Occupational Injuries of Immigrant Poultry Workers: Development and Progression
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Abstract *(500 words or less)*

U.S. poultry processing workers experience a disproportionate share of occupational injuries and illness compared to workers in other industries. Recent trends in this industry have resulted in a worker population that is poor, minority, and increasingly comprised of immigrants. Little research documents the onset of occupational injuries among immigrants in the poultry processing industry, the progression of these occupational injuries, or the occupational and personal characteristics associated with these occupational injuries. The overall goal of this research study was to document the nature and sources of occupational injuries among minority poultry processing workers. It followed several years of community participatory research by this team with workers in the target communities, in which a sampling frame had been developed.

The specific aims were: (1) to compare the prevalence of selected musculoskeletal (MSDs) and skin disorders among Latino poultry processing workers and controls (non-poultry, Latino manual laborers), and assess the mediating and moderating effects of occupational (task, shift), structural (income, education, access to healthcare), and sociocultural (ethnicity, beliefs, values, acculturation) factors on these disorders; (2) to document the development of selected MSDs and skin disorders and assess the mediating and moderating effects of occupational, structural, and socio-cultural factors on this development; (3) to delineate the impact of selected MSDs and skin disorders on workers' and controls' health-related quality of life, both cross-sectionally and over time; and (4) to determine the interpretation of occupational illness and injury symptomatology, self-care behaviors, and barriers to prevention, treatment seeking, and reporting among workers.

These specific aims were achieved using a linked cohort and ethnographic design, combining qualitative and quantitative research methods. A total of 742 workers were recruited for interviews: 406 immigrant poultry workers with experience in processing line work </= 3 yr and 336 controls. A total of 518 participated in physical examinations, which included nerve conduction, wrist ultrasound, dermatological examination, and musculoskeletal examination. Workers disease-free (for carpal tunnel and skin disease) were invited back for follow-up one year later.

Section 1. Executive Summary

Significant Key Findings

The overall goal of this research study was to document the nature and sources of occupational injuries among minority poultry processing workers. These data are necessary for later strategies to reduce such injuries and promote better worker health. The original project had 4 specific aims. A supplement received added a respiratory health component to Aim 1.

1. To compare the prevalence of selected musculoskeletal (MSDs), skin disorders, and respiratory health indicators among Latino poultry processing workers and controls (non-poultry, Latino manual laborers), and assess the mediating and moderating effects of occupational (task, shift), structural (income, education, access to healthcare), and socio-cultural (ethnicity, beliefs, values, acculturation) factors on these disorders.
2. To document the incidence of selected MSDs and skin disorders in Latino poultry processing workers and controls (non-poultry, Latino manual laborers); and assess the mediating and moderating effects of occupational, structural, and socio-cultural factors on this incidence.
3. To delineate the impact of selected MSDs and skin disorders among Latino poultry processing workers and controls on workers' health-related quality of life (QOL), both cross-sectionally and over time.
4. To determine the interpretation of occupational illness and injury symptomatology, self-care behaviors, and barriers to prevention, treatment seeking, and reporting among poultry processing workers.

Aim 1: To compare the prevalence of selected musculoskeletal (MSDs), skin disorders, and respiratory health indicators among Latino poultry processing workers and controls (non-poultry, Latino manual laborers).

- The most definitive differences between poultry and non-poultry workers were for carpal tunnel disorder (CTS). The prevalence of CTS was 8.7% for poultry workers, compared to only 4.0% for the comparison group.
- Musculoskeletal disorders (low back pain, rotator cuff syndrome, and epicondylitis) do not appear to vary between poultry and no-poultry workers. However, significant between-employer differences were observed in rotator cuff syndrome and low back pain among poultry workers, suggesting that equipment, organization of work, and other company-specific factors contribute to the observed high rates of such disorders.
- Skin disorders onychomycosis and melasma were more common among poultry processing workers (62.4% vs. 37.6%, and 72.9% vs. 27.1%, respectively). Pachydermodactyly was diagnosed in several poultry processing workers; this may be related to repetitive motion in specific processing tasks.
- Overall, respiratory health for poultry workers exceeded that of non-poultry workers, suggesting a healthy-worker effect. Nevertheless, airway obstruction appeared to be more likely among workers deboning chicken, suggesting that certain poultry processing jobs may increase the risk for specific respiratory health problems.
- Aspects of work safety climate and work organization were examined for both poultry and non-poultry workers. Poultry workers were characterized by work organization hazards such as low job control and high psychological demands. These hazards predicted greater prevalence of MDSs. Within poultry work, personal protective equipment provision and use was low. Work safety climate and use of personal protective equipment varied by employer. Across all female workers, MSDs were associated with work organization.

Methodologically, this study demonstrated that neuromuscular ultrasound was an accurate technique that could substitute for nerve conduction studies for screening large at-risk populations. The additional benefit of ultrasound is its ability to detect anatomical features (e.g., muscle intrusion into the carpal tunnel, bifid median nerves and persistent median arteries) that appear to be common and increase the risk of CTS.

Aim 2: To document the incidence of selected MSDs and skin disorders in Latino poultry processing workers and controls (non-poultry, Latino manual laborers).

- The one-year incidence of CTS was higher among poultry worker than non-poultry workers (19.8% vs 11.7%.
- Across all workers, psychological demand was associated with incident rotator cuff syndrome; and awkward posture and decision latitude with incident low back pain.

Aim 3: To delineate the impact of selected MSDs and skin disorders among Latino poultry processing workers and controls on workers' health-related quality of life (QOL), both cross-sectionally and over time.

- Overall, this population experiences a high degree of social isolation, which is associated with poor physical- and mental-health related quality of life.
- Upper-body musculoskeletal symptoms lasting more than one day were reported by 35% of workers. Symptom reporting was higher among poultry processing than non-processing workers.
- Impaired skin-related quality of life was reported by 23% of workers overall. There was no clear association of skin-related quality of life with poultry processing work. Thhis may be due to the need to conduct skin examinations on Sunday, two days after last previous work exposure for many workers.

Aim 4: To determine the interpretation of occupational illness and injury symptomatology, self-care behaviors, and barriers to prevention, treatment seeking, and reporting among poultry processing workers.

- Poultry processing workers experiencing occupational illness express explanatory models of illness that are quite consistent with biomedical models. While some of their treatments include tradiational remedies, they also use over-the-counter and biomedical treatments. Most know the future consequences of CTS will include chronic pain and that they will need to quit their jobs to achieve a cure. However, situational factors (e.g., lack of other available employment due to rural residence or documentation status) force them to endure CTS.

Translation of Findings

The key findings of this research point to the high rates of occupational injury and illness found among both poultry and non-poultry Latino manual workers. These rates are elevated in some cases for poultry processing workers. Factors such as safety climate and work organization are related to injuries. Among poultry processing workers, between-company differences exist in work organization and in MSD prevalence.

These findings point for the need for change in poultry processing so that all companies provide work environment that reduces the conditions related to occupational injury and illness. Adoption of an ergonomic standard might well reduce repetitive motion injuries. The high levels of MSDs in poultry processing and between company differences suggest that differences in mechanization of the work process and possibly differences in organization of work responsible shold be identified and promoted.

As a whole, this work provides a picture of the working conditions of immigrant workers, both in poultry and in other manual occupations. While the between-group differences are not always clear, the fact that large numbers of Latino, immigrant manual workers experience musculoskeletal, neurological, and skin injuries and illnesses points to need for further development of programs to improve worker health. Whether this is accomplished through worker education and empowerment or through engineering modifications in the workplace, such measures should be investigated and the most effective, adopted.

Outcomes/impact

Potential outcomes include the finding of highly prevalent conditions, including repetitive motion injuries, CTS, and MSDs, rotator cuff syndrome and low back pain. Steps to reduce repetitive motion (e.g., job rotation or mechanization of tasks such as trimming, deboning, and hanging) might reduce these occupational injuries. At the same time, improvements in work safety climate and organization of work might encourage workers to seek treatment before conditions become disabling.

Intermediate outcomes include the use of findings related to CTS in documents submitted with reference to USDA's proposed linespeed increase. A variety of organizations, including the Southern Poverty Law Center and Council of La Raza used the published findings from this study in formulating their arguments. In particular, the qualitative data collected in thie study, which allow workers to express the impact of workplace conditions and injuries on their lives and on their potential for future employment or disability are compelling and have been useful for advocates for improved workplace conditions for immigrant workers.

Section 2. Scientific Report

A. Specific Aims

Poultry processing workers in the US experience a disproportionate share of occupational injuries and illnesses compared to workers in other industries (Bureau of Labor Statistics [BLS] 1999, 2000). Recent trends in this industry have resulted in a worker population that is poor, minority, and increasingly comprised of immigrants (Striffler 2005). Occupational injuries among immigrant workers, including poultry processing workers, are one factor driving the health disparities in minority communities (Lipscomb et al. 2006).

Little research documents the prevalence of occupational injuries among immigrant workers in the poultry processing industry, or the occupational and personal characteristics associated with these occupational injuries (for exceptions see, Quandt et al. 2006a; Lipscomb et al. 2007a, 2007b; Loomis et al. 1997). This information is vital for identifying sources of occupational health disparities and developing culturally and educationally appropriate industrial hygiene and occupational safety programs to reduce the number and severity of these occupational injuries among poultry processing workers. However, our experience with poultry processing companies that employ Hispanic immigrant workers and the experience of other occupational health investigators with companies that employ African American workers (Lipscomb et al. 2005) is that poultry processing employers are antagonistic to working with occupational health researchers. Therefore, researchers must use innovative designs to document the development, determinants, and impacts of occupational injuries among poultry workers.

The overall goal of this research study is to document the nature and sources of occupational injuries among minority poultry processing workers. These data are necessary for later strategies to reduce such injuries and promote better worker health. The specific aims are:

1. To compare the prevalence of selected musculoskeletal (MSDs) and skin disorders among Latino poultry processing workers and controls (non-poultry, Latino manual laborers), and assess the mediating and moderating effects of occupational (task, shift), structural (income, education, access to healthcare), and socio-cultural (ethnicity, beliefs, values, acculturation) factors on these disorders.
2. To document the incidence of selected MSDs and skin disorders in Latino poultry processing workers and controls (non-poultry, Latino manual laborers); and assess the mediating and moderating effects of occupational, structural, and socio-cultural factors on this incidence.
3. To delineate the impact of selected MSDs and skin disorders among Latino poultry processing workers and controls on workers' health-related quality of life (QOL), both cross-sectionally and over time.
4. To determine the interpretation of occupational illness and injury symptomatology, self-care behaviors, and barriers to prevention, treatment seeking, and reporting among poultry processing workers.

These specific aims will be achieved using a linked cohort and ethnographic design, combining qualitative and quantitative research methods. Such a design is appropriate for understanding health disparities, which have individual to community level determinants, and that include behavioral, social, and cultural phenomenon.

B. Background and Significance

B.1. Poultry and Meat Processing Industries in Rural Communities

During the past several decades, poultry and meat slaughterhouses and processing facilities have moved from urban centers to rural communities (Fink 1998; Griffith et al. 1995; Striffler 2005; Stull 1994; Stull & Broadway 2004). Made possible by technological innovations (refrigeration, an efficient interstate highway system), this has allowed processors to reduce costs by moving closer to the farms that are the sources of their raw materials and to not ship excess weight (feathers, entrails, skins). Vertical integration of these industries has also increased. That is, processors control producing animals through contract farming, slaughtering the animals, adding value through greater processing of the meats into their finished form (e.g., chicken "tenders"

rather than whole chickens), and marketing. This transition to rural communities also allows them to move to areas with less organized labor support and control.

This movement has had a profound effect on community structure and demographics (Gouveia & Stull 1997; Griffith 1990; Horowitz & Miller 1999; Constance & Tuinstra 2005; Striffler 2005; Bonanno & Constance 2006). Poultry plants require a large work force. The turnover in plants creates a constant demand for more workers than are present in rural communities (Grey 1997, 1999; Kay 1997a,b; Bloom 2006; Striffler 2005). This is exacerbated by the lack of native US residents willing to do poultry work. Therefore, only those who cannot get better jobs enter and stay in poultry processing. Further, those with limited skills migrate to these communities for the poultry processing jobs. In the US, such persons are often immigrants from Latin America, the Caribbean Islands, and Southeast Asia. They usually do not speak English and are willing to work in situations many native residents reject when an alternative is available. In some cases employers recruit workers from different backgrounds because they are different from and cannot communicate with each other, and so are less likely to organize and complain about working conditions (Fink 1998).

B.2. The Nature of Poultry Processing Work

Poultry work is violent and dirty. It applies high-speed assembly line technology to the hatching, growing, killing and butchering of animals in an industry with a small profit margin. With intensification and vertical integration, the industry relies on high risk work done by low-wage, minority workers. In the first stage, poultry production, live birds are raised to desired weights in confinement facilities that turn farms into factories and foul the air for miles around with the smell of chicken excrement. When the birds are ready for slaughter, “catchers” enter the confinement buildings, frequently in darkness so the birds are more docile. In these buildings, the air is rank; the dust, dander and dried droppings are as thick as smoke in the air. Thousands of birds cackle, drowning out human voices. Catchers must work quickly, catching six struggling birds by their feet at a time and flinging them into small cages that are then stacked on flatbed eighteen-wheel trucks for their journey to the processing plant. Major health hazards for catchers are respiratory, from exposure to organic dusts (litter, manure, dander, microbiologicals, endotoxins) and ammonia, and dermatological (lacerations).

The processing plants, while meeting USDA standards for hygiene, are wet and cold; some areas are foul-smelling. The birds are taken from their cages, stunned, and hung by their feet on hooks on an overhead moving belt. They are killed, plucked, eviscerated, butchered, often de-boned, and packaged – all at a speed of more than one bird per worker per second. This efficiency can only be accomplished by workers who work at high rates of speed for long periods without breaks. Working in awkward positions in the wet and the cold, repeating the same movements, and using sharp tools, workers risk respiratory, dermatological and musculoskeletal injuries (GAO 2005). The stress of this work is often exacerbated by supervisors who push to keep the line moving at the desired speed. Frequently, supervisors do not speak the same language as the workers; they intimidate these workers and treat them with disrespect (Marín et al. 2006).

B.3. Epidemiology of Occupational Injuries and Illnesses in Poultry Processing

Poultry processing workers have some of the highest occupational injury rates of all US industries (GAO 2005). In 2004, close to 20,000 poultry workers nationwide reported occupational injuries or illnesses severe enough to miss work or seek medical care, for a rate of 7.8 per 100 full-time workers. The nonfatal injury rate was 5.5/100 workers (BLS 2005a), and the illness rate, 2.3/100 (BLS 2005b). Poultry processing had the sixth highest occupational illness rate of any private industry in the US in 2004 (BLS 2005c).

The process combines rapid line speed with distinct divisions of labor on the processing line (Lipscomb et al. 2005). MSDs are thought to be the principal on-the-job safety problems for workers on the processing line. In one study (Stuart-Buttle 1994), 65% of poultry plant workers reported musculoskeletal discomfort using a self-rated pain intensity scale. Among workers reporting pain, back pain ranked the highest in intensity, followed by the arm (Stuart-Buttle 1994). Research among poultry workers (Armstrong et al. 1982; Stuart-Buttle 1994; Kirschberg et al. 1994; Quandt et al. 2006a; Lipscomb et al. 2007) and meat packing workers (Kirschberg et al. 1994; Viikari-Juntra et al. 1991; Chiang et al. 1991; Viikari-Juntra 1983; CDC 1985; Novek et al. 1990; Roto & Kivi 1984) has shown that the majority of MSDs were injuries to the neck, back and upper extremity (Quandt et

al. 2006a). MSDs affect workers whose jobs require repetitive movements, awkward body positions, forceful exertions or exposure to hand-transmitted vibration (Armstrong et al. 1982; Campbell 1999; OSHA 1993). Poorly designed hand tools and other instruments used to cut meat exacerbate these conditions. In 1994, the Occupational Safety and Health Administration (OSHA) identified hazards associated with specific work tasks in poultry processing, and, where applicable, possible engineering controls (OSHA 1994). Although ergonomic standards were published for the poultry industry in 2004 (OSHA 2004), their adoption is voluntary.

