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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.

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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).

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

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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 mononeuropathy) (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:

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

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,

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