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Prevalence of carpal tunnel syndrome among employees at a poultry processing plant

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Abstract

Objective—To determine prevalence of carpal tunnel syndrome (CTS) among poultry processing employees while taking into account non-occupational factors and assess any association between CTS prevalence and exposure groups.

Methods—Performed a cross-sectional survey to assess CTS (n = 318). A CTS case was defined as an employee with self-reported CTS symptoms, an abnormal hand symptom diagram, and an abnormal nerve conduction study (NCS). Log-binomial regression was used to estimate prevalence ratios.

Results—Three hundred and one participants had sufficient symptom information or NCS data to be classified. 126 (42%) of 301 participants had evidence of CTS. In the adjusted analysis, the highest exposure group had CTS prevalence that was significantly higher than that for the lower exposure group [PR: 1.61; 95% CI = (1.20, 2.17)].

Conclusions—Increasing levels of hand activity and force were associated with increased CTS prevalence among participants. Recommendations were provided to reduce exposure to these risk factors.

Keywords

Ergonomics; Poultry processing; Occupation

1. Introduction

Across all U.S. industries, carpal tunnel syndrome (CTS) resulted in the highest number of lost workdays (25 or more days per case) in 2011 and continues to be a major cause of disability and cost to society (Bonfiglioli et al., 2013). Carpal tunnel syndrome is the most commonly reported peripheral nerve entrapment neuropathy (Herbert et al., 2000).

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On the basis of a review of several epidemiologic studies, there is evidence for positive associations between exposure to workplace factors such as repetition, force, and posture and CTS (NIOSH, 1997). Poultry work is highly repetitive and involves forceful movements and awkward postures, and puts employees at risk for CTS (Armstrong et al., 2008; Burt et al., 2011; Cartwright et al., 2012; Lipscomb et al., 2008). Previous work has found that certain medical conditions such as obesity, diabetes mellitus, and thyroid disease have been associated with CTS (Becker et al., 2002; Karpitskaya et al., 2002). Other individual risk factors for CTS include sex and age (Atcheson et al., 1998).

In 2011, approximately 224,000 U.S. poultry employees slaughtered approximately nine billion birds for human consumption (BLS, 2012; USDA, 2008). In the 1960s, 85% of broiler chickens were sold as whole carcass. At that time, only 13% were sold as cut-up parts. By 1990, only 18% were sold as whole carcass and 56% were now sold as cut-up parts (USDA, 1998). Additionally, poultry meat processing has dramatically increased within rural areas of the southern U.S. in recent decades (McPhee and Lipscomb, 2009; Owens et al., 2010).

As part of a 2012 health hazard evaluation (HHE) requested by plant management, National Institute for Occupational Safety and Health (NIOSH) investigators determined the prevalence of CTS among poultry processing employees. This workplace HHE was conducted by NIOSH investigators following the authorizing federal regulations found in 42 CFR 85. The HHE request was required by the United States Department of Agriculture (USDA)/Food Safety and Inspection Service (FSIS) to obtain an evisceration line speed waiver approval as part of its Salmonella Initiative Program.

The objective of our evaluation was to determine prevalence of CTS among poultry processing employees using an epidemiologic case definition while taking into account non-occupational factors and assess any association between CTS prevalence and exposure groups. A CTS case was defined as an employee with self-reported CTS symptoms, an abnormal hand symptom diagram, and an abnormal nerve conduction study (NCS).

2. Material and methods

2.1. Population

In May 2012, we observed work processes and practices, coordinated data collection efforts, and held confidential employee medical interviews. In August 2012, we did an ergonomic assessment of job tasks focusing on hand and wrist activity and we invited first-shift Fresh Plant production employees and all first-shift live hang contract employees to participate in our assessment. Participation was voluntary and we obtained written informed consent from participants. Among the 375 Fresh Plant first-shift production employees and live hang contractors, 318 (85%) completed the questionnaire and 284 completed an NCS; one of these NCS was not interpretable. Nerve conduction studies were not conducted on all questionnaire participants because of logistical issues and employee availability.