Other aspects of the work environment are responsible for skin injuries and illnesses. Poultry processors handle raw poultry carcasses in a damp cool environment, contributing to irritant contact dermatitis. Friction leads to callosities on the skin, particularly on the knuckles and palms (Samitz 1947). Contact urticaria can occur due to the chemical nature of the raw meat/body fluid (Beck & Nissen 1982; Taylor 1980). Candida and staph infections around nails, viral warts, and bacterial infections on the hands occur (Mergler et al. 1982); among poultry workers, those who handle raw carcasses are 5.6 times more likely to have warts than those in other jobs (Stehr-Green et al. 1993). Poultry workers refer to the skin eruptions caused by their work as "chicken poison disease" (Marks et al. 1983). Allergy to rubber in gloves or nickel in tools can also cause contact dermatitis (Ho & Mitchell 1985). In this work environment, individuals susceptible to allergy may have significant problems, due to irritant contact dermatitis and secondary infection (von Odia et al. 1994). They are at increased risk for protein contact urticaria (from meat or latex in gloves). Other, less common, dermatologic conditions that occur in this environment include Raynaud's phenomenon (from cold exposure) (Kaminski et al. 1997). Skin injuries are common due to sharp tools and bones (Cohen 1987). Work-related dermatitis in poultry processing is under-reported by up to 90-98% (MMWR 1986). The impact on activities of daily living and QOL is not well documented. In a study of 25 current poultry workers in western North Carolina (NC) examined by a dermatologist, Quandt et al. (2005) found that all workers had at least one skin condition (most common were infections, followed by inflammatory diseases); none had sought medical care.

The illness and injury rates reported in the poultry industry are likely to be the tip of the iceberg (National Research Council 2003). Workers often see the hazards as part of the job, or they move on to other jobs as symptoms develop, especially when symptoms limit work activity (Human Rights Watch 2004; Lipscomb et al. 2005). Among immigrant—particularly undocumented—workers, reporting illnesses and injuries is difficult because of language barriers and brings with it the fear of job loss or deportation (GAO 2005; Fink 1998; Quandt et al. 2006a). Because the only sources of occupational health statistics for the poultry industry are OSHA reports, symptoms or illnesses not reported or not considered by worker or supervisor to be work-related are not included (Azaroff et al. 2002).

B.4. Organization of Work

The organization of work refers to organizational practices related to management and production methods as well as the way jobs are designed and performed (Sauter et al. 2002). Virtually every element of workers' lives on the job ranging from the safety climate within the organization to the physical and psychological demands of the work is shaped by the organization of work. Following 10 years of systematic research initiated by the National Occupational Research Agenda, substantial evidence indicates that how work is organized contributes to worker health outcomes including onset of musculoskeletal problems, greater risk of compensable spinal injury, experiencing an occupational accident, as well as coronary heart disease and cardiovascular mortality (Kivimaki et al. 2002; Kuper & Marmot 2003; Krause et al. 1998; Swaen et al. 2004).

The organization of poultry processing creates a variety of factors that undermine worker health (GAO 2005; Lipscomb et al. 2005). Increased mechanization and assembly line production requires protracted periods of standing and rapid repetitive motions; both contribute to MSDs, including repetitive trauma disorders and chronic low back pain (Carayon et al. 1999; GAO 2005). Close proximity among workers on the production line coupled with rapid line speeds and heavy reliance on hand tools contributes to unintentional injuries (GAO 2005). The relative lack of control over work, particularly the speed of the production line, and restricted range of task variety inherent in assembly line production creates stress (Grzywacz et al. 2007a) and contributes to illness and injury (Ahlberg-Hulten et al. 1995; Carayon et al. 1999; GAO 2005). Chronic ambient noise and the continual pace of the production line are psychologically demanding and are believed to undermine worker health through physiological and behavioral stress processes (Carayon et al. 1999; Cohen & Herbert 1996;

Grzywacz et al. 2007b). Intense competition among the poultry processing operations can undermine safety standards within the industry as companies seek ways to minimize production costs (Lipscomb et al. 2005). Finally, an ethnically diverse, foreign-born workforce is at risk for occupational injury and illness because of difficulties in communication, training, and enforcement of safety standards, as well as fears on the part of undocumented workers about raising safety concerns (GAO 2005).

Little research has examined associations of health with variables reflecting how poultry processing work is organized. Evidence from a single cohort of poultry processing workers in France indicates that several variables reflecting the organization of work are associated with worker illness and injury. Measures of production methods and job design (e.g., working in awkward postures, performing repetitive movements, and arm exertion) were associated with greater risk of Raynaud's phenomenon, general sickness absence, and musculoskeletal-related sickness absence (Kaminski et al. 1997; Messing et al. 1998). Other indicators of job design (e.g., psychological strain), production methods (e.g., working irregular hours), and management methods (e.g., quality of supervisor-subordinate relations) were also associated with greater risk of Raynaud's, elevated blood pressure, and sickness absence (Ledesert et al. 1994; Messing et al. 1998). Several of these findings, concerning psychological strain and the quality of supervisor-subordinate relations, were recently replicated among immigrant Latinos in poultry processing in NC (Grzywacz et al. 2007b).

B.5. Contribution to NORA and Research to Practice (r2p)

This research study addresses needs identified in the National Occupational Research Agenda. Within the NORA Manufacturing Sector, this proposed research was designed to will address three NIOSH Cross-Sector Programs: Musculoskeletal Disorders, Immune/Dermal/Infectious Diseases, and Work Organization & Stress-Related Disorders. The proposed project also focused on the NIOSH Coordinated Emphasis Area of Occupational Health Disparities. The nature of poultry processing places workers at high risk for MSDs and dermatological injury. Recent changes in the structure of this industry have reduced the price and therefore increased the consumption frequency of chicken. These changes have also resulted in a low-wage, minority and immigrant work force that suffers high levels of health disparities. These workers live in rural communities that lack an extensive medical or public health system. While occupational health risks of these workers are acknowledged, few data document the progression of MSDs and dermatological disorders among poultry processing workers, or the mediating or moderating effects of occupational structure or socio-cultural factors on the development of these disorders. This project uses a multi-method design to document the development of these disorders and the effects of these disorders on worker quality of life, as well as determine worker interpretations of such disorders. Such findings are key to designing effective, culturally-appropriate interventions.

C. Preliminary Studies

The investigators' previous series of projects with Latino immigrant workers in NC provided a strong foundation for this application. These projects provided basic data on distinct aspects of the occupational, environmental and social stressors to which these Latino immigrant workers and their families are exposed, and some of the health outcomes of these exposures. The just-completed project provided the opportunity to merge many of these distinct aspects into a conceptually integrated project. Experience with these projects demonstrated that we had the ability to recruit Latino immigrant workers and their families, maintain contact with them over extended periods, collect both qualitative and quantitative data, collaborate with community members and community-based organizations, and report study results back to participating individuals and communities, as well as in diverse formats for the scientific, public health, and public policy audiences. This project was completed by a transdisciplinary group of investigators, representing anthropology, medicine, epidemiology, work psychology, and social ecology.

C.1. JUSTA: Justice and Health for Poultry Workers (R25 OH008335)

Project team members Quandt, Arcury, Grzywacz, and Marín conducted JUSTA. This NIOSH-funded grant was designed to assist poultry workers in understanding the source of health problems resulting from poultry work and address these through community education and empowerment. The JUSTA team conducted a

cross-sectional survey of 200 poultry workers (Quandt at el. 2006a) in the counties targeted for the study proposed here. The sampling frame of community enclaves and non-enclave-dwelling workers proposed for the completed project was piloted. Data on MSDs and dermatological symptoms were collected by self-report. Other data included job demands, safety climate, and work exposures. With a team of 2 full- and 3 part-time interviewers, workers were recruited and interviewed in three months, demonstrating the team's ability to implement the sampling and recruitment plan. Overall, 59.5% of workers experienced at least 1 of 5 symptoms potentially related to poultry processing work in the prior 30 days: respiratory, skin and musculoskeletal symptoms of neck/back, arms/wrists/hands, or legs/feet. Musculoskeletal symptoms were the most commonly reported (by 46%, 36%, 23%, respectively). Workers reported their jobs frequently required awkward postures and repetitive movements and that they had little control over and variety in their work. Risk factors for MSDs were low variety in job tasks, and high levels of psychological job demands. Low commitment to safety (perceived by workers) was a risk factor for respiratory symptoms. There was considerable variation in worker-rated safety climate of the processing plants. Overall, 89.3% of workers considered the possibility of being injured at work in the next 12 months as very likely. A minority (19%) felt that supervisors did as much as possible to make the job safe, and 64.5% thought supervisors were only interested in doing the job fast and cheap. Between-company differences in provision of personal protective equipment were found. One of the striking features was the low percentage of workers who reported symptoms who had taken time off work. This finding was explained by the strong reported need to work to support family (Grzywacz et al. 2007a).

In addition, JUSTA staff conducted a series of in-depth interviews with 30 current or former poultry workers to understand their perspectives on work, relations in the plants, and injuries (Marín et al. 2006). These revealed a social organization characterized by racism, sexism, and fear, which may create a work environment in which injuries are likely to occur, but not be reported. Whether documented or not, most workers fear immigration difficulties for reporting injuries. Based on these findings and interactions with the community, the JUSTA project has developed a lay health advisor program which provides information to workers about their rights; western North Carolina Workers' Center (WNCWC) has also received a grant from the Poverty & Race Research Action Committee to develop advocacy strategies based on these data.

C.1.a. Community Health Fair In October 2006, the JUSTA team conducted a community health fair to test the feasibility of the data collection time frame in the current proposal and to obtain additional preliminary data. Working with the WNCWC, we recruited 70 immigrant Latino workers to the health fair: 28 poultry workers, and 42 from other industries. Katz diagram for carpal tunnel syndrome (CTS) diagnosis and skin examinations were conducted with all participants by Spanish-speaking physicians, and basic clinical (i.e., height, weight, blood pressure) and lab (i.e., total cholesterol and blood glucose) data were collected. Face-to-face interviews were conducted with poultry workers by four trained, native Spanish-speaking interviewers. The health fair lasted four hours, and most participants were at the event for 60 – 90 minutes. They were given only non-monetary incentives (health education materials, a sports water bottle, and raffle ticket for a bicycle).

The preliminary data suggested high levels of MSDs and dermatologic illnesses that are likely related to poultry processing employment. 32% of poultry workers had classic or probable CTS, based on Katz hand diagrams, whereas fewer than 1% of non-poultry workers met potential caseness (χ_2=13.73; p<.01). Skin diseases common in the sample were tinea pedis (45%), melasma (22%), onychomycosis (17%), atopic dermatitis (13%), acne/folliculitis (13%), and warts (9%). Warts were more common among poultry workers (X_2=4.98; df=1; p=.026). 12 poultry processing workers indicated having a skin problem on the hands, wrists or forearms in the past 3 months and that the problem was made worse by contact with materials at work, specifically cleaning solvents ("Clorox") or "juice" from the chickens. 75% of participants with a skin problem reported that the problem usually improved after being away from work.

The preliminary data also suggested that injuries and illnesses common among poultry processing workers are associated with poorer quality of life. The average disability/symptom score from the Disabilities of the Arm, Shoulder, and Hand questionnaire (DASH) (Hudak et al., 1996) was 21.5 (SD=11.9) among poultry processing workers with classic or probable CTS. By contrast the average score was 10.2 (SD=8.2) and 10.1 (SD=14.7) for poultry processing participants without signs of CTS and for a general population sample (Hunsaker 2002), respectively. Nearly one-third (n=9) of poultry processing workers had Dermatological Life Quality Index (DLQI) (Finlay & Kahn 1994; Finlay 1998) scores suggestive that skin has a "moderate" or "very large" negative effect

on daily life; 7 (23.3%) had scores suggesting that skin has a "small" effect on daily life. Four of six participants (66%) reporting urticaria had DLQI scores suggestive of "moderate" or "very large" effects on daily life, compared to only 21% of individuals without urticaria (χ_2=10.4; df=3; p<.05). DLQI scores were not elevated among individuals with atopic dermatitis, melasma, warts, or onychomycosis.

C.2. Occupational Skin Disease among Minority Farmworkers (R01 ES012358)

Project team members (Quandt, Arcury, Feldman, Schulz, Marín) conducted Occupational Skin Disease among Minority Farmworkers, which provided preliminary data for this application. First, 25 male western NC Latino poultry workers completed interviews and skin examinations (by a dermatologist) in 2004 to help validate data collection procedures to be used with Latino farmworkers. Similar to the data collection methods proposed in this application, these poultry workers were recruited from Latino enclaves in one of the study counties and participated in a clinic held in a church hall. All workers had at least one diagnosed skin disease (Quandt et al. 2005): 17 (68%) had inflammatory diseases (acne/folliculitis, atopic dermatitis, psoriasis); 10 (40%) had pigmentary disorders (melasma, post inflammatory pigment change); 23 (92%) had infections (onychomycosis, tinea pedis, warts); 7 (28%) had trauma (scars, traumatic skin lesion, traumatic nail lesion); and 1 had a tumor suspicious for malignancy. Second, also in 2004, the project conducted data collection clinics in two farmworker camps. Workers completed interviews and received skin exams from a dermatologist. More than three-fourths (77.7%) of the 54 male farmworkers and 100% of the 5 female workers were diagnosed with a skin disease (Krejci-Manwaring 2006); most commonly diagnosed skin diseases were onychomycosis, tinea pedis, acne, and other types of tinea. Third, a cohort of 304 farmworkers residing in 45 camps across 9 counties in eastern NC were recruited and interviewed up to 5 times at 3 week intervals from May to October, 2005. Workers were interviewed about their hygiene and personal protection practices, and about work tasks performed during the week prior to each interview. A standard set of photographs of the worker's skin was taken at each interview; sets were reviewed by a dermatologist (co-investigator Feldman), who diagnosed skin diseases visible in the photos. These data show a variety of skin diseases similar to Quandt et al. (2005) (Arcury et al. 2007). Finally, as proposed below, in-depth interviews were conducted with 30 male and female Latino farmworkers across NC. These textual data were used to determine Spanish terms commonly used to refer to skin problems (Vallejos et al. 2005), to delineate farmworkers' beliefs about causes of skin disease and examine farmworker skin disease self-management (Arcury et al. 2006a, 2006b).

C.3. Ultrasound Studies

Investigators Walker, Cartwright, and other neurologist colleagues have extensive research and clinical experience in the development of the use of high-resolution ultrasound as a tool for evaluation of the peripheral nervous system. In the 1980s they began using ultrasound to evaluate peripheral muscles (Walker et al. 1990; 2004). Subsequently, high resolution ultrasound began to be used to accurately visualize nerves, which led to its use for the diagnosis of focal nerve disease (Caress et al. 2003; Cartwright et al. 2005, Wiesler et al. 2006a; Cartwright et al. 2007a, Cartwright et al. 2007b) and CTS, in particular (Wiesler et al. 2006b). Walker and Cartwright brought this experience to this study; ultrasound is an ideal complement to nerve conduction studies, providing anatomic information not obtainable with electrodiagnosis.

D. Research Design and Methods

D.1. Overview

This project was designed to be completed over four years. Data collection included three major components. Component One addressed Specific Aims 1 and 2. This cross-sectional study was to include and in-person interviews, followed by assessment of MSDs and skin disorders among 276 Latino poultry workers and 276 controls through direct examination. Component Two addressed Specific Aim 3. It was to assess a subsample of 133 poultry workers (disease free, < 6 months work in poultry) and a subsample of 133 non-poultry workers from the original cohort with in-person interviews at 6 and 12 months after baseline assessment and a physical examination at 12 months. Component Three addressed Specific Aim 4, using in-depth interview methods to elicit poultry workers' interpretation of occupational illness and injury symptomatology, self-care behaviors, and barriers to prevention, treatment seeking, and injury and illness

reporting. A subsample of poultry processing workers was to be asked to complete these interviews.

