational factors may have had on the presence of CTS. Thus, caution should be exercised if the results are generalized to other large-herd dairies outside of this small sample. It would be beneficial to investigate the effect of

these operational factors on the prevalence of CTS in future studies.

CONCLUSIONS

The results of this study indicate that CTS is a significant challenge for dairy parlor workers. The prevalence of CTS was found to be significantly higher among dairy workers performing tasks in the milking parlor as opposed to workers performing tasks in other areas of the dairy farm. Although modern mechanized milking equipment is a necessity in large-herd dairy operations, the tasks performed by the milking parlor workers involve highly repetitive movements, forceful exertions, and awkward wrist motions. The results of the present study emphasize the need for administrative and engineering controls to limit the exposure to physical risk factors that are associated with upper limb disorders such as CTS. Future studies assessing the effectiveness of interventions (e.g., educational programs, light weight milking clusters, mechanical cleansing of teats) are needed to address worker injury prevention, herd health, and productivity issues.

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