2.2. Poultry plant description

NIOSH investigators focused on the Fresh Plant sections of the poultry plant involving First Processing (live hanging contractors, slaughtering, eviscerating, and chilling) and Second Processing (post-chilling, deboning, and cut-up). First Processing operated two evisceration lines across two shifts. Each evisceration line operated at 90 birds per minute, which was below the maximum speed of 140 birds per minute allowed by the USDA/FSIS for a facility of this type. Second Processing included five cone lines for manual cut-up and deboning, each running at 35 birds per minute, as well as automated and manual thigh deboning.

2.3. Epidemiologic assessment of carpal tunnel syndrome

To be considered a CTS case in our evaluation, participants had to meet all of the following criteria:

- Answered "yes" on the questionnaire to having pain, burning, numbness, or tingling in the hands or wrists more than three times **or** lasting 7 days or longer in the past 12 months.
- Marked or shaded the location of their symptoms in the median nerve distribution area on a modified Katz (Katz et al., 1990) hand symptom diagram.
- Had abnormal median nerve conduction (median mono-neuropathy) (Burt et al., 2011) in the symptomatic hand (s) as determined by neurologist-interpreted NCS.

The case definition for CTS was based on published studies (American Association of Electrodiagnostic Medicine, 1992; Katz et al., 1990) including the NIOSH ergonomic musculoskeletal disorders (MSDs) consortium studies (Burt et al., 2011). A participant was considered to have evidence of CTS if at least one hand met the case definition.

2.4. Questionnaires

The questionnaire obtained information on employees' demographics (sex, age, race), work history and duties (work hours, length of employment, job rotation), and hand-intensive tasks outside of their job. We also collected medical history thought to be associated with CTS (thyroid problems, kidney failure, diabetes mellitus, pregnancy, obesity) and information on the presence, frequency, and duration of neuropathic symptoms (pain, burning, numbness, or tingling in their hands or wrists) and other musculoskeletal symptoms.

Participants who reported hand or wrist symptoms in the past 12 months also completed a hand symptom diagram (Katz et al., 1990). Participants indicated the location of their hand or wrist symptoms by marking areas on the diagrams. These diagrams were used to identify symptoms associated with a classic median nerve distribution. Two NIOSH medical officers independently evaluated the hand diagrams for each hand; a third medical officer resolved any evaluations that differed.

2.5. Nerve conduction studies

An electrodiagnostic technologist certified by the American Association of Electrodiagnostic Technologists performed all of the NCS according to established guidelines (American Association of Electrodiagnostic Medicine, 1992; American Association of Electrodiagnostic Medicine et al., 2002) and was blinded to participant's job title, medical information, and questionnaire responses. The NCS consisted of orthodromic distal median and ulnar motor and sensory latencies, amplitudes, and distances on both hands using surface electrodes and standard techniques on an XLTEK NeuroMax 1002 (Oakvale, Ontario, Canada). We measured each NCS participant's height and weight to calculate body mass index (BMI) according to the following formula:

$$\text{BMI} = \text{weight}(\text{in pounds}) \times 703/[\text{height}(\text{in inches})]^2$$

Two board-certified neurologists independently reviewed the NCS tracings and interpreted results as either normal or abnormal based on established criteria (Burt et al., 2011); they resolved discrepancies by discussion. They were blinded to participant's job title, medical information, and questionnaire responses. Abnormal median nerve conduction was defined as a slowed latency or a decreased amplitude in the median nerve and either (1) normal distal ulnar nerve latency and amplitude or (2) distal median nerve latency greater than ulnar nerve latency. Participants were provided with their NCS results, an interpretation of their meaning, and NIOSH contact information if they had questions or concerns.

3. Ergonomic exposure assessment

Our job assessments focused on hand and wrist activity, classifying jobs based on a combination of repetitive/forceful movements and extreme/awkward postures, and tool use. We identified jobs with more hand-intensive and tool-oriented tasks for further evaluation. We compared our measurements of hand activity and force to the action limit (AL) and threshold limit value (TLV®) recommended by the American Conference of Governmental Industrial Hygienists (ACGIH®) (ACGIH, 2012). This TLV was validated in a large cohort study by Bonfiglioli et al. (2013), and predicted both CTS symptoms and CTS confirmed by NCS (Bonfiglioli et al., 2013). We used the following approach to evaluate selected jobs:

- Hand activity level (HAL): Two NIOSH ergonomists used the HAL scale to rate repetitiveness for right and left hands during at least five complete work cycles. They independently rated each job task.
- Force: Both NIOSH ergonomists independently also rated exertion of the right and left hands using the modified Borg CR-10 scale (Borg, 1982).