D.2. Conceptual Model

This project was guided by a conceptual model focused on the organization of poultry processing work (Figure D1). Organization of work is posited to underlie all aspects of occupational health and quality of life among immigrant workers. The organization of work shapes exposure to physical demands in the workplace that undermine worker health, which becomes manifest in physical symptoms and can proceed to a specific MSD. The degree of mechanization in the plant, for example, influences the speed and repetition at which workers perform tasks, as well as the amount of physical exertion required of workers. Likewise, management practices, such as commitment to worker health and safety, influence the relative level of physical demand through the availability of specialized equipment (e.g., pneumatic scissors) and the execution of job rotation strategies. The conceptual model also suggests that the organization of poultry processing work has direct effects on occupational health outcomes. The lack of control, excessive psychological pressure, as well as discrimination and coercion in the workplace contribute to stress responses that contribute to musculoskeletal and dermatologic symptoms. Finally, the organization of work can exacerbate the effects of occupational illness and injury on worker quality of life. Abusive supervision tactics, for example, can exacerbate the effects of disorder on quality of life because workers may not report injuries for fear of job loss or other reprisals. Conversely, organizational responsiveness to worker health, such as provision of effective treatments or job reassignment, can minimize the negative effect of occupational injury or illness on worker quality of life. Equally important to the organization of poultry processing work are immigrant workers' social and cultural circumstances. Social factors like education and cultural factors, such as acculturation, shape the types of jobs in which workers find themselves. Likewise, the model posits that social and cultural factors such as access to health care and beliefs about health, and appropriate treatment of symptoms, will have direct effects on worker health and health-related quality of life. Finally, our model acknowledges that the health-related consequences of several physical work demands differ depending on personal characteristics. For example, recognizing that work stations are designed for "average" workers, the effect of repetitive activities on upper extremities will likely be compounded for those with short stature.

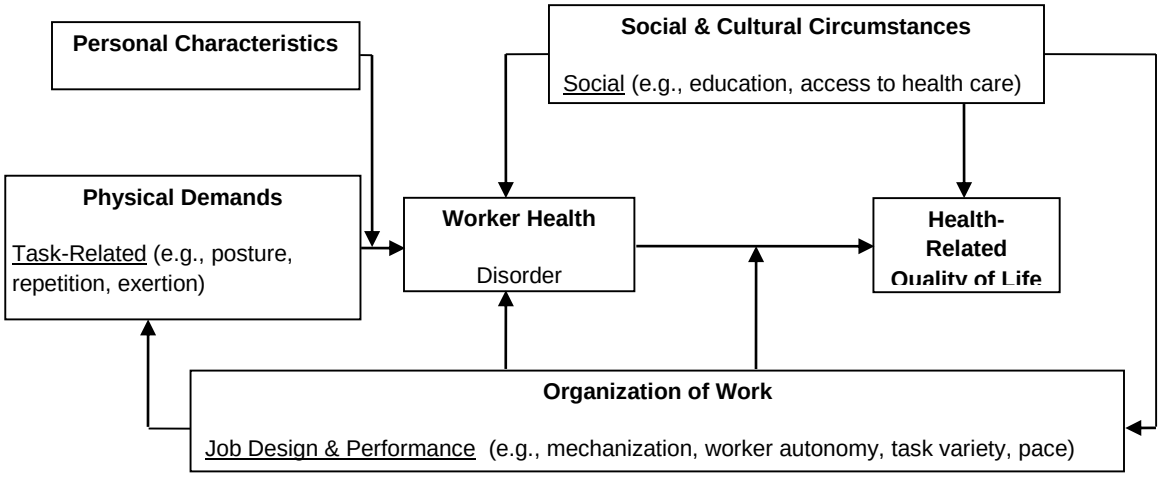

Figure D1. Conceptual model of worker health and quality of life among immigrant Latinos

D. 3. Research Sites

This project focused on Latino poultry processing workers residing in six rural NC counties (see Map, Appendix A). These counties are west of Winston-Salem in the foot hills of the Appalachian Mountains and fall into 3 sectors: Dobson (Surry, Yadkin), Wilkesboro (Wilkes), and Morganton (Caldwell, Alexander, and Burke). They share common social and economic characteristics; they are not ethnically diverse, with African Americans making up less than 5% (compared to 22% in all of NC). The Latino population has grown dramatically since 1990.

The proportion of the US population that is Latino expanded considerably during the 1990s. In 1990, Latinos in the US numbered 22,354,059 (9% of the total population), but by 2000, the numbers had increased to 35,305,818 (12.5% of the total population). The great majority were from Mexico (66.1% of US Latinos).

Several areas historically have had large Latino populations, including California, the Southwest, Texas and Florida, as well as large cities in the Northeast. For other states, particularly the more rural states of the Southeast, this expanding Latino population is a phenomenon of the 1990s; these states are still adjusting to the growth of this culturally distinct population segment (Kochhar et al. 2005). NC has experienced remarkable growth in its Latino population. Official 2000 US Census results indicate that the state's Latino population increased five-fold, from 76,745 in 1990, to 378,963 in 2000, the largest growth of any state (Kochhar et al. 2005). The US Census estimates the 2006 NC Latino population at 593,386, 6.7% of the state population. This population growth has included most rural counties in the state.

There is general agreement that Census figures are an undercount (Table D1) and that the Latino population has continued to increase. The US Census provides 2006 estimates for county populations. FaithAction International House (2005) has also provided a 2005 estimate of Latino population in NC counties. Using either set of estimates, it is clear that the Latino population in these counties is significant. Few of these Latino immigrants have health insurance; even those employed by companies that provide health benefits do not take the health insurance due to cost. Because they are immigrants, many have limited access to private or public health services (Cunningham et al. 2006). Latino workers in these counties are employed in poultry processing, as well as other local manufacturing (textile and furniture), construction, landscaping, service industry, and other manual labor jobs.

Table D1: Population in Project Counties

County	Total 2000 (Census)	Latino 2000 (Census)		Latino 2006 (Census Estimate)		Latino 2005 (FaithAction Estimate)	
	n	n	%	n	%	n	%
Alexander	33,603	841	2.5	1,194	3.3	1,668	4.7
Burke	89,148	3,180	3.6	4,413	4.9	4,092	4.6
Caldwell	77,415	1,927	2.5	2,874	3.6	3,013	3.8
Surry	71,219	4,620	6.5	6,396	8.8	8,340	11.5
Wilkes	65,632	2,262	3.5	3,231	4.8	3,522	5.2
Yadkin	36,348	2,357	6.5	3,273	8.6	4,967	13.2

D. 4. Community Entrée

Our procedures for establishing and maintaining community entrée are described in Quandt et al. (1999). Community entrée, establishing positive relationships with the study communities, is important for several reasons. First, it is an ethical approach to research in communities. Letting community leaders and residents know we are conducting research in their communities, what we hope to accomplish, and that we will guard the anonymity and confidentiality of study participants is a way to obtain "community informed consent." Second, sharing what we have learned in our research with Latino community leaders and service providers ensures that they will be willing to share their knowledge of the communities with us. Third, being known in the community and being able to give community leaders as references helps us in recruiting participants; they are more apt to have heard of us and to know that we are not trying to exploit them Finally, being known in the community will help in retaining participants over the one-year follow-up period.

Entrée for this project was built on our existing relationships with the Latino communities in the project counties. Beginning in 2000, we established the Center for Latino Health Research, a program to investigate health related problems that confront the Latino community in NC. The advisory committee for the center included representatives from CBOs and health departments in Caldwell, Surry, and Wilkes counties. At the urging of Latino community leaders, we undertook research projects on acculturative stress (Grzywacz et al. 2005; Hiott et al. 2006), intimate partner violence (Grzywacz et al. under review), and food insecurity (Quandt et al. 2006b). These leaders supported our research on the neurobehavioral development of Latino children (Rohlman et al. 2005; 2007). We collaborated with CBOs in the development of projects for extramural support. In addition to the JUSTA collaboration, we had a second collaboration with WNCWC, "Reducing Occupational Injuries and Illnesses among Latino Poultry Workers in NC," funded by the Poverty & Race Research Action Council. We had an EPA-funded project to reduce lead exposure among Latino children in collaboration with three county health departments, and a project submitted to US-EPA in collaboration with HOLA, a new CBO in Wilkes County, "Structural Integrated Pest Management in North Carolina's Spanish-Speaking Households: Using a Lay Health Advisor Approach to Community Education". Finally, a member of our project staff, Field Coordinator Antonio Marín, was a long-time leader in the Wilkes County Latino community and was known to community leaders in all project counties.

We initiated several activities during Project Year 1 to expand entrée into these counties. First, the

investigators and staff met with community leaders and service providers. For Latino communities, leaders included CBO officials and clergy, as well as less formal opinion leaders such as store and restaurant owners. Service providers include health department, social services, and public school personnel. This approach of interviewing community leaders and service providers was valuable in our earlier research (Arcury et al. 1998) including JUSTA. Second, we made presentations to members of community organizations and churches to tell residents about the study. Third, we worked with Spanish language media outlets in the region to release information about the project. Our growing familiarity with current events, local history, and human relations in the counties created an atmosphere in which community leaders and individual adults felt more comfortable when we contacted them.

In Project Years 2-4, we continued the community entrée process. This included: (1) reporting our progress to the leadership of CBOs; (2) providing project information to the general communities through presentations to community organizations and churches; and (3) reporting project activities and results to poultry workers and the larger immigrant community by providing news releases to the local Spanish language media outlets.

D.5. Sample Design for Components 1 and 2: Selection, Recruitment and Retention

The sample design for this study was complex due to the nature of the population and the data collection design. The population consisted of immigrant workers who could not be accessed at worksites, for whom no enumeration or list existed, and who wished to remain un-noticed by governmental authorities. Data collection involved a cross-sectional cohort-comparison component (Component 1), and a longitudinal component in which sub-samples of the poultry workers and the comparison group were followed over one year (Component 2).

D.5.a. Sample: Special Considerations for a Hard-to-Reach Population The cross-sectional Component 1 and longitudinal Component 2 focused on a representative, but not random, sample of poultry processing workers and controls. Plans for recruitment were designed to address the limitations in working with this population: it was dispersed, largely undocumented, and feared detection. Experience (our own, Quandt et al. 2006a, and those of Lipscomb et al. 2005) had shown that the poultry processing companies would not collaborate in occupational health research and would not provide a list of their employees from which to draw a sample. Latino immigrant workers are a hard to reach or hidden population, for which special sampling methods are appropriate (Heckathorn 1997; Parrado et al. 2005).

D.5.b. Sample Size and Inclusion Criteria Data for the cross-sectional Component 1 was designed to be collected at initial data collection clinics from a sample of 276 poultry processing workers and 276 controls. Thus, the Component 1 cross-section study was to include a sample of 552 participants. Data for longitudinal Component 2 were to be collected from a sub-sample of 133 of the initial sample of poultry processing workers and 133 of the initial sample of controls who would complete an interview 6 months after their initial data collection clinic and in a second data collection clinic 12 months after their initial data collection clinic. Each sample was to be divided equally among men and women. We required a sample of 100 participants in each of the Component 2 groups (poultry workers and non-poultry workers); we intended to recruit a sample of 133 in each group because we anticipated a 25% rate of loss to follow-up. We instituted an intensive retention program to ensure that our rate of loss to follow-up was no greater than 25%.

Inclusion criteria for poultry processing workers in the component 1 (cross-sectional) sample were: age ≥18 yr, Latino (self or parents born in a Latin American country, or self-identified as “Latino”), intention to remain in the area for 12 mo, employment in poultry processing of ≤ 3 yr, and current employment as a processing line worker from hanging through packing. Current poultry workers in maintenance, quality control, and supervisory positions were excluded, as they would not have experiences the same exposures for musculoskeletal and dermatological injuries as line workers. Controls were recruited from the same communities so they would have similar access to health care and exposure to environmental stressors. Inclusion criteria were age 18 years or older, Latino (self or parents born in a Latin American country, or self-identified as “Latino”), currently employed in manual occupations excluding poultry processing or production (e.g., service occupations, landscaping, and other manufacturing), lifetime total employment in poultry processing or production < 6 mo, and not employed in poultry industry for at least two yr.

D.5.c. Sample Frame We constructed a sampling frame based on our ethnographic understanding of Latino communities in rural NC (Parrado et al. 2005). This frame is described in Quandt et al. (2006a), and was updated for this study.

The research team did not have access to workplaces, and no census existed of Latino manual workers in the area. Therefore, community-based sampling was used to assure that a representative sample would be selected (Arcury & Quandt, 1999). A sample frame was developed of dwellings where Latinos lived in the study area. The study team and a community-based organization partnered to map areas mostly populated by Latino residents (enclaves). The research team also surveyed other areas of the counties to identify other dispersed dwellings that were likely inhabited by Latino residents. To identify such dwellings, surveyors looked for cultural or behavioral indicators known to characterize Latino residents (e.g., car decals, bicycles, particular satellite dishes). The lists of enclave and dispersed dwellings contained 4,376 possible Latino dwellings, with about two-thirds in residential enclaves. The lists were randomized, and assigned proportionately to recruit two-thirds from enclaves and one-third from dispersed dwellings.

D.5.d. Participant Recruitment for Component 1 Well known members of the Latino community were hired as recruiters; 2 to 4 recruiters worked in each study county. Recruiters visited randomly selected dwellings in order; if no one was home, recruiters returned at different times and on different days. Residents were screened for inclusion criteria: self-identified as being Latino or Hispanic, worked 35 hrs or more per week in a manual labor job, and were 18 yrs or older. Manual labor jobs were defined as employment in non-managerial jobs in industries such as landscaping, construction, restaurant work, hotel work, child care, or manufacturing. Non-poultry manual workers with previous work in poultry only qualified if lifetime employment in poultry production or processing was 6 months or less, and not within the past 2 years. Work in poultry processing was defined as any type of non-supervisory work in a poultry processing plant with job categories from receiving through sanitation. Employees of poultry production farms were excluded. More than one resident per dwelling could be recruited, if eligible. Figure 1 reports the recruitment rates. Of 1681 dwellings selected, 965 were screened, for a screening rate of 57%. A total of 1,526 residents were screened. Of those eligible, 78% were interviewed; 70% of those interviewed attended the data collection clinic for the physical examination.

Table 1 shows the number of individuals recruited, by worker type (poultry and non-poultry) and gender.

Table 1. Component 1 sample

Component 1	**Poultry**	**Non-poultry**	**Total**
Male	230	194	424
Female	176	142	318
Total	406	336	742

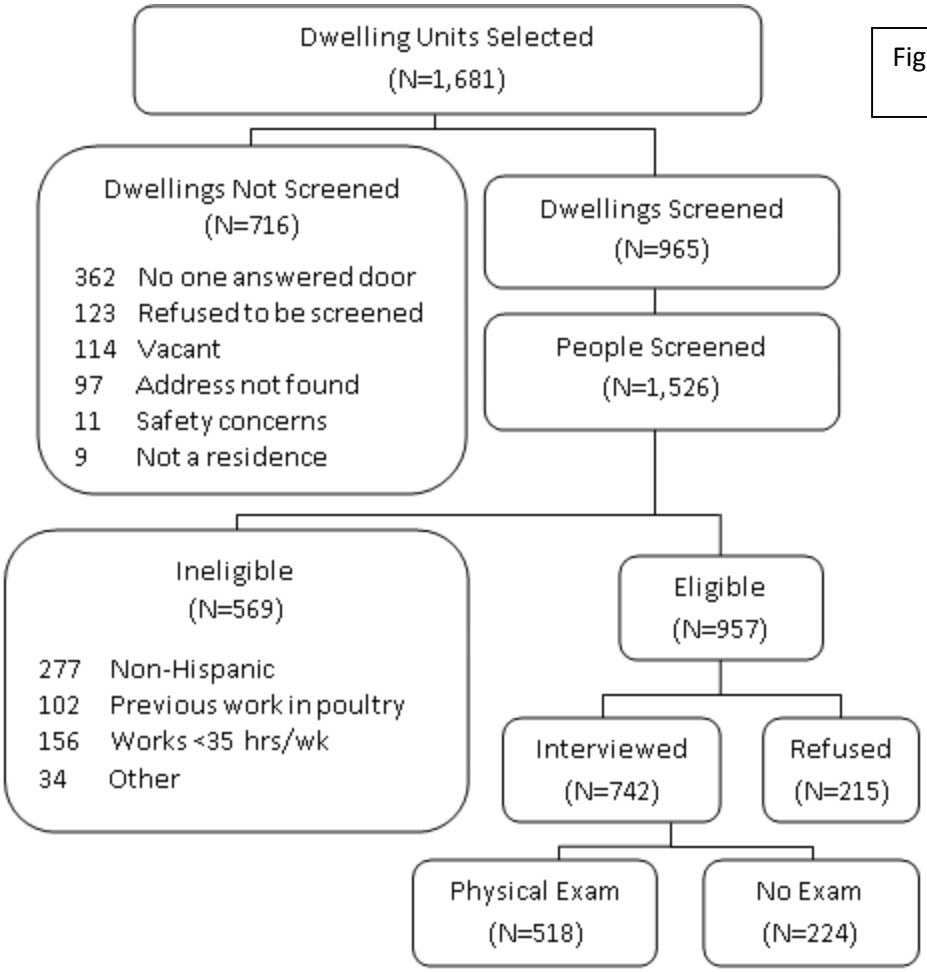

Figure 1. Sampling and recruitment.

D.5.e. Participant Recruitment for Component 2 Participants from the clinics were recruited for the longitudinal Component 2 with the following eligibility to classify as "disease free".

For skin disease, subjects were eligible for follow-up if they were free of both the listed inflammatory skin diseases (acne, atopic dermatitis, contact dermatitis, folliculitis, psoriasis, seborrheic dermatitis, stasis dermatitis, urticaria) and the listed infectious skin diseases (Candida, cellulitis, impetigo, molluscum, onychomycosis, pitted keratolysis, tinea pedis, tinea versicolor, all other tineas, scabies, warts, and other skin infections such as TB, syphilis, leprosy) at baseline.

For carpal tunnel syndrome, subjects were eligible for follow-up if they were free of carpal tunnel syndrome in both wrists. To be considered free of carpal tunnel syndrome in both wrists a subject had to meet the following criteria,

1) Report no pain, tingling, numbness, or decreased sensations in the thumb, index finger or long finger of either hand that lasted two or more days in the month preceding the exam or pain in those digits could not extend beyond the dorsum of the thumb, index or long digit and,
2) Have a sensory peak latency difference of less than 0.5 milliseconds in each wrist.

D.5.f. Tracking and Retention Tracking is essential to maximize retention. It is difficult in the best of situations; with a hidden population, such as immigrant poultry processing workers, it was extremely challenging

We used a "case manager" approach to track the study participants. The Field Project Coordinator and the Field Assistants were responsible for tracking and managing the participants they recruited. The project team's long-term, ethnographic presence in the communities was maintained during the entire project. Our

familiarity and presence in the communities (e.g., attending Latino church services, making presentations to Latinos through service and advocacy organizations, "hanging-out" at tiendas) facilitated this approach.

D.6. Component 1: Cross-sectional Study Data Collection

Component 1 data collection consisted on an in-person interview, generally conducted at the time of recruitment. This was followed within a month with the participant coming to a centralized data collection clinic for the physical examination. These were conducted at a location known to the members of the Latino community in each county; we used churches, community centers, and CBO facilities. Clinics were held on Sundays, as that was the day most workers were available and most of the professional data collectors could travel to the clinics. Transportation was provided for participants who needed it. Participants received a $40 incentive for the clinic.

D.6.1. Flow and Procedures Each clinic has 8 components: intake and informed consent, interview, anthropometrics, musculoskeletal exams, nerve conduction, ultra sound, dermatological exam, and check out and incentive. Several members of the research staff were be available to help participants to move efficiently among components. Participants were able to complete the clinic in about 2 hours.

Anthropometrics included height, weight, and wrist breadth and depth. Weight was measured with a calibrated electronic scale, while height was measured with a portable stadiometer.

Musculoskeletal exams were conducted by a physician at each clinic. Exams were focused on the wrist, arm and shoulder, and back. Nerve conduction and ultrasound were conducted for both wrists by a physician or technician. Dermatological exams were be conducted by a third physician, and were focused on the face and neck, hands and arms, and feet.

D.7. Component 2: Longitudinal Study Data Collection

Component 2 addresses Specific Aim 3, to document the development of MSDs and skin disorders in Latino workers; and assess the mediating and moderating effects of occupational, structural, and socio-cultural factors on this development. For this component 133 poultry processing workers (1) with less than 6 months total employment in poultry work at baseline, and (2) free of MSDs and dermatological illness will be recruited for follow-up. In addition, 133 matched other manual workers selected from the initial clinics will be recruited. These workers will also be free of MSDs and dermatological illnesses. Each of these 266 participants will be asked to complete a 6 month follow-up interview, and a 12 month follow-up clinic. For planning purposes, we must assume that equal numbers of Component 2 participants will be recruited from each of the 6 initial clinics.

D.7.a.Six Month Interview At the midpoint between the initial and follow-up clinic data collections, participants will complete an interview designed to capture potential onset of symptoms indicative of occupational injury or illness. The interview will focus primarily on self-reported musculoskeletal symptoms, such as experiences of numbness or tingling in hands or wrists in the past 30 days, as well as dermatologic symptoms and quality of life. Assessments will also document changes in participants' work status. This intermediate assessment is essential for describing the progression of occupational disorder between baseline and one year follow-up, and for determining whether changes in symptoms precede or follow changes in health-related quality of life. These interviews will also be an integral part of the process of tracking participants between the two data collection clinics. The interviews will be collected in the participant homes (or another location chosen by the participant) by the Field Assistants.

D.7.a.1. Interview Questionnaire The interview questionnaire will generally include the same items used in the clinic interview, including current work characteristics, organization of work, general health, mental health and stressors, musculoskeletal health, and dermatological health. The work history items will not be repeated. The process of developing and translating this questionnaire has been described in "D.2.2.a.2. Development and Pre-testing of Data Collection Forms."

D.7.a.2. Interviewers, Training, and Procedures The Field Project Assistants will conduct these six month

interviews. Training these staff members for conducting the interviews has been described in "D.2.2.a.3. Training and Quality Control." The Field Project Assistants will maintain contact with the participants who complete the initial data collection clinics as described in "D.2.1.d. Tracking and Retention." The protocol calls for each participant to be contacted by the Field Coordinator and Field Assistants at least monthly to check on their status and note any residential changes. At the contact 6 months after the initial clinic, the participants will be interviewed by their Field Assistant contact and receive their $20 incentive.

D.7.a.3. Supervision and Quality Control Project Coordinator and Field Project Coordinator will supervise the Field Assistants to ensure the tracking process and six month interview are conducted properly. The number of completed interviews and interview schedule will be reviewed at weekly meetings; Co-Investigator Arcury will attend these meetings. Any problems encountered will be discussed and resolved. The Project Coordinator or Field Project Coordinator will re-contact 5% of the participants completing six month interviews to ensure interview integrity and quality.

D.7.2. Follow-up Clinic The 6 follow-up clinics will be identical in procedure and content to the initial clinics but involve a smaller number of participants. Approximately 20-25 participants will participate in each of these clinics. The six follow-up clinics will be conducted beginning in the last 3 months of Project Year 2 and ending in month 2 of Project Year 4. They will be conducted at the same locations as were the initial clinics. Data collection will be scheduled on Sunday afternoon (12:30 – 4:30 pm). Refreshments will be available. The Project Field Coordinator and Assistants will contact the participants in the week before each Follow-up Clinic and schedule a time for their participation. They will record any participants who cannot be located or who refuse to participate in the Follow-up Clinic. Clinic procedures and training and quality control procedures will be the same as those described for baseline. The incentive given will be $60.

D.8. Measures

D.8.a. Outcomes: Health-Related Quality of Life

Health-Related QOL: *Health-related quality of life* was measured at each interview using the Medical Outcomes Short Form-36 Health Survey, V 2.0, Acute form (Ware et al. 2000). This instrument measures 8 health concepts over the past week representing discrete aspects of a person's functioning most likely to be affected by injury or disease, as well as treatment. The U.S. Spanish version of the SF-36 (version 1) was translated using standard procedures including forward and backward translation (Ware et al. 1993) and has been validated in several Latino samples (Arocho & McMillan 1998; Bennett & Riegel 2003; Peek et al. 2004). In the 2nd version of the SF-36, emphasis was placed on improving the cross-cultural interpretation of items, and evidence suggests that this new version has excellent reliability and validity (Ware et al. 2000).

Musculoskeletal QOL: The Disabilities of the Arm, Shoulder, and Hand questionnaire (DASH) was developed by WHO's Upper Extremity Collaborative Group to measure *impairment and limitations in activities due to disorders of the upper limbs*. DASH is available in Spanish (Rosales et al. 2002); it measures patients' own perspectives of their upper extremity disability. Its 30 items relate to daily activities, recreation, self-care, sleep, sports, family care, occupation, socializing, and self-image, with optional questions related to work and sports. Reliability, validity and responsiveness have been evaluated in patients with disorders of the shoulders, elbows, wrists, and hands (Atroshi et al. 2000; Beaton et al. 2001; Soohoo et al. 2002; Turchin et al. 1998, Jester et al. 2005). Test-retest reliability (ICC=0.96) (Beaton et al. 2001), internal reliability (0.96) (Offenbaecher et al. 2002), and construct validity are all strong.

The Roland-Morris Disability Questionnaire (RDQ) is a measure that is used to assess *physical disability due to low back pain*. The RDQ consists of 24 statements which focus on a limited range of function including: walking, bending over, sitting, lying down, dressing, sleeping, self-care, and daily activities. The RDQ has been demonstrated to be valid, reliable, and responsive to change (Deyo 1986; Jensen et al. 1992; Underwood et al. 1999; Beursken et al. 1996; Roland & Fairbanks 2000; Turner et al. 2003). It has good internal consistency and reproducibility (Hsieh et al, 1992; Kopec & Esdaile 1995; Jarvikoski et al, 1995; Roland & Morris 1983; Johansson & Lindberg 1998; Deyo & Centor 1986). In a population of workers receiving compensation for back injury, Turner et al. (2003) found that the RDQ was a valid and consistent (α =0.95)

measure of physical disability among workers with back injuries. The RDQ has been translated into Spanish (Kovacs et al. 2002). Internal consistency of the translated version is good (Fritz & Irrgang 2001).

Skin-Related QOL: The Dermatological Life Quality Index (DLQI) was used to measure skin-related QOL (Finlay & Khan 1994; Finlay 1998). This 10-item instrument is reliable and sensitive to clinically-significant changes in skin conditions. It has been cross-validated with general health measures (e.g., SF-36) and with disease-specific questionnaires (Finlay 1998). The DLQI addresses a range of areas for which respondents rate the effect of any skin problem over the past week on a 3-point Likert-type scale. The questions form 6 subscales (Symptoms & Feelings, Daily Activities, Leisure, Personal Relationships, Work & School, and Treatment) and a total score. Score ranges have been correlated with overall health-related QOL (Hongbo et al. 2005). The DLQI was originally developed in English and has been translated and validated in multiple languages. In order to ensure fidelity to the original DLQI, we received permission from Dr. Andrew Y. Finlay, its developer, to create a validated version using the technique he requires for all new versions (see website: http://www.dermatology.org.uk/ index.asp?portal/quality/dlqiinstruc.html). Our results of summer surveillance of a farmworker population (n=304; 1048 total interviews) indicate that two scales in particular, Symptoms & Feelings and Work & School, are linked to working environment (Quandt et al. 2008a, b).

D.8.b. Outcomes: Worker Health Both musculoskeletal and dermatological outcomes were assessed in two ways: through physical examination and through worker self-reports.

General and occupation specific symptoms were assessed at baseline, 6 month interview, and 12 month follow-up. General symptoms were assessed with the Cohen-Hoberman Inventory of Physical Symptoms scale (CHIPS)(Cohen & Hoberman 1983). The CHIPS consists of 33 items (e.g., “back pain, “dizziness”, “cold or cough”) rated from 0 (“not bothered”) to 4 (“extreme bother”) over the prior 2 week period. A total symptom score is the sum of all item ratings with higher scores indicating greater symptoms.

Other instruments were used to assess symptoms of MSD and skin disorders. A modification of the Standardized Nordic Musculoskeletal Questionnaire (NMQ) will be used to assess location and the severity of pain (Kuorinka et al. 1987). This modification incorporated the administration system of a recent instrument appropriate for low literacy populations and validated among Latino farmworkers (Faucett et al. 2001). A “faces” scale was used to characterize the severity of each symptom. To obtain detailed information about hand symptoms, the Katz hand diagram for CTS was used (Katz & Stirrat 1990; Katz et al. 1990). This has been widely used (e.g., Werner et al. 2005) in conjunction with nerve conduction studies for identifying CTS cases. Pain items from the RDQ and DASH were also used to assess symptoms.

The Nordic Occupational Skin Questionnaire (long form) was used to assess symptoms of atopy, hand and forearm eczema, and contact urticaria (Susitaival et al. 2003). These involve 30 items; skip patterns shorten the instrument for those not experiencing symptoms. Spanish translation of the pertinent section of the form was conducted during the first 6 months of the project as recommended in Flyvholm et al. (2002).

D.8.b.1 Clinical Exams For MSDs Several clinical exams for different regions of the upper body were utilized to determine the existence of MSDs. Case definitions are based on criteria and consensus documents for evaluating upper-extremity MSDs (Rempel et al. 1998; Sluiter et al. 2001). Four specific disorders were diagnosed: CTS, rotator cuff syndrome, epicondylitis, and low back injury.

Carpal Tunnel Syndrome (CTS): CTS, or median mononeuropathy at the wrist, is the most common nerve entrapment syndrome (Latinovic et al. 2006), arising from chronic median nerve compression. Manual labor involving the hand, wrist, and arm is associated with CTS development; therefore, it is a commonly reported occupational condition (Abbas et al. 1998). Nerve conduction studies and electromyography have been used to diagnose CTS. Recently, high-resolution ultrasound has proven to be an accurate tool for the evaluation of CTS (Wiesler et al. 2006a). It provides anatomic information about the median nerve and its surrounding structures that cannot be obtained with routine electrodiagnostic studies.

In addition to history and physical exam, sensory nerve action potentials (to determine conduction velocity) were combined with the cross-sectional area of the median nerve at the distal wrist crease (measured with

ultrasound) in an effort to provide objective evidence of the presence or absence of CTS. The case definition of classic/probable CTS was: history of numbness, tingling, burning OR pain in at least 2 of digits 1-3; normal OR decreased sensation palmar aspect digits 1-2 OR weakness of abductor pollicis longus muscle; AND (a) slowed sensory conduction velocity across the wrist (44m/s); OR (b) median nerve >12 mm^2 at the distal wrist crease. This definition is consistent with Rempel et al. 1998.

Two factors were key in the decision to use both nerve conduction studies and ultrasound to diagnose CTS. First, electromyography, which typically accompanies nerve conduction studies, was not used because it is too uncomfortable; so ultrasound provided a second test to complement nerve conduction studies. Second, since a high incidence of musculoskeletal complaints were expected in this population, the history alone may overestimate the rate of CTS. Therefore, two different objective measures (electrodiagnosis and anatomic information from ultrasound) were be used to help verify the correct diagnosis of CTS.

Nerve Conduction Studies: Median nerve sensory conduction velocities were calculated bilaterally for all participants using standard techniques (Kimura 2001). Erasable marks were drawn to mark the middle of the proximal phalange on digit 2 (site of the recording electrode) and 150mm proximal on the forearm (site of nerve stimulation). Two ring electrodes were placed over digit 2. Stimulation was performed at the distal forearm with increasing strength until supramaximal nerve stimulation was obtained. Conduction velocity was obtained by measuring the onset latency of the sensory waveform. Velocities < 44 m/s were considered abnormal and consistent with CTS.