We used the HAL and force ratings to calculate a ratio using the following formula: Ratio = Force/(10 – HAL) (Eastman Kodak, 2004). If the ratios for the hands were different, we used the more protective (higher) ratio. We used the calculated ratio to determine an exposure value for each job task for comparison to the ACGIH reference values. We classified job tasks by exposure values into the following three groups:

- Ratios below 0.56 were below the AL (exposure Group 1)
- Ratios 0.56–0.78 were at or above the AL to the TLV (exposure Group 2)
- Ratios above 0.78 were above the TLV (exposure Group 3)

4. Statistical analysis

All statistical analyses were done using SAS Version 9.3 (SAS Institute Inc., Cary, NC). We reported descriptive statistics for demographic, occupational, and non-occupational variables. Frequencies and prevalences were reported for CTS cases for each exposure group. Some of the prevalences of the individual components that made up the CTS case definition were also calculated.

We used log-binomial regression with the copy method (Deddens et al., 2003) to estimate adjusted CTS prevalence and to evaluate the relationship between CTS prevalence and the exposure groups after adjusting for age, sex, BMI, and diabetes mellitus. We reported prevalence ratios and 95% confidence intervals. Confidence intervals that did not include the null value (1) indicated a statistically significant relationship.

5. Results

5.1. Epidemiologic assessment of carpal tunnel syndrome

Table 1 shows the demographics and personal characteristics of the participants. The average age of participants was 39 (range: 19–73), and participants were predominantly African American (94%). Two hundred twenty-four (70%) were female and 18 reported being pregnant. Of 284 participants who had NCS, 143 (50%) had a BMI ≥ 30, which is considered ‘obese’ (CDC, 2014).

We asked participants about medical conditions ever diagnosed by a physician. Of 318 participants, 32 (10%) reported that a physician diagnosed them with CTS, 27 (8%) hand or wrist tendonitis, 18 (6%) thyroid problems, 17 (5%) diabetes mellitus, 14 (4%) trigger finger, 8 (3%) ganglion cyst, and 1 (0.3%) kidney failure.

We asked participants about hours worked, length of employment, and overtime. The participants worked for an average of 38 h the week prior to our visit and had been at the plant for an average of 8 years. Of 150 (47%) employees who usually worked some overtime, the amount of overtime hours worked ranged from 0.3 to 18 h per week with an average of 7 h per week.

The prevalence of hand or wrist symptoms in the last 12 months (a component of the CTS case definition) was 67%; 150 (71%) of 212 with these symptoms reported having these symptoms in the last 7 days. Of 137 with symptoms within 7 days of our visit, 98 (72%) met the case definition for carpal tunnel syndrome. Also, for this investigation, we had two independent neurologists interpret NCS results (a component of the CTS case definition), resulting in 204 of 283 (72%) with abnormal results, indicating the presence of median mononeuropathy.

The number of participating employees meeting the case definition for CTS was 126 of 301 (42%). Fig.1 (*Defining a Case of Carpal Tunnel Syndrome among Poultry Employees*) illustrates how a case of CTS was defined among poultry employees. This denominator of 301 included all participants who had sufficient questionnaire (symptom information including frequency, duration, and location) and/or NCS results to be classified according to the multipart case definition. Table 2 shows the prevalence of CTS cases among participants by exposure group. Unadjusted prevalence increased with increasing exposure, rising from 36% in the lowest exposure group to 48% in the highest exposure group.

Table 2 also shows the results from our log-binomial regression model adjusting for sex, age, BMI, and diabetes mellitus, independent variables known to be associated with CTS. The adjusted prevalence of CTS in exposure Group 3 was statistically significantly higher than that for exposure Group 1 [PR = 1.61, 95% CI = (1.20, 2.17)].