Neuromuscular Ultrasound: Median nerve cross-sectional area was calculated bilaterally for all subjects. Gel was applied to the worker's wrist, and a linear array transducer was used to image the median nerve at the distal wrist crease. Once the median nerve was accurately imaged the picture was frozen and the trace function (accurate to 0.1mm^2) was used to calculate the cross-sectional area of the nerve in mm^2. The same process took place on the other wrist. Cross-sectional areas > 12mm^2 were be considered abnormal and consistent with CTS.

Rotator Cuff Syndrome: The rotator cuff is a group of flat tendons that fuse together and surround the front, back, and top of the shoulder. Rotator cuff syndrome is experienced as intermittent, activity-dependent pain in the shoulder region which may radiate down the arm and may be worse at night. Pain increases when the arm is elevated. Injuries to the rotator cuff usually coincide with the start of repetitive motion work, particularly overhead use of the shoulder. Those working in poultry processing are particularly at risk because workers reach up to hang the birds. Case definition: symptoms of intermittent pain in the shoulder region without paresthesias, worsened by elevation of the upper arm. One or more of the following signs must also be present at time of the exam or at least 4 of the past 7 days before the exam: pain with resisted shoulder abduction, external rotation, or internal rotation; pain with resisted elbow flexion; or painful arc on elevation.

Epicondylitis: Epicondylitis is an injury to the muscles and tendons of the elbow. It occurs with any type of repetitive wrist dorsiflexion activity, as may occur among workers whose work calls for repeated forceful wrist extension. Poultry workers may be at an increased risk because of the cutting and deboning required in the processing. Symptoms may occur at night, but are usually more pronounced during activity that involves grasping or wrist extension and flexion. Epicondylitis is characterized as intermittent pain at the muscle-tendon junction in the elbow with possible weakness in the grip. Case definition: symptoms of intermittent, activity-dependent pain around the lateral or medial epicondyle and signs of local pain on resisted wrist extension or wrist flexion at time of the exam or for at least 4 of the past 7 days before the exam.

Lower Back Injury: Primary movements of the lumbar spine are flexion, extension, side flexion, and rotation. Combined movements (e.g., flexion with rotation) carry the highest injury potential (Drezner & Herring 2001). Repetitive movements can fatigue and overwhelm the viscoelastic protective mechanisms of the intervertebral disks and ligaments or create muscle fatigue that results in reflex muscle spasm (Hainline 1995). Acute overload of a contracting muscle can lead to microscopic tearing of muscle fibers or ligaments, and injury commonly termed a back strain or sprain (Kaul & Herring 1998). Workers in the poultry industry who typically twist and bend repetitively to lift birds up onto lines would be at risk for these types of injuries. Other than painful decreased range of motion, most patients with low back injury have no specific clinical signs or

symptoms (DeFer 2004). Case definition: symptoms of constant or intermittent pain in the lumbosacral region that limits lower back movement and at least one of the following signs at time of the exam or for at least 4 of the past 7 days before the exam: tenderness to palpation of bony or soft tissue structures in the lumbosacral region, pain with low back flexion, extension, side flexion, or rotation

D.8.b.2. Clinical Dermatological Examinations Dermatological examinations of the face, neck, arms, hands and feet were performed by a physician with at least one year of specialized dermatological training. For each exam, the physician completed a recording sheet to document the presence of skin diseases.

The recording sheet listed skin diseases in the following categories: inflammatory diseases, pigmentary disorders, infections, malignant and premalignant tumors, and trauma. Specific occupational skin diseases that will be diagnosed include the inflammatory diseases (folliculitis, atopic dermatitis, and irritant and allergic contact dermatitis), infections (onychomycosis, tinea pedis, tinea corporis and warts), and trauma (skin and nail lesions). The list of diseases was based on our review of the most common conditions seen in primary care (Adawalla et al. in press), as well as data from our farmworker skin research (Arcury et al. 2007) and our preliminary research with poultry workers (Quandt et al. 2005). Participants with suspected malignant lesions were referred for biopsy. The skin exam used similar decision rules and recording sheet to those used for our Farmworker Skin Disease study. For analysis, skin disorders were grouped (e.g., cold injuries, irritant reactions, folliculitis) to test whether workers with particular exposures (e.g., cold, irritant, trauma) had greater likelihood of developing particular disorders.

D.8.c. Independent Variable: Physical Demands This project relies on workers' self reports of exposure to physical demands at work because we are unable to directly observe workers while performing their job related tasks (see section D.5.a.) and pen and paper based observational techniques only assess a limited number of exposures and have limited precision (see Li & Buckle 1999). Although self-report instruments have limited ability to quantify total exposure to physical demands definitively, they are useful for characterizing relative levels of exposure (e.g., low versus high) that may contribute to work-related injury (Stock et al. 2005). Although there is little doubt that self-report assessments of workplace exposures are less desirable than direct assessments, several researchers conclude that they are valuable (Hollmann et al. 1999; Pope et al. 1998).

Physical demands of work was assessed with a self-report instrument that provides measures of worker exposure to two distinct hazards: (1) physical workload, and (2) awkward posture and repetitive movements (Bot et al. 2004). In a previous publication (Grzywacz et al. 2007b), we had assessed the internal consistency of items contained in the 2 factors reported by Bot and colleagues, and dropped items with low item-to-total correlation. This resulted in 9 items measuring physical workload or the frequency the worker is required to move, lift, and carry heavy loads while working, and 6 items assessing the frequency workers are required to work in awkward postures and engage in repetitive movements. Items in each set were summed with higher values reflecting greater frequency of *physical workload* (α = .83) and *posture and repetitive movements* (α = .79). The inter-correlation of physical workload with posture and repetitive movements was modest ($r = 0.22$; Grzywacz et al. 2007b). Other results with Latino poultry processing workers suggest the self-report instrument is valid: physical workload was associated with recent injury whereas posture and repetitive movements was associated with musculoskeletal symptoms in the past 30 days (Grzywacz et al 2007b).

Multiple aspects of environmental exposure were assessed including temperature of work environment, presence of water and other chemicals, and slipperiness of surfaces. Questions included in the Nordic Occupational Skin Questionnaire exposures section were used, with modifications made for the poultry processing industry (e.g., specifying common exposures) according to procedures of Flyvholm et al. (2002).

D.8.d. Independent Variable: Organization of Work. The organization of work was assessed using self-report instruments, in large part because we were unable to conduct workplace observations. Organization of work variables fall into either management practices or job design and performance. Two distinct management practices were assessed with separate instruments. *Perceptions of managers' safety commitment* was assessed using 7 items from the Perceived Safety Climate Scale (e.g., "workers are regularly made aware of dangerous work practices and conditions") (Gillen et al. 2002). We also measured abusive supervision because previous research with Latino poultry processing workers indicated that workers frequently confront

punitive supervisor practices including assignment to more dangerous job tasks (Marín et al. 2006). *Abusive supervision* was measured with a 7-item index assessing the extent to which supervisors/managers use coercive tactics with their employees (e.g., "my supervisor could make my work difficult for me")(Tepper 2000). In our previous research with Latino poultry processing workers, perceived safety commitment and abusive supervision were modestly correlated (r = -0.14), and related to distinct health outcomes suggesting discriminant validity (Grzywacz et al. 2007b). Cronbach's alphas were .74 and .75.

Job design and performance variables were measured using a modified version of the Job Content Questionnaire (JCQ)(Karasek & Theorell 1990). The JCQ, perhaps the most widely used instrument in occupational stress research, assesses worker exposure to 3 distinct stressors while working. *Authority* was assessed with 3 items tapping opportunities to exert control over work (e.g., "How often are you allowed to make your own decisions about your work?"). *Variety* was assessed with 6 items tapping how jobs vary in content, location, and routine (e.g., "How often do you do a variety of different things on your job?"). *Psychological workload* is assessed with 9 items tapping the stressors inherent in participants' jobs (e.g., "How often is your job hectic?"). The intercorrelation of these concepts among Latino poultry processing workers ranges from -0.22 to 0.52, and they are independently associated with recent musculoskeletal symptoms suggesting discriminant validity (Grzywacz et al. 2007b). In over 10 years of field research, we have learned that immigrant Latinos have difficulty responding to affectively based response items (e.g., 'strongly agree' versus 'strongly disagree'); consequently, we modified the JCQ to use a 4-point frequency-based response set ('never' to 'always'). We have used this modified instrument in our previous research with immigrant Latino poultry workers; Cronbach's alpha for each set of items, ranged from .72 to .79, suggesting good reliability.

D.8.e. Independent Variables: Social & Cultural Circumstances. Participants' marital status was categorized into three categories: single/unmarried, married/living as married with partner in the U.S., and married/living as married with partner in country of origin. Parental status and number of dependent children (both in the U.S. and country of origin), and frequency of sending money to country of origin were asked to measure family obligations. Household size was enumerated by asking participants to identify the total number of persons residing in their household. Educational attainment was assessed based upon the grading system used in Latin American countries (i.e., Primaria, Secundaria, Preparatoria, Universidad). Access to health care was assessed by asking participants if they have a regular doctor, health insurance and the type of insurance carried (private versus Medicaid), distance to health care provider both in miles and travel time (# of minutes).

Multiple aspects of acculturation can be assessed as a key cultural circumstance affecting immigrant Latinos. A number of possible measures exist. Measure used was language preference assessed using seven items from the Acculturation Rating Scale for Mexican-Americans-II (ARSMA-II) (Cuéllar et al. 1995). Additionally length of residence in the U.S. and length of residence in NC were assessed.

D.8.f. Covariates: Personal Characteristics Covariates were age and gender. Weight and stature were be assessed at baseline and one-year follow up. Body mass index was calculated at baseline and one year follow up using Quetelet's index (wt/ht^2). Wrist breadth and depth were used to calculate wrist index (Boz et al. 2004). Smoking was measured with standard questions that permit classification as current, former, or never smoker, and calculation of pack years. Alcohol consumption was measured with questions on frequency and quantity in the past three months, to allow creation of measures of frequency, typical consumption, and frequent heavy drinking. CAGE questions were asked for a measure of alcohol abuse or dependency (Saitz et al. 1999).

D.9. Statistical Power and Analysis Plan

D.9.a. Power Analysis Our original plans called for recruiting a sample of 552 participants (276 poultry workers and 276 controls) at baseline and follow up 266 of them (133 poultry workers and 133 controls) to one year. Because of the number not attending the data collection clinics, we extended the interview sample to a total of 742, of which 518 attended a data collection clinic. The following estimates the power with the larger sample.

Table D2. ORs to be detected at 80% power, by reference proportion in control group

Sample size	**Reference Proportion of Condition**							
	0.10	0.12	0.14	0.16	0.18	0.20	0.22	0.24
Cross-sectional sample (552)	2.05	1.95	1.90	1.85	1.80	1.75	1.75	1.70
Longitudinal sample (200)	3.00	2.85	2.70	2.60	2.50	2.45	2.40	2.35

The primary objective in the cross-sectional component of this study was to compare the prevalence of selected MSDs and skin disorders among poultry and non-poultry workers. In the longitudinal component, one of the primary objectives was to compare the development of selected musculoskeletal and skin disorders among poultry and non-poultry workers who are disease free at baseline. Therefore, the power calculations were based on two-sided Chi-square tests (α=0.05) for both components, and accounts for clustering of workers within plants. Due to variability in the reported prevalence of MSDs (e.g., CTS) and skin (e.g., presence of inflammatory disease) disorders observed in the immigrant Latino population (see Preliminary Studies), we considered a range of values for the prevalence of disorder. In Table D2, reference proportion refers to the proportion of musculoskeletal or skin disorder in the control group. For the cross-sectional sample, assuming a modest intra-class correlation (ICC) of 0.02 due to clustering within plants, we expected to have at least 80% power to detect even small differences between poultry and non-poultry workers—i.e., odds ratios of 1.70-2.05. For Component 2, based on previous research with this immigrant population we expected to retain at least 75% of the recruited 266 participants (Quandt et al. 2002) resulting in a final sample of 200 participants at 12 mo. Evidence from previous research with workers in manufacturing indicates that 12% of workers acquire CTS within a one-year time frame (Punnett et al., 2004). With a projected final sample of 200 participants we expected to have >80% power to detect an odds ratio of 2.35-3.00, again assuming a modest ICC. We also examined power adjusting for gender. Assuming 5% and 15% prevalence rates for male and female controls (Stevens et al. 1988), respectively, we expected to have >80% power to detect an adjusted odds ratio of 2.1 for the cross-sectional study. For the longitudinal study, we had 70% and 80% power to detect adjusted ORs of 2.8 and 3.0, respectively.

D.9.b. Analysis Plan The objective of Specific Aim 1 was to compare the prevalence of selected MSD and skin disorders among poultry and non-poultry workers, and to assess the mediating and moderating effects of occupational, structural, and socio-cultural factors on these disorders. In general, for this cross-sectional portion of the study, logistic regression models were used for binary outcomes, and multiple linear regression models were used for continuous outcomes. Furthermore, to account for the inherent clustering of workers within discrete poultry processing plants, we used a generalized estimating equations (GEE) approach for the categorical outcomes to obtain population parameter estimates. For continuous outcomes, we allowed a random intercept in the mixed effect models to accommodate the non-independence of observations among workers in the same plant. We started with basic models (see below for details) to obtain crude regression coefficients, and then expanded the models to incorporate potential confounders (e.g., age, gender, education, length of time employed) to obtain adjusted regression coefficients. Usual model assumptions were assessed through regression diagnostics.

The objective of Specific Aim 2 was to document the incidence of selected MSD and skin disorders; and assess the mediating and moderating effects of occupational, structural, and socio-cultural factors on this development. In general, in this longitudinal portion of the study, generalized estimating equations (GEE) were used for repeated measures on binary outcomes, and linear mixed effects models (LMM) were used for repeated measures on continuous outcomes. Both approaches can account for the additional clustering of sample within plants.

For Specific Aim 3, we modeled approaches similar to those described for Specific Aim 1 to examine the impact of selected MSD and skin disorders on workers' QOL cross-sectionally. Since outcomes on QOL are continuous, we ued multiple linear regression models. To examine the impact of selected MSD and skin disorders on workers' QOL over time, we used the LMM approach described for Specific Aim 2.

D.10. Component 3: Qualitative Study

Component 3 addressed Specific Aim 4 of the application. The goal of this component was to produce an understanding of how poultry workers who develop occupational injuries or illnesses understand these, what self-care behaviors they use to treat them, and what barriers they experience for preventing, seeking treatment, and reporting the injuries or illnesses. These issues were best suited to exploration using qualitative analysis techniques.

The Qualitative Study was framed by Kleinman's Explanatory Models (EMs) of Illness, which propose that each culture has its own EMs of illness that guide people's behaviors in regard to prevention and treatment and that these models differ from established biomedical models (Kleinman 1994). EMs guide obtaining information on aspects of illness: (1) etiology, (2) time and mode of onset of symptoms, (3) pathophysiology, (4) course of sickness, and (5) treatment. People vary in the content of their EMs, but these EMs share common features to the extent that persons share common cultural and social orientation (Rubel & Haas, 1995). EMs are usually a combination of both conscious and tacit knowledge. EMs are well-suited for exploring the beliefs and perceptions about occupational injury and illness. The investigators have used the EMs of Illness framework to study of green tobacco sickness (Rao et al. 2002) and skin disease (Arcury et al. 2006b) among Latino farmworkers, as well as of diabetes beliefs among Latino immigrants (Arcury et al. 2004).

D.10.a. Sample The sample for the Qualitative Study was designed to include up participants from the Cross-Sectional Study. Subjects were eligible for a qualitative interview if they worked in poultry AND they had any of the inflammatory or infectious skin diseases at baseline. A board certified dermatologist examined each subject and made a judgment of (present/absent) for each of the inflammatory and infectious diseases listed above.

Subjects were eligible for a qualitative interview regarding carpal tunnel syndrome if they were classified as a having a probable or definite case of carpal tunnel syndrome in either wrist. A subject's wrist was classified as probable or definite case of carpal tunnel syndrome if it met the following criteria: 1) pain, tingling, numbness, or decreased sensations were reported in the thumb, index finger or long finger that extended beyond the dorsum of the thumb, index or long digit for two or more days in the month preceding the exam or, 2) a sensory peak latency difference of greater than or equal to 0.5 milliseconds was recorded. However, subjects classified with either probable or definite carpal tunnel syndrome were excluded from the qualitative interviews if they did not report the relevant pain, tingling, numbness, or decreased sensations because a primary purpose of the qualitative interviews is to explore the explanatory models that the subjects use to explain their syndrome. We would not expect explanatory models from subjects without symptoms.

D.10.b. Interview Procedures Interviews were conducted in Spanish by a native Spanish speaking interviewer who had experience and training in qualitative interview techniques and who was trusted by residents of the study area. Interviews were conducted from September, 2009 through July, 2010. Interviews took approximately 60 minutes to complete. Interview guides were constructed to reflect the Explanatory Models of Illness framework [Kleinman, 1980, 1988]. Interview guides asked workers to describe their jobs and how their work was organized, how their jobs affected their health, their self-care behaviors and barriers to prevention and treatment, and injuries and illness reporting they had. Probes were used to elicit descriptions of their working conditions, and their perceptions of the health consequences of their jobs. The EM portion of the interview included seven sets of questions designed to elicit the worker's name for the condition, the explanation of etiology, symptoms attributed to the condition, the expected natural course of the condition, pathophysiology, best treatment, and effects on quality of life. Participants were provided with an incentive of $20 at the end of the interview.

D.10.c. Data Management and Analysis The interviews were recorded, transcribed, and translated to English. An iterative data analysis process was used, with analysis starting as soon as data collection began. Interview transcripts were read by the study team, and topics were identified for further exploration by the interviewers. Once all data were collected, a list of codes was constructed for topics of interest, with mutually exclusive definitions established. The primary codes used in this analysis were those corresponding to the seven EMs components.

Transcripts and notes were entered into Atlas.ti (Version 6.2) text analysis software; codes were applied to segments of text by one of the study team members. The coding was reviewed by two other team members, and corrections and additions were made. A variable-based analysis was used, such that all segments associated with relevant codes were extracted, reviewed, and summarized. Revisions of these summaries were made until they adequately reflected the interview content. Threats to validity (e.g., focus on extreme cases) were considered in constructing and revising the summaries [Miles & Huberman, 1994].

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RESULTS

Aim 1

To compare the prevalence of selected musculoskeletal (MSDs) and skin disorders among Latino poultry processing workers and controls (non-poultry, Latino manual laborers), and assess the mediating and moderating effects of occupational (task, shift), structural (income, education, access to healthcare), and socio-cultural (ethnicity, beliefs, values, acculturation) factors on these disorders.

1-1. The Prevalence of Carpal Tunnel Syndrome in Latino Poultry-Processing Workers and Other Latino Manual Workers

ABSTRACT

Objective: To determine the prevalence of carpal tunnel syndrome (CTS) in Latino poultry processing workers.

Methods: Symptoms and nerve conduction studies were used to prospectively assess 287 Latino poultry processing workers and 226 Latinos in other manual labor occupations.

Results: The prevalence of CTS was higher in poultry processing (8.7%) compared to non-poultry manual workers (4.0%, $p < 0.0001$). The adjusted odds ratio for the prevalence of CTS in poultry workers was 2.51 (95% CI of 1.80 to 3.50) compared to non-poultry workers. Within the poultry workers, those who performed packing, sanitation, and chilling had a trend toward less CTS than those who performed tasks requiring more repetitive and strenuous hand movements.

Discussion: Latino poultry processing workers have a high prevalence of CTS, which likely results from the repetitive and strenuous nature of the work.

CLINICAL SIGNIFICANCE

This study uses clinically relevant techniques to demonstrate the high prevalence of carpal tunnel syndrome in Latino poultry processing workers. Knowledge of this high prevalence should prompt clinicians to increase surveillance for CTS in this population and may result in positive changes to poultry processing environments.

INTRODUCTION

Carpal tunnel syndrome (CTS) is a common condition with an estimated prevalence in the general population of 2.7% and healthcare costs in the United States exceeding $500 million per year.(1, 2) Typical symptoms include numbness, tingling, and pain in the palmar and lateral aspects of the hand; and weakness of hand muscles may occur as the condition progresses. It is thought to result from chronic compression of the median nerve as it passes through the rigid carpal tunnel in the wrist.(3) Therefore, those who perform manual labor involving repetitive wrist movement are at increased risk for the development of CTS. CTS is a leading cause of workers' compensation claims and results in significant lost time and productivity in manual workers.(4)

Poultry processing involves strenuous and repetitive work, with workers at risk for overuse injuries.(5, 6) Live birds are received and then passed through a production line that requires workers to hang, kill, pluck, clean, eviscerate, cut, package, and box poultry parts at a rapid pace, and workers also clean and repair equipment, assemble boxes, and move pallets of packaged poultry.(7, 8) Potential risk for overuse injuries such as CTS exists with each of these occupational duties.

Across the United States, the poultry processing workforce has become largely composed of immigrants, with Latinos making up a large proportion.(5, 9) This group bears a disproportionate burden of workplace injury because of language and cultural barriers that prevent workers from receiving health and safety measures, as well as reluctance of workers to complain about work conditions.(10-12) Therefore, this study was conducted to examine the prevalence of CTS in Latino poultry processing workers and to compare this prevalence to Latinos in other manual labor positions. In addition, it was designed to assess characteristics that may increase the risk of CTS in poultry processing workers.

METHODS

Participants

Latinos in poultry and non-poultry manual labor occupations were recruited in four western North Carolina counties from June 2009 to November 2010 to participate in a study assessing musculoskeletal, dermatologic, and respiratory conditions in these populations. Since there was not access to workplaces, community-based sampling of dwelling units was performed with a focus on regions with a high proportion of Latino residents. Only those who self-identified as Latino or Hispanic, were age 18 or older, and who worked 35 hours or more per-week in a manual labor job were recruited. Work in poultry was defined as any type of non-supervisory work in a poultry processing plant with job categories from receiving through sanitation, and employees of poultry production farms were excluded. Manual labor jobs were defined as employment in non-managerial jobs in industries such as landscaping, construction, restaurant work, hotel work, child care, and manufacturing. Non-poultry workers with previous work in poultry only qualified if lifetime employment in poultry processing was 6 months or less, and not within the past two years. More than one resident per dwelling could be recruited, if eligible. Those who chose to enroll in the study underwent an hour-long interview and then attended a data collection clinic. The data collection clinics occurred on seven Sundays evenly dispersed throughout the study period. All participants signed informed consent and the study was approved by the Institutional Review Board of Wake Forest School of Medicine.

Over the course of the study 1,526 individuals were screened and 957 were eligible for enrollment. Of those, 742 underwent interviews and 518 attended the data collection clinics. Five individuals left the data collection clinics prior to undergoing nerve conduction studies, which resulted in 513 that had nerve conduction studies and filled out hand diagrams (1026 wrists). Of those, 287 (574 wrists) were poultry workers and 226 (452 wrists) were in non-poultry manual labor.

Clinical Evaluations

Each participant's height and weight were recorded. They were asked if they had numbness, pain, or weakness in their hands for two or more days in the previous month. If they answered affirmatively, they completed the Katz hand diagram to indicate distribution of symptoms. The hand diagrams were scored "unlikely" (0), "possible" (1), "probable" (2), or "classic" (3) for CTS based upon previously published methods for scoring of the diagram, and each diagram was scored by two clinicians (MSC and FOW) blinded to the participant's occupation and nerve conduction results.(13)

Nerve Conduction Studies

All study participants underwent bilateral nerve conduction studies using a Teca TD10 Electromyograph (Teca Corporation, Pleasantville, NY). The studies were performed by experienced technicians blinded to the participant's occupation and clinical evaluations. Hands were warmed to 32 degrees Celsius, and median and ulnar antidromic sensory studies were performed, stimulating the wrist and recording with ring electrodes 140 mm distally on the 2nd and 5th fingers. The onset and peak latencies were recorded, and those without median sensory potentials underwent orthodromic median motor studies recording from the abductor pollicis brevis muscle.

Measures

A combination of symptoms, as reported through the Katz hand diagram, and nerve conduction abnormalities, was used to define CTS. If the hand diagram was scored a 1, 2, or 3, then the participant was assigned a score of "1" for symptoms; if not, the participant was assigned a "0." Peak median and ulnar sensory latencies were compared. If the median was less than 0.49 ms longer than the ulnar, it was scored a "0"; if it was 0.50 to 0.79 ms longer, it was scored a "1"; and if it was greater than 0.80 ms longer, it was scored a "2." The symptom score and nerve conduction score were then added, and a total score of 0 was defined as "no CTS," 1-2 as "possible CTS," and 3 as "CTS." Similar CTS case definitions, with 0.50 ms and 0.80 ms cut-offs for peak latency difference, have been used in previous studies.(14) This scoring system was applied to each

wrist that was studied. In addition, individuals were defined as having "no CTS" if both wrists were scored as "0," "possible CTS" if one or both wrists was scored a "1 or 2", and "CTS" if either wrist was scored a "3."

Poultry processing workers underwent standardized interviews regarding their work schedule and environment. Workers were asked to identify which of the following tasks they performed: cutting, eviscerating, washing, trimming, deboning, receiving, hanging, killing, plucking, packing, sanitation, chilling, and other. Those who performed a single task greater than 50% of the time were categorized into that task for statistical analyses, and those who performed multiple duties and no single task occupied more than 50% of their time were categorized into "multiple tasks." Many of the tasks were similar in nature, so to assist in analysis four groups were created to determine if similar tasks increased the risk of CTS. The groups include: packing, sanitation, chilling, and other (category 1); cutting, eviscerating, wash-up, trimming, and deboning (category 2); receiving, hanging, killing, and plucking (category 3); and multiple jobs (category 4).

Statistical Analyses

Descriptive statistics were calculated as means and standard deviations for continuous variables, and percentages and frequencies for discrete variables. Demographics between the poultry and non-poultry groups were compared using Student's t-tests for continuous variables and chi-square tests of association for categorical variables. The prevalence of CTS was compared between the two groups using a chi-square test of association, and this was done at the level of individual wrists and participants. Adjusted odds ratios and 95% confidence intervals predicting the prevalence of CTS were calculated using ordinal logistic regression and adjusting for age, BMI, sex, occupation, and clustering amongst individuals. In poultry workers, variables were analyzed to determine if they predicted the prevalence of CTS by calculating p-values using ordinal logistic regression for continuous variables and chi-square tests of association for categorical variables, and this was done at the wrist level. Similar occupational duties were grouped together for analysis, as described above under "Measures." The score test for the proportional odds assumption was used to validate all models. All p-values were considered significant at the 0.05 level and statistical calculations were performed using SAS Version 9.2 (SAS, Cary, NC).

RESULTS

The demographic characteristics for the poultry processing workers and non-poultry workers are described in Table 1. Poultry workers were older than non-poultry workers (36.3 vs. 32.7 years, $p = < 0.0001$). The poultry group also weighed less and had a trend toward being shorter, which resulted in similar BMIs between the groups (28.6 in poultry and 29.2 in non-poultry, $p = 0.1739$). The groups were similar in the percentage of women and the distribution of spoken languages, and the poultry workers had less formal education ($p = 0.0354$).

The prevalence of CTS was higher in the poultry workers than the non-poultry workers ($p < 0.0001$), and this held true when the prevalence was evaluated by considering either the wrist or the worker as an individual unit for statistical analysis (Table 2). When wrists were assessed, 6.5% of the poultry worker wrists had definite CTS compared to 2.4% for non-poultry, and 48.0% of the poultry worker wrists had possible or definite CTS compared to 26.3% of non-poultry. When individuals were assessed, 8.7% of the poultry workers had definite CTS compared to 4.0% for non-poultry, and 59.2% of the poultry workers had possible or definite CTS compared to 35.0% of non-poultry. The adjusted odds ratio (controlling for age, BMI, and gender) for the prevalence of CTS was 2.51 (95% CI of 1.80 to 3.50) in poultry workers compared to non-poultry workers (Table 3). Table 3 also shows the increased risk of CTS with increasing age (odds ratio of 1.04, 95% CI 1.02 to 1.06) and BMI (odds ratio of 1.08, 95% CI 1.05 to 1.12), and that gender was not associated with an increased risk of CTS.

In the 287 poultry workers (574 wrists), greater age was seen in those with CTS compared to those with possible or no CTS (Table 4). Table 4 also shows that job category predicted the prevalence of CTS, with those in category 1 (packing, sanitation, chilling, and other) having less CTS than those in category 4 (multiple jobs) and a trend towards less than those in category 2 (cutting, eviscerating, wash-up, trimming, and deboning). Comparisons of CTS prevalence in job categories two, three, and four to each other did not approach statistical significance.

DISCUSSION

In this study, multiple analyses were performed, both at the level of the wrist and the individual, and the prevalence of CTS was consistently higher in Latino poultry processing workers compared to other Latino manual workers. The prevalence of CTS in the non-poultry manual workers (2.4% of wrists and 4.0% of individuals) was similar to the prevalence in the general population found in previous studies,(1) whereas the odds of CTS was more than 2.5 times greater in the poultry processing workers. It is unlikely that factors other than occupational tasks accounted for the difference in CTS prevalence, as the two groups were similar in BMI and gender distribution, and the poultry workers were actually younger in age (older age is associated with an increased risk of CTS). Therefore, the repetitive and strenuous nature of poultry processing work likely resulted in the increased CTS prevalence. This is supported by the finding that poultry workers that performed tasks requiring the most repetitive hand manipulation (cutting, eviscerating, washing, trimming, deboning and multiple tasks) had more, or a trend toward more, CTS than those performing other tasks along the production line (packing, sanitation, chilling, and other).

The actual prevalence of CTS in the poultry workers depends on the parameters used to define CTS. The most sensitive combination of symptoms and nerve conduction studies results in 48% of the wrists and 59.2% of the individuals categorized as possible or definite CTS, whereas the most specific combination of parameters results in 6.5% of the wrists and 8.7% of the individuals categorized as definite CTS. The true prevalence certainly lies somewhere between these values, but no matter which definition is used, it is clear the prevalence of CTS is high in this population.

Some limitations exist in this study. First, defining CTS in a large population such as this can be challenging, as it is not feasible to obtain a detailed history, physical examination, and electrodiagnostic study on each participant. We opted to use a combination of self-reported symptoms and sensory nerve conduction studies to assess for CTS. While this is less thorough than the evaluation performed by a meticulous clinician on an individual patient, it is at least as complete as other studies in which large populations were screened for CTS.(15-17) The second limitation occurred when trying to categorize poultry workers by tasks, as many workers performed multiple tasks along the production line on a weekly basis. It was decided that a worker would only be categorized to a task if they performed it greater than 50% of the time, and otherwise they were placed into the “multiple tasks” category. This strategy allowed most workers to be categorized, but many participants performed tasks on a weekly basis other than the one to which they were grouped. For this reason, it is challenging to identify very specific tasks associated with a higher prevalence of CTS. While these limitations are present, they are relatively minor and the strengths of the study, including a large sample size, relevant comparison group, and systematic approach to CTS diagnosis outweigh the limitations.