We examined the relationship between CTS and several variables. Females were found to have significantly higher prevalence of CTS than males [PR = 1.67, 95% CI = (1.16, 2.39)]. The participants who reported a physician diagnosis of diabetes mellitus were significantly more likely than those without a physician diagnosis of diabetes mellitus to meet our CTS case definition [PR = 1.54, 95% CI = (1.02, 2.30)]. Obese participants were found to have significantly higher prevalence of CTS than non-obese participants [PR = 1.74, 95% CI = (1.32, 2.30)]. The participants with CTS were significantly older than those without CTS (mean age 42 versus 38, $P = 0.02$). Reporting a physician diagnosis of thyroid problems was not significantly associated with our CTS case definition [PR = 1.13, 95% CI = (0.67, 1.91)]. No one who reported kidney failure met our CTS case definition. Reporting regularly doing hand-intensive tasks outside of the job (working at home, doing hobbies, playing sports, or working at a second job) was not found to be statistically significantly related to our CTS case definition [PR = 0.78, 95% CI = (0.54, 1.13)].

5.2. Ergonomic assessment

The two ergonomists individually assessed 67 job tasks in the plant. For these assessments, the ergonomists HAL and force ratings never differed more than one point. The 67 job tasks listed by department and exposure group are shown in Table 3. Although the ACGIH TLV for hand activity and force is intended for individual jobs, the TLV documentation states that it can be extended to multitask jobs by using time-weighted exposures (ACGIH, 2012). The number of participating employees that reported rotating job tasks was 130 of 318 (41%). We calculated the time-weighted exposures using job task rotation information provided by each employee for an average day. Although some participants indicated that they worked overtime, we did not have access to overtime information and did not include overtime in the time-weighted exposures. Participants were then grouped into exposure categories using the ACGIH reference values (the AL and TLV). Table 4 shows the distribution of participants by exposure group.

6. Discussion

Other studies have defined CTS by different criteria, using symptoms in combination with physical examination, median NCS alone, symptoms alone, or a combination of these criteria. This variation in case definition may contribute to differences in the reported prevalence of CTS ranging from 7.8% to 73.9% (Cartwright et al., 2012; Kim et al., 2004).

We found that 42% of participants met our CTS case definition. Although the CTS prevalence is higher in this evaluation than that reported in other poultry industry studies, a similarly high prevalence of CTS has been reported in employees performing other highly repetitive and forceful manual operations (Bonfiglioli et al., 2006; Rosecrance and Douphrate, 2010). A CTS prevalence of 74% was found among meat and fish-processing plant employees (Kim et al., 2004) and a CTS prevalence of 43% was found among assembly employees (Bonfiglioli et al., 2006) using case definitions similar to ours. Cartwright et al. (2012) reported on results of CTS among poultry processing employees and other manual labor occupations (Cartwright et al., 2012). Cartwright categorized positive CTS results as “possible CTS” or “CTS.” Both those categories would be included in our CTS case definition as Cartwright's categories were based on a scoring system using similar criteria. Because both early detection and aggressive treatment are key to averting problems and possibly disabling injuries (Dokuztug et al., 2006; Poultry Safety and Health Committee, 1986), we chose a more sensitive (inclusive) case definition for CTS than that chosen by Cartwright.

Because of the work required in processing chickens, workers must use their dominant and non-dominant hands. Therefore, the risk of work-related MSDs is not limited to the dominant hand. In our evaluation, we found bilateral CTS in 83 (66%) of the 126 individuals that met our CTS case definition for either hand.

In our analysis, we adjusted for sex, age, BMI, and diabetes mellitus; we found that work factors (force and repetition) were still significantly associated with CTS. Approximately 41% of participants were performing job tasks that were above the ACGIH TLV for hand activity and force. We found a higher CTS prevalence among employees with greater exposure. A previous study (in fish-processing workers) found a significant relationship between increasing exposure to repetition and force and increasing prevalence of CTS (Chiang et al., 1993).