The high prevalence of CTS in this population indicates that measures should to be taken to reduce the amount of repetitive strain on the hands and wrists of poultry processing workers and to increase early identification of CTS. Since some poultry processing tasks (such as packing, sanitation, and chilling) were associated with less CTS, one consideration would be for all workers to rotate through these tasks on regular intervals. Other interventions, such as an emphasis on ergonomics, should also be considered, although the data supporting this type of intervention are limited.(18) Finally, increased surveillance for the development of CTS in this population could result in earlier identification and treatment.(19)

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Table 1. Demographic Characteristics in the Poultry and Non-poultry Laborers

Characteristic	All Laborers Mean [SD] or N (column %)	Poultry Mean [SD] or N (column %)	Non-poultry Mean [SD] or N (column %)	p-value
Age	34.7 [10.4]	36.3 [11.2]	32.7 [9.1]	< 0.0001
Height (cm)	157.7 [8.4]	157.2 [8.3]	158.4 [8.6]	0.0934
Weight (kg)	71.9 [13.6]	70.8 [12.9]	73.3 [14.3]	0.0344
BMI	28.9 [4.9]	28.6 [4.5]	29.2 [5.3]	0.1739
Gender				0.6591
Male	278 (54.2)	158 (55.0)	120 (53.1)	
Female	235 (45.8)	129 (45.0)	106 (46.9)	
Spoken Language				0.2858
Indigenous	106 (20.8)	64 (22.5)	42 (18.7)	
Non-indigenous	403 (79.2)	220 (77.5)	183 (81.3)	
Education				0.0354
0 – 6 yrs	298 (58.1)	181 (63.1)	117 (51.8)	
7 – 9 yrs	120 (23.4)	60 (20.9)	60 (26.5)	
10+ yrs	95 (18.5)	46 (16.0)	49 (21.7)	

Table 2. The Prevalence of Carpal Tunnel Syndrome in Poultry and Non-poultry Laborers

	Overall N (column %)	Poultry N (column %)	Non-poultry N (column %)	p-value
By Wrists (N = 1026)				< 0.0001
No CTS	632 (61.6)	299 (52.1)	333 (73.7)	
Possible CTS	346 (33.7)	238 (41.5)	108 (23.9)	
Definite CTS	48 (4.7)	37 (6.5)	11 (2.4)	
By Individuals (N=513)				< 0.0001
No CTS	264 (51.5)	117 (40.8)	147 (65.0)	
Possible CTS	215 (41.9)	145 (50.5)	70 (31.0)	
Definite CTS	34 (6.6)	25 (8.7)	9 (4.0)	

Table 3. Adjusted Odds Ratios for the Prevalence of Carpal Tunnel Syndrome (N = 1026 wrists)

Characteristic	AOR*	95% CI	p-value
Type of Work			< 0.0001
Poultry	2.51	(1.80, 3.50)	
Non-poultry	---	---	
Age	1.04	(1.02, 1.06)	< 0.0001
BMI	1.08	(1.05, 1.12)	0.0001
Gender			0.8733
Female	1.03	(0.74, 1.43)	
Male	---	---	

* Adjusted odds ratio

Table 4. Characteristics Potentially Associated with Carpal Tunnel Syndrome in Poultry Workers (N = 574 wrists)

Characteristic	No CTS Mean [SD] or N (row %)	Possible CTS Mean [SD] or N (row %)	CTS Mean [SD] or N (row %)	Multivariate Analysis AOR*	p-value
Age	34.4 [11.0]	38.2 [10.7]	40.1 [12.1]	1.04	0.0008
BMI	28.1 [4.4]	29.0 [4.4]	30.3 [5.5]	1.04	0.0842
Gender					
Female	131 (50.8)	108 (41.9)	19 (7.4)	1.09	0.7045
Male **	168 (53.2)	130 (41.1)	18 (5.7)	---	---
Poultry Job Task†					0.0283 df = 3
Category 1 **	123 (58.6)	75 (35.7)	12 (5.7)	---	---
Category 2	129 (50.4)	115 (44.9)	12 (4.7)	1.57	0.0661
Category 3	21 (47.7)	16 (36.4)	7 (15.9)	2.09	0.1156
Category 4	26 (40.6)	50 (50.0)	6 (9.4)	2.66	0.0035

* Adjusted odds ratio

** Reference category

† Category 1: Packing, Sanitation, Chilling, Other
Category 2: Cutting, Eviscerating, Wash-up, Trimming, Deboning
Category 3: Receiving, Hanging, Killing, Plucking
Category 4: Multiple job tasks

1-2. Utrasound for Carpal Tunnel Syndrome Screening in Manual Laborers

ABSTRACT

Introduction—Manual laborers are at increased risk for carpal tunnel syndrome (CTS), and a combination of history, physical examination, and nerve conduction studies is often used to screen for CTS in this population. Neuromuscular ultrasound may be a better screening tool, because it is painless. In this study we compare the accuracy of nerve conduction studies and ultrasound for CTS screening.

Methods—Five hundred thirteen manual laborers were screened prospectively for CTS using nerve conduction studies and neuromuscular ultrasound, and the accuracy of the 2 techniques was compared using the Katz hand diagram as the diagnostic standard.

Results—The ROC curves for the 2 techniques were not significantly different (P = 0.542), indicating that the approaches had similar diagnostic accuracy.

Conclusions—Neuromuscular ultrasound is a painless technique that has diagnostic accuracy similar to nerve conduction studies and can be used to screen large populations at risk for CTS.

INTRODUCTION

Carpal tunnel syndrome (CTS) is a condition that affects about 3% of the general population and results in over $500 million in medical costs in the USA annually.1,2 CTS is caused by chronic compression of the median nerve at the wrist as it passes through the rigid carpal tunnel, and it therefore occurs more commonly among workers in occupations involving manual labor and repetitive use of the hands.3–5 The diagnosis of CTS is typically established through history and clinical examination. Affected individuals have pain, numbness, and paresthesias in the median nerve territory and sometimes weakness in the affected hand.6 Traditionally, nerve conduction studies that demonstrate median mononeuropathy at the wrist are used to confirm the diagnosis of CTS.7 Although many cases of CTS are straightforward, the diagnosis can be less clear if it is complicated by atypical symptoms or if some, but not all, of the nerve conduction study techniques, each with varying levels of sensitivity and specificity, suggest an abnormality.

Just as the diagnosis of CTS in an individual can be complicated, screening and defining CTS in at-risk populations can also be challenging. Studies using surveys or brief interviews alone often result in very high rates of CTS, some with prevalence exceeding 70% in certain populations,8 whereas screening protocols in which nerve conduction studies are used to define CTS are more specific and result in lower prevalence values.9 Although nerve conduction studies are useful in diagnosing and screening for CTS, they have limitations; they require warming of cool extremities, they are technically challenging with regard to performance and interpretation, they may be painful, and they require anatomic inferences to be made based on electrical data. For these reasons, new techniques are being examined to assist in the diagnosis of CTS, and over the past several years neuromuscular ultrasound has emerged as an accurate diagnostic tool which correlates with nerve conduction studies.10–12 Despite its diagnostic value, the application of neuromuscular ultrasound for CTS screening is underutilized. We therefore designed this prospective study to compare the accuracy of nerve conduction studies and neuromuscular ultrasound for screening a large population of manual laborers at risk for CTS.

METHODS

Participants

As part of a large study on occupational health disparities, Latinos in poultry and nonpoultry manual labor occupations were recruited in 4 western North Carolina counties from June 2009 to November 2010 to participate in a study of musculoskeletal, dermatologic, and respiratory conditions. The data collection that took place in this study has been described elsewhere,5 but aspects pertinent to this study are highlighted in the following sections. Community-based sampling of dwelling units was performed with a focus on regions with a high proportion of Latino residents in order to recruit a population-based sample across multiple industries and

job sites. Only those who self-identified as Latino or Hispanic, were ≥18 years of age, and who worked ≥35 hours per week in a manual labor job were recruited. Study participants underwent a 1-hour-long interview, which focused on several aspects of their health and occupation, and they then attended a clinical examination clinic. These clinics occurred on 7 Sundays evenly dispersed throughout the study period. All participants provided signed informed consent, and the study was approved by the institutional review board of the Wake Forest University School of Medicine.

Over the course of the study 1526 individuals were screened, and 957 were eligible for enrollment. Of these, 742 underwent interviews, and 518 attended the clinics. Five individuals left the clinics prior to undergoing nerve conduction studies or ultrasound, which resulted in 513 who had nerve conduction studies, neuromuscular ultrasound, and completed hand diagrams (1026 wrists).

Clnical Evaluations

At the clinic, participants were asked if they had numbness, pain, tingling, or weakness in their hands for ≥2 days in the previous month. If they answered affirmatively, they completed the Katz hand diagram to indicate distribution of symptoms. The hand diagrams were scored “unlikely” (0), “possible” (1), “probable” (2), or “classic” (3) for CTS based on previously published methods for scoring of the diagram, and each diagram was scored by 2 clinicians (M.S.C. and F.O.W.), who were blinded to all participant information.13 The Katz diagram was used as the reference standard for the diagnosis of CTS.

All participants underwent bilateral nerve conduction studies using an electromyography (TD10; Teca Corp., Pleasantville, New York). The studies were performed by experienced technicians blinded to the participant’s occupation, clinical evaluation, and ultrasound data. Hands were warmed to 32°C, and median and ulnar antidromic sensory studies were performed, stimulating the wrist and recording with ring electrodes 140 mm distally on the second and fifth fingers. The onset and peak latencies were recorded, and those without median sensory potentials underwent orthodromic median motor studies recording from the abductor pollicis brevis muscle.

Finally, all participants underwent bilateral neuromuscular ultrasound evaluations of the median nerve at the wrist using a Biosound MyLab25ultrasound device (Esaote Group, Genoa, Italy) with an 18-MHZ linear-array transducer. Three neurologists experienced with neuromuscular ultrasound performed all studies, and they were blinded to occupation, clinical information, and nerve conduction results. The participants were seated with their arms supine and forward on a table. The median nerve at the wrist was imaged in crosssectional view and scanned from 3 cm distal to 3 cm proximal to the distal wrist crease to identify the site of maximal nerve enlargement. The cross-sectional area of the median nerve at the site of maximal enlargement was obtained by using the freehand trace function and outlining the nerve, erring just to the inside of the epineurium (Fig. 1).

The ultrasonographer also made assessments of the echogenicity, mobility, and vascularity of the median nerve at the site of maximal enlargement, using the same techniques as reported previously.14 Echogenicity was rated as either “normal” (0), “slightly decreased” (1), or “decreased” (2), based on visual inspection of the image, with normal nerve echogenicity showing a honeycomb pattern with a mixture of dark fascicles interspersed among a brighter background. To assess median nerve mobility, the participant was asked to repeatedly flex and extend the fingers and wrist, while the transducer was maintained over the distal wrist crease. Mobility was rated as “normal” (0), “slightly decreased” (1), or “decreased” (2). Normal mobility is when the median nerve dives deep to the flexor tendons during finger and wrist flexion. Vascularity was assessed by placing the power Doppler box over the median nerve, and slowly increasing the gain. If color flow was seen in the nerve prior to other structures (in particular, the flexor tendons), then vascularity was rated as either “increased” (2) or “slightly increased” (1), based on the degree of color flow, and “normal” (0) when there was no early color Doppler signal in the nerve.

Statistical Analyses

Descriptive statistics were calculated as means and standard deviations for continuous variables, and percentages and frequencies for discrete variables. The standard for the diagnosis of CTS was the Katz hand

diagram, and all analyses of nerve conduction study and ultrasound accuracy were performed using different Katz diagram scoring cut-offs, with the most sensitive definition being all participants who scored 1, 2, or 3 and the most strict being only those who scored a 3 on the diagram.

The sensitivity and specificity of nerve conduction studies and neuromuscular ultrasound were first calculated using pre-specified cut-off levels. For the nerve conduction studies, peak median and ulnar sensory latencies were compared, and 2 different cut-offs were used to define a study consistent with CTS: a median latency either 0.5 ms or 0.8 ms longer than the ulnar latency, as described in previous studies.15 For neuromuscular ultrasound the prespecified cut-off for a positive result was a median nerve cross-sectional area ≥12 mm2, based on previous studies.16,17 Next, receiver operating characteristic (ROC) curves were generated for nerve conduction studies and neuromuscular ultrasound to determine the optimal cut-off for CTS diagnosis for both modalities, based on the collected data. This was done using the Youden index to maximize sensitivity and specificity.18 These curves were also compared with each other to determine whether 1 modality was more accurate than the other by comparing the area under the curves using a chi-square test.

Finally, several parameters were explored to maximize the sensitivity and, alternately, the specificity of neuromuscular ultrasound for the diagnosis of CTS. This included adjusting the median nerve cross-sectional area cut-off and including the measures of echogenicity, mobility, and vascularity in combination with median nerve area. All P-values were considered significant at the 0.05 level, and statistical calculations were performed using SAS, version 9.2 (SAS, Cary, North Carolina).

RESULTS

The personal characteristics for all 513 participants in the study are described in Table 1, which also includes the personal characteristics for those with CTS (34 participants with CTS in at least 1 hand) and without CTS (479 participants), when the diagnosis is based on the Katz hand diagram. Those with CTS were older (41.7 vs. 34.2, P < 0.001), weighed more (77.6 kg vs. 71.5 kg, P = 0.011), and had greater body mass index (31.5 vs. 28.7, P = 0.001) than those without CTS. There was also a trend toward a greater percentage of those in the CTS group being women than in the group without CTS (61.8% vs. 44.7%, P = 0.053).

Altering the reference standard definition of CTS based on the Katz hand diagram to include or exclude scores of 1 or 2 only changed the diagnostic accuracy of the different nerve conduction and neuromuscular ultrasound parameters by 1–2 percentage points. Therefore, the sensitivity and specificity numbers presented in Table 2 (and all other calculations) are based on a score of 0 (unlikely) or 1 (possible) on the Katz hand diagram indicating no CTS, and a score of 2 (probable) or 3 (classic) indicating the presence of CTS. No disagreements occurred between the 2 clinicians who graded the hand diagrams.

The ROC curves (Fig. 2) demonstrate that nerve conduction studies and neuromuscular ultrasound had similar diagnostic accuracy, with an area under the curve for nerve conduction studies of 0.6317 and for neuromuscular ultrasound of 0.6394, which are not significantly different (P = 0.542). A calculation of the Youden index (the point of the ROC curve farthest from the diagonal) showed the optimal median-to-ulnar latency difference to be 0.6 ms and the optimal median nerve cross-sectional area cut-off to be 13 mm2 (Table 2). The median nerve cross-sectional area that maximized sensitivity (>95%) was 8 mm,2 and an area that maximized specificity (>95%) was 18 mm2 (Table 2). A combination of median nerve cross-sectional area >12 mm2, or abnormal mobility, echogenicity, or vascularity, resulted in a sensitivity of 89%. Borderline median nerve cross-sectional area (8–12 mm2) occurred in 69.3% of wrists, but only 2.4% of those in this category had abnormal hand diagrams, and only 10.8% had abnormal nerve conduction studies.

DISCUSSION

In this study the accuracy of neuromuscular ultrasound as a screening tool for the diagnosis of CTS in a large population was assessed prospectively, and it was compared with nerve conduction studies, a more traditional diagnostic test for CTS. Neuromuscular ultrasound measurement of a single parameter (median nerve cross-sectional area at the wrist) demonstrated similar sensitivity and specificity to nerve conduction studies in which the median sensory nerve conduction velocity was compared with that of the ulnar nerve. This indicates that neuromuscular ultrasound, which is a painless, quick, inexpensive, and radiation-free imaging modality, can be

considered for screening large populations at risk for CTS in a manner similar to what has been done previously with nerve conduction studies.9,19

Interestingly, neither ultrasound nor nerve conduction studies were particularly accurate in this study, which may have been due to several factors. First, and most importantly, the reference standard in this study was the Katz hand diagram. Although the hand diagram has a high negative predictive value, it is only moderately accurate itself for the diagnosis of CTS when used in large epidemiological studies, with a sensitivity of 64% and specificity of 73%.20 The moderate accuracy of this reference standard likely resulted in lowered accuracy of the nerve conduction studies and neuromuscular ultrasound, which was a limitation acknowledged during conceptualization of this study. Although it would be ideal for each participant to have a detailed history and examination for CTS, and to use this conclusion as the reference standard, it was not feasible from a time and financial perspective. Participants already underwent a 1-hour-long interview, conducted by a non-clinician researcher, that focused on many aspects of their health and occupation, so further detailed assessment for CTS was not feasible. Using a different reference standard for diagnosis, such as one involving nerve conduction studies, would not have allowed for direct comparison of the accuracy of nerve conduction studies and ultrasound.