Regarding workplace changes, on the basis of the high prevalence of CTS in the lowest exposure category (Group 1), job task rotation alone is unlikely to be sufficient to control MSDs in this plant. We identified CTS cases in all three exposure categories, with a significantly higher prevalence of CTS in the higher exposure group as compared to the lower exposure group. It is possible that some cases in the lower exposure groups (below the ACGIH AL and below the ACGIH TLV) were a result of employees having worked in jobs or performed job tasks in the higher exposure category in the past, or other factors were involved that we could not identify in this cross-sectional evaluation. Moreover, a review of the rotation logs showed that, although 41% of participants reported rotating to different job tasks, the rotation was usually from one high exposure job task (Group 3) to another high exposure job task (Group 3) or from one lower exposure job task (Group 1) to another lower exposure job task (Group 1). Rotation among job tasks of similar exposure risk has not been found to reduce the risk of developing MSDs (Jonsson, 1988). Job rotation should reduce fatigue and stress of muscles and tendons by rotating employees to job tasks that use different muscle-tendon groups (OSHA, 1993). Rotating from higher exposure tasks to lower exposure tasks has been found to result in less fatigue and improved performance (Raina and Dickerson, 2009). Job rotation decisions should include evaluating jobs using the ACGIH TLV; when the AL is exceeded, other ergonomic controls should be employed.

Since 1986, the Poultry Safety and Health Committee Task Force (Poultry Safety and Health Committee Task Force, 1986) has publicized the importance of early medical intervention for preventing serious MSDs and that early detection and aggressive treatment of MSDs is the key to averting problems and possibly disabling injuries (Poultry Safety and Health Committee Task Force, 1986). Medical intervention, however, must be combined with job changes to reduce exposure to the known factors inherent in the current methods for processing poultry.

7. Strengths and limitations

Our CTS case definition used well-accepted criteria (including objective nerve conduction measurements assessed by two independent board-certified neurologists). To assess hand activity and force we used the ACGIH TLV for HAL, a standardized and validated assessment tool. This evaluation was a cross-sectional survey that measured health outcomes and exposures at a single point in time; cross-sectional studies provide data useful for supporting inferences of cause and effect. Selection bias was reduced because of the 85% participation rate. Inherent in this type of study is the potential for “survivor bias” (i.e., including people who may have remained in their jobs, and not capturing those who may have left work because of injury or other reasons). Such survivor bias may result in an underestimation of the prevalence of CTS. Some exposure misclassification may have occurred because our exposure assessment was based on the current job(s) and did not account for overtime work or shift work. Of 150 who usually worked some overtime, the average was 7 h per week. Also, some evidence shows that employees on later work shifts experience more injuries and, therefore, our evaluation of only the first-shift may be an underestimation of the prevalence (Strong and Zimmerman, 2005).

8. Conclusions

Forty-two percent of participating poultry processing employees had evidence of CTS, and 41% of participants were working in jobs above the ACGIH TLV for hand activity and force. Also, increasing levels of hand activity and force were associated with increased CTS prevalence among participants. Despite repeated studies in this industry in the past 20 years finding high prevalence of CTS, poultry processing jobs continue to be hazardous. OSHA has had guidance for preventing MSDs in the poultry industry since early 2000 (OSHA, 2013). Likewise, the National Chicken Council and the Poultry and Egg Institute have long standing workplace recommendations regarding ergonomics and injury prevention (National Chicken Council, 2008; The Poultry & Egg Institute, 2013). We found that many of these recommendations were not being followed; that employees at this plant were exposed to hand activity and force levels above the recommended TLV, and those employees were not adequately followed up medically. We provided several recommendations to the plant to reduce employee exposure to levels of hand activity and force, including: (1) designing job tasks so that they are below the ACGIH TLV; (2) automating or semi-automating front half deboning and thigh deboning tasks; (3) employing a job rotation schedule in which employees rotate between jobs that use different muscle groups and that are below the AL of the ACGIH TLV; and (4) instituting a medical surveillance program for MSDs to monitor employee health and determine the effectiveness of exposure prevention and medical management strategies. The challenge to the industry is to design poultry processing work to reduce risk factors for MSDs and to closely follow existing guidelines for prevention, early recognition, and medical management of MSDs.

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References

ACGIH. TLVs® and BEIs®: threshold limit values for chemical substances and physical agents and biological exposure indices. American Conference of Governmental Hygienists; Cincinnati, OH. 2013.

American Association of Electrodiagnostic Medicine. Guidelines in electro-diagnostic medicine. Muscle Nerve. 1992; 15:229–253. [PubMed: 1549146]

American Association of Electrodiagnostic Medicine, American Academy of Neurology, American Academy of Physical Medicine and Rehabilitation. Practice parameter for electrodiagnostic studies in carpal tunnel syndrome: summary statement. Muscle Nerve. 2002; 25:918–922. [PubMed: 12115985]

Armstrong T, Dale AM, Franzblau A, Evanoff BA. Risk factors for carpal tunnel syndrome and median neuropathy in a working population. J Occup Environ Med/Am Coll Occup Environ Med. 2008; 50:1355–1364.

Atcheson SG, Ward JR, Lowe W. Concurrent medical disease in work-related carpal tunnel syndrome. Arch Intern Med. 1998; 158:1506–1512. [PubMed: 9679791]

Becker J, Nora DB, Gomes I, Stringari FF, Seitensus R, Panosso JS, Ehlers JC. An evaluation of gender, obesity, age and diabetes mellitus as risk factors for carpal tunnel syndrome. Clin Neurophysiol: Off J Int Fed Clin Neuro-physiol. 2002; 113:1429–1434.

BLS. Incidence Rates of Nonfatal Occupational Injuries and Illnesses By Industry and Case Types, 2011. 2012

Bonfiglioli R, Mattioli S, Armstrong TJ, Graziosi F, Marinelli F, Farioli A, Violante FS. Validation of the ACGIH TLV for hand activity level in the OCTOPUS cohort: a two-year longitudinal study of carpal tunnel syndrome. Scand J Work Environ Health. 2013; 39:155–163. [PubMed: 22752342]

Bonfiglioli R, Mattioli S, Spagnolo MR, Violante FS. Course of symptoms and median nerve conduction values in workers performing repetitive jobs at risk for carpal tunnel syndrome. Occup Med. 2006; 56:115–121.

Borg GA. Psychophysical bases of perceived exertion. Med Sci Sport Exerc. 1982; 14:377–381.

Burt S, Crombie K, Jin Y, Wurzelbacher S, Ramsey J, Deddens J. Workplace and individual risk factors for carpal tunnel syndrome. Occup Environ Med. 2011; 68:928–933. [PubMed: 21613639]

Cartwright MS, Walker FO, Blocker JN, Schulz MR, Arcury TA, Grzywacz JG, Mora D, Chen H, Marin AJ, Quandt SA. The prevalence of carpal tunnel syndrome in Latino poultry-processing workers and other Latino manual workers. J Occup Environ Med/Am Coll Occup Environ Med. 2012; 54:198–201.

CDC, 2014. Assessing Your Weight.

Chiang HC, Ko YC, Chen SS, Yu HS, Wu TN, Chang PY. Prevalence of shoulder and upper-limb disorders among workers in the fish-processing industry. Scand J Work Environ Health. 1993; 19:126–131. [PubMed: 8316780]

Deddens JA, Petersen MR, Lei X. Estimation of prevalence ratios when proc genmod does not converge. Proceedings of the 28th Annual SAS Users Group International Group Conference. 2003

Dokuztug F, Acik E, Aydemir A, Issever H, Yilmaz A, Erer M. Early symptoms of the work-related musculoskeletal disorders in hand and upper extremity in the poultry industry. J Med Sci. 2006; 6:305–313.

Eastman Kodak, C. Kodak's Ergonomic Design for People at Work. second. John Wiley and Sons; Hoboken, NJ: 2004.

Herbert R, Gerr F, Dropkin J. Clinical evaluation and management of work-related carpal tunnel syndrome. Am J Industr Med. 2000; 37:62–74.

Jonsson B. Electromyographic studies of job rotation. Scand J Work Environ Health. 1988; 14(Suppl 1):108–109. [PubMed: 3393862]

Karpitskaya Y, Novak CB, Mackinnon SE. Prevalence of smoking, obesity, diabetes mellitus, and thyroid disease in patients with carpal tunnel syndrome. Ann Plast Surg. 2002; 48:269–273. [PubMed: 11862031]

Katz JN, Stirrat CR, Larson MG, Fossel AH, Eaton HM, Liang MH. A self-administered hand symptom diagram for the diagnosis and epidemio-logic study of carpal tunnel syndrome. J Rheumatol. 1990; 17:1495–1498. [PubMed: 2273490]

Kim JY, Kim JI, Son JE, Yun SK. Prevalence of carpal tunnel syndrome in meat and fish processing plants. J Occup Health. 2004; 46:230–234. [PubMed: 15215667]

Lipscomb H, Kucera K, Epling C, Dement J. Upper extremity musculo-skeletal symptoms and disorders among a cohort of women employed in poultry processing. Am J Industr Med. 2008; 51:24–36.