Other potential causes of decreased diagnostic accuracy of both modalities included limitations of the testing environment, such as electrical noise and a bright room. The ideal of using the most advanced electrodiagnostic and ultrasonographic equipment in electrically shielded dark rooms, with time to employ the most sophisticated comparative techniques (such as mixed-palmar or multidigit studies for electrodiagnosis and wrist-to-forearm ratio for ultrasound21) were likewise not feasible. Fortunately, the limitations were systematic and unlikely to have affected 1 modality more than the other. In addition, both nerve conduction studies and neuromuscular ultrasound have demonstrated much higher accuracy when used in populations in which the diagnosis of CTS was established through traditional history and physical examination.22 This suggests that both modalities likely would have higher accuracy as screening tests in this population if the reference standard was more accurate.

The sensitivity of neuromuscular ultrasound for the diagnosis of CTS greatly improved when other parameters were included in addition to nerve cross-sectional area. In those with at least 1 abnormality in median nerve cross-sectional area, echogenicity, mobility, or vascularity, the sensitivity of ultrasound increased to 89%. Another way to maximize sensitivity was to decrease the cut-off of the cross-sectional area to <8 mm2, which raised the sensitivity to 96%. Conversely, a cross-sectional area cut-off of >18 mm2 increased the specificity to 97%. Therefore, future screening studies could accurately include or exclude those with CTS based on the goals of the study using solely a single, quickly obtained parameter (median nerve cross-sectional area). In fact, a recently published study addressed just this issue and found that a median nerve cross-sectional area at the wrist >9 mm2 resulted in a sensitivity of 99% for the diagnosis of CTS, so the investigators suggested a potential change in the typical testing paradigm for CTS may be warranted, with ultrasound used as the initial screening modality.23 The strengths of this study include the prospective data collection, large number of participants, blinding of all examiners, inclusion of a broad spectrum of participants at risk for CTS, use of an appropriate and pre-specified gold standard, and generation of measures of diagnostic accuracy (sensitivity and specificity). As stated previously, the main limitation is that the Katz hand diagram is only moderately accurate for the diagnosis of CTS, but it is an appropriate reference standard. Other modest limitations are that the study involved a homogeneous population (Latino manual laborers); older nerve conduction study equipment was used; and ultrasonographic measures of mobility, echogenicity, and vascularity lack the quantitative rigor of the cross-sectional area measurement. Despite these limitations, the strengths of the study design would qualify this as a Class I study based on the American Academy of Neurology criteria for rating an article for diagnostic accuracy.24

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Table 1. Characteristics of study participants

Demographics	All participants (*N* = 513)	With CTS[a] (*n* = 34)	Without CTS (*n* = 479)	*P*-value[b]
Age	34.7 (10.4)	41.7 (11.0)	34.2 (10.2)	<0.001
Height (cm)	157.7 (8.4)	157.3 (9.0)	157.8 (8.4)	0.733
Weight (kg)	71.9 (13.6)	77.6 (14.1)	71.5 (13.5)	0.011
Body mass index	28.9 (4.9)	31.5 (5.4)	28.7 (4.8)	0.001
Gender				0.053
Men	278 (54.2)	13 (38.2)	265 (55.3)	
Women	235 (45.8)	21 (61.8)	214 (44.7)	

Data expressed as mean (SD) or number (%).

[a] CTS defined by scoring a “2” or “3” on the hand diagram in either or both hands.

[b] *P*-value from Student *t*-test or chi-square test of association.

Table 2. Sensitivity and specificity of diagnostic tests for CTS

Diagnostic parameter	Sensitivity (%)	Specificity (%)
NCS (difference >0.5 ms)	50	69
NCS (difference >0.8 ms)	39	83
NCS (difference >0.6 ms)	48	75
Ultrasound (>12 mm^2)	56	63
Ultrasound (>13 mm^2)	48	77
Ultrasound (combined parameters)[a]	89	27
Ultrasound (>8 mm^2)	96	6
Ultrasound (>18 mm^2)	17	97

NCS, nerve conduction studies.
[a]"Combined parameters" ultrasound data resulted in a diagnosis of CTS when: median nerve cross-sectional area >12 mm2; or mobility = 1 or 2; or echo = 1 or 2; or vascularity = 1 or 2.

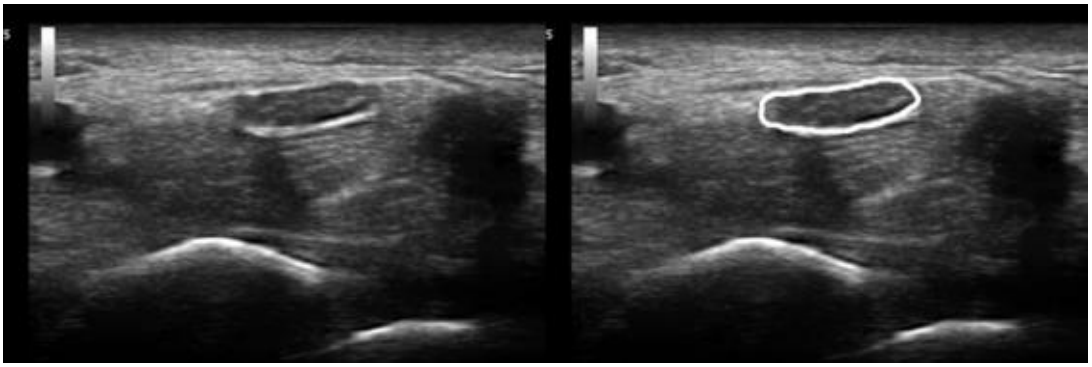

Figure 1. The left and right images are the same, except that in the right image the measuring technique for outlining the median nerve at the wrist and measuring cross-sectional area is depicted by the white tracing. This median nerve had a cross-sectional area of 11 mm2.

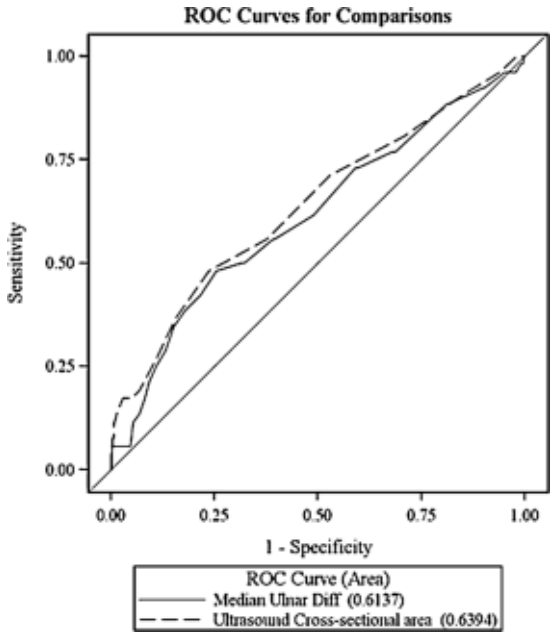

Figure 2. ROC curves to assess the diagnostic accuracy of nerve conduction studies (solid line: difference between the median and ulnar sensory velocities) and neuromuscular ultrasound (dashed line: cross-sectional area of median nerve at the wrist) are presented. No significant difference (P = 0.542) in diagnostic accuracy was detected between the 2 modalities.

1-3. Muscle Intrusion as a Potential Cause of Carpal Tunnel Syndrome.

ABSTRACT

Introduction: To determine if there is an association between flexor digitorum and lumbrical muscle intrusion into the carpal tunnel and carpal tunnel syndrome (CTS).

Methods: 513 manual laborers (1,026 wrists) were evaluated with ultrasound to determine if those with CTS had more muscle intrusion into the carpal tunnel than those without CTS. 190 of the participants without CTS at baseline (363 wrists) were followed over one year to determine if muscle intrusion at baseline predicted the development of CTS.

Results: Participants with CTS had more muscle within the carpal tunnel with the wrist in the neutral ($p = 0.026$) and flexed positions ($p = 0.018$) than those without CTS. Baseline muscle intrusion did not predict the development of CTS at one year.

Conclusions: Muscle intrusion into the carpal tunnel is associated with CTS, but muscle intrusion alone does not predict the development of CTS over the course of one year.

INTRODUCTION

Carpal tunnel syndrome (CTS) is a common condition, affecting 2.7% of people and costing over $500 million annually in United States healthcare spending.[1, 2] CTS is thought to be caused by chronic irritation of the median nerve at the wrist, as it passes through the fibro-osseous carpal tunnel along with nine finger flexor tendons. Risk factors for CTS such as female sex, obesity, pregnancy, hypothyroidism, rheumatoid arthritis, diabetes, and family history have been identified, but it remains unclear why some with risk factors develop CTS and others do not.[1] One theory is that increased pressure within the carpal tunnel leads to chronic compression of the median nerve, which causes microvascular trauma and results in a median mononeuropathy at the wrist and CTS.[3] While several aspects of this theory are plausible, the initial cause of increased pressure within the tunnel in those with idiopathic CTS is not understood.

Over the past 20 years, neuromuscular ultrasound has been used to examine median mononeuropathy at the wrist, and it is now an accepted modality for the diagnosis of CTS.[4] Ultrasound provides anatomic information about the median nerve and contents of the carpal tunnel that cannot be obtained with nerve conduction studies. Our diagnostic neurology laboratory has been using ultrasound to evaluate suspected cases of CTS for more than 10 years. During that time we have noted many individuals with muscle, either flexor digitorum or lumbricals, entering into the carpal tunnel with certain finger and wrist movements.[5] In addition, there are scattered case reports in the surgical literature over the past four decades of CTS suspected to be secondary to anomalous muscle intrusion into the carpal tunnel.[6, 7] Given these findings, we postulated that idiopathic CTS may be secondary to increased pressure within the carpal tunnel caused by repetitive muscle intrusion into the tunnel; and this study was conducted to explore this hypothesis.

METHODS

Participants

This study is part of a larger investigation into health disparities in Latino poultry processing workers, including dermatologic, pulmonary, and musculoskeletal conditions. Participant recruitment and study design have been discussed in detail previously.[8] Prior to initiation, this study was approved by the Institutional Review Board at Wake Forest School of Medicine, and all participants provided signed informed consent. Participants were paid $40 for attending the initial data clinic and $60 for attending the one-year follow-up clinic.

Participants were recruited from four counties in western North Carolina. All participants self-identified as Latino and worked full-time in manual labor positions, and each attended a data collection clinic that occurred

on one of twelve Sundays evenly dispersed from June 2009 to November 2011. Those without CTS at baseline (defined by symptoms and nerve conduction studies) were asked to return for repeat evaluations one year later.

There were 1,526 individuals who underwent baseline screening; 957 were eligible for enrollment, 742 underwent interviews, 518 attended baseline data collection clinic, and 513 had ultrasound, nerve conduction studies, and filled out hand diagrams at the baseline data collection clinic (1,026 wrists). Two-hundred sixty four participants were identified as not having CTS at baseline in either hand and were invited to return to a second data collection clinic one year later. Of those, 173 (65.5%) returned for one year follow-up. In addition, there were 17 workers who were invited back for the dermatologic portion of the study that did not have CTS in one of their wrists at baseline, and they were included in the follow-up data analyses to increase the number of individuals studied. This resulted in 363 total wrists without CTS at baseline that underwent follow-up at one year.

Data Collection

During the data collection clinics the participants were asked about hand symptoms, filled out a Katz hand diagram,[9] underwent bilateral nerve conduction studies, and were evaluated with neuromuscular ultrasound of both wrists. The interview and hand diagram were conducted in Spanish. Nerve conduction studies were performed with a Teca TD10 Electromyograph (Teca Corporation, Pleasantville, NY) by a technician with at least 5 years of experience, and the technician was blinded to the clinical and ultrasonographic information. Wrist temperature was maintained greater than 32 degrees Celsius, and median and ulnar antidromic sensory studies were performed by stimulating at the wrist and recording with ring electrodes 14 cm distally on the 2nd and 5th fingers. Onset and peak sensory latencies were recorded. If a median nerve sensory action potential was not obtainable, then an orthodromic median motor study was conducted.

Ultrasound of the wrist was performed using a Biosound MyLab25 ultrasound device (Esaote Group, Genoa, Italy) with an 18 MHz linear array transducer. Participants were seated with their forearms supinated and resting on a table, and ultrasonography was done by a neurologist with at least 5 years of neuromuscular ultrasound experience. The ultrasonographer was blinded to the clinical and nerve conduction study data. The site of maximal median nerve enlargement at the wrist was identified, and the cross-sectional area of the median nerve at this site was measured using the trace function and tracing along the outer portion of the nerve, erring just to the inside of the bright epineurium. Next, the cross-sectional area of the muscle entering into the carpal tunnel was measured at the level of the distal wrist crease. This was done with the wrist in the neutral position, as well as with the wrist fully extended and fully flexed. When the fingers and wrist were fully extended, the amount of flexor digitorum muscle entering into the tunnel was measured, and with the fingers and wrist fully flexed the amount of lumbrical muscle entering into the tunnel was measured. To position the fingers and wrist in full extension and flexion the participant was instructed to actively move their fingers and wrist, and none of the positioning was obtained with passive movement. The muscle measurements were performed using the trace function and same method as for the nerve, and in some cases the results of more than one tracing were added together to get the total cross-sectional area of multiple muscles entering into the carpal tunnel (Figure 1).

Defining CTS

A combination of symptoms (based on the hand diagram) and nerve conduction study results was used to define the presence of CTS. First, if the hand diagram scored a “1”, “2”, or “3” then the diagram was assigned a score of “1” and if not it was assigned a “0.” Next, median and ulnar peak latencies were compared. If the median was less than 0.49 ms longer than the ulnar, it was scored a “0”; if it was 0.50 to 0.79 ms longer, it was scored a “1”; and if it was greater than 0.80 ms longer, it was scored a “2.” The hand diagram and nerve conduction score were then summed, and a total score of 0 was defined as “no CTS,” 1-2 as “possible CTS,” and 3 as “CTS.” Similar CTS case definitions, with 0.50 ms and 0.80 ms cut-offs for peak latency difference, have been used previously in large-scale CTS screening studies.[10] This scoring system was applied to each wrist, and those that scored a 0 bilaterally during the initial visit were invited to return one year later. In

addition, 17 wrists from the dermatologic portion of the study also scored a 0 at baseline in one wrist, and were evaluated one year later.

Statistical Analyses

In general, continuous variables were calculated as means and standard deviations and discrete variables as percentages and frequencies. The initial group of 513 participants (1,026 wrists) was evaluated to determine the amount of muscle intrusion into the carpal tunnel with the wrist in the neutral, extended, and flexed positions; and multivariate nominal logistic regression, controlling for data collection site, participant dwelling (to account for related individuals), wrist side, age, sex, and body mass index (BMI) was used to examine the association between the muscle area in wrists and the prevalence of CTS at baseline. Hard cut-offs of >15 mm^2 of muscle in any wrist position, >30mm^2 of muscle in any position, and any muscle intrusion in any position were also evaluated in this model in those with and without CTS. Next, those without CTS at baseline and with 1 year follow-up data (190 participants, 363 wrists) were evaluated to determine if muscle intrusion predicted the development of CTS. Two models were created, one in which CTS was strictly defined as only those participants that developed "CTS" (total score = 3) and one in which the definition of CTS was more flexible and included both "possible CTS" and "CTS" (total score = 1-3). In each model, the following variables were evaluated: age, sex, BMI, muscle area (in neutral, extended, and flexed wrist positions), presence of muscle area in any position > 15 mm^2, presence of muscle area in any position > 30 mm^2, and any muscle intrusion into the tunnel. No differences were detected between the strict and less strict models. Because only 2 participants developed CTS over one year by the strict definition, only data from the less strict model