McPhee CS, Lipscomb HJ. Upper-extremity musculoskeletal symptoms and physical health related quality of life among women employed in poultry processing and other low-wage jobs in northeastern North Carolina. Am J Industr Med. 2009; 52:331–340.

National Chicken Council. Chicken Industry Emphasizes Worker Safety. 2008

Bernard, B., editor. Musculoskeletal disorders and workplace factors: a critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. Cincinnati, OH: NIOSH; 1997.

OSHA. Ergonomics Program Management Guidelines for Meatpacking Plants. 1993

OSHA. Prevention of Musculoskeletal Injuries in Poultry Processing. 2013

Owens, C.; Alvarado, C.; Sams, AR. Poultry Meat Processing. second edition. 2010.

Poultry Safety and Health Committee Task Force. Repetitive Motion Disorders, The Medical Ergonomics Training Program, a Guide for the Poultry Industry. 1986

Raina SM, Dickerson CR. The influence of job rotation and task order on muscle fatigue: a deltoid example. Work. 2009; 34:205–213. [PubMed: 20037232]

Rosecrance, JC.; Douphrat, D. International Conference Ragusa SHWA 2010-September 16—18, “Work Safety and Risk Prevention in Agro-food and Forest Systems”. Ragusa Ilba Campus; Italy: 2010. Hand and wrist disorders among U.S. poultry processing workers.

Strong LL, Zimmerman FJ. Occupational injury and absence from work among African American, Hispanic, and non-Hispanic White workers in the national longitudinal survey of youth. Am J Public health. 2005; 95:1226–1232. [PubMed: 15983275]

The Poultry and Egg Institute. Poultry Industry Workplace Safety Issue Kit. 2013

USDA. Poultry & Eggs. 1998

USDA, National Agricultural Statistics Service. Poultry Slaughter: 2007 Annual Summary. 2008

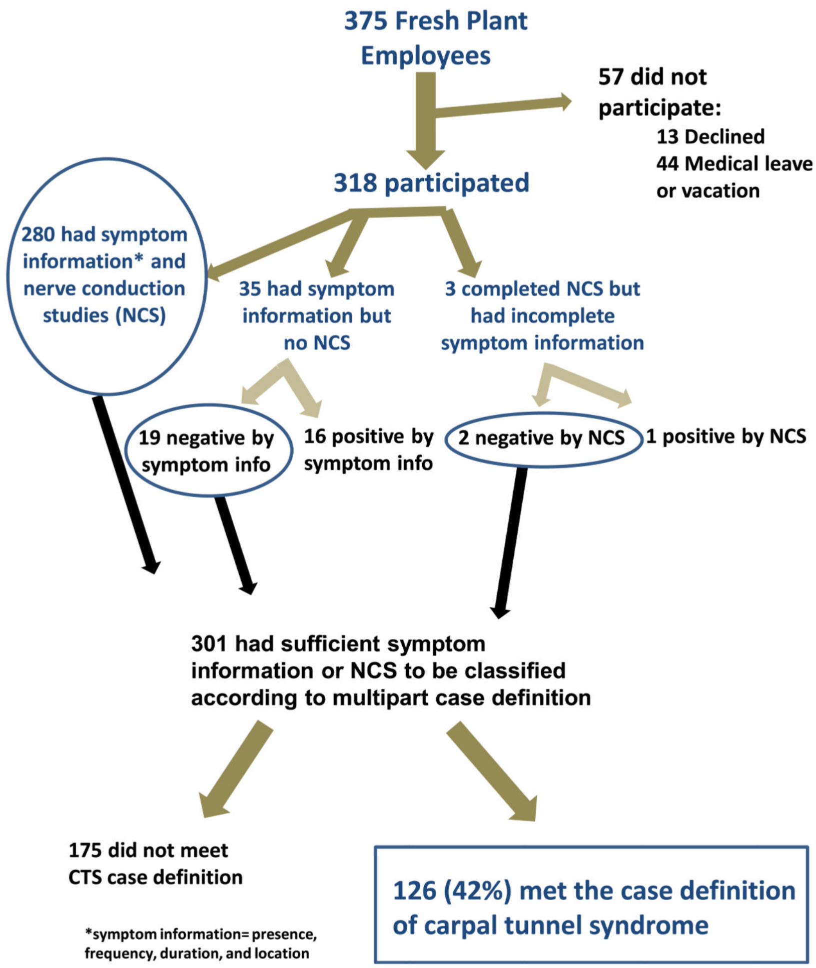

Fig. 1.

Defining a case of carpal tunnel syndrome among poultry employees.

Table 1

Demographics and personal characteristics of participants (*n* = 318).

Age (years)	**Mean 39 (range: 19–73)**
	No. (%)
Sex	
Male	94 (30)
Female	224 (70)
Currently pregnant[a]	18 (9)
Race	
White	13 (4)
Black or African American	298 (94)
Other	7 (2)
Body mass index[b]	
< 25	62 (22)
25 up to 30	79 (28)
≥ 30	143 (50)
Hand-intensive tasks at home, hobbies, sports, or second job	68 (21)
Hands/wrists	
Ever had an accident or injury	41 (13)
Ever had surgery	22 (7)

[a]Out of 210 responding females.

[b]Out of 284 measured participants.

Table 2

Carpal tunnel syndrome prevalence by exposure group.

Exposure groups	Unadjusted prevalence *n* = 301	Prevalence[a]	Adjusted analysis prevalence ratio	95% Confidence interval
Group 1 (<AL[c])	48/133 (36%)	34%	1	
Group 2 (AL-TLV[d])	20/46 (43%)	39%	1.16[b]	(0.76, 1.60)
Group 3 (>TLV)	58/122 (48%)	55%	1.61[b]	(1.20, 2.17)

[a] Adjusted for sex, age, body mass index, and diabetes mellitus.

[b] Group 1 was considered the referent group.

[c] AL = Action limit for the ACGIH TLV for hand activity and force.

[d] TLV = ACGIH threshold limit value for hand activity and force.

Table 3

Job tasks by area and department categorized by exposure group.

Area	Department	Exposure group 1	Exposure group 2	Exposure group 3
First processing	Evisceration	Backup killer Backup rehanger Vent opener Reprocess vacuum USDA trimmer/helper	Final trim	Reprocess salvage
	Paws	Grader (Line 1) Grader (Line 2) Bagger Box/stack	N/A	Grader (incoming product needs rework)
Second processing	Cone lines	Bone hawk	Loader	First cut (left shoulder) First cut (right shoulder) Wing roller Wing saw Breast trimmer Tender score/cut Tender clip Tender pull
	Thigh debone	Machine loader 1 Machine loader 2 Machine loader 3	N/A	Manual trimmer Machine trimmer
	Cut-up	Legs scale One leg saw One leg load Whole leg pack Whole leg lid/label Whole leg box maker Thigh flipper Drumstick packer Wing operation pack tips Wing operation grade/drum/midjoint	Whole leg scale Rework leg Wing operation saw	Box maker combo One leg knife Whole leg stack/strap Rehang
	Multi-vac	Loader Box pack	Bagger	Dumper Box stack
	DSI	Loader/X-ray Slitter loader DSI loader 1	Marriage cut nuggets/sizing	Loader (pull meat apart with hands)

Area	Department	Exposure group 1	Exposure group 2	Exposure group 3
		DSI loader 2		
		DSI grader		
		Rework/X-ray		
		Check trim		
	IPM	Classifier loader	N/A	Pack tenders
		Loader to index 1		
		Loader to index 2		
		Loader to index 3		
		Loader to index 4		
		Grader		
		Cut nuggets		

Table 4

Distribution of questionnaire participants by exposure groups (n = 318).

Exposure groups	No. (%)
Group 1 (<AL[a])	139 (44)
Group 2 (AL-TLV[b])	49 (15)
Group 3 (>TLV)	130 (41)

[a]AL = Action limit for the ACGIH TLV for hand activity and force.

[b]TLV = ACGIH threshold limit value for hand activity and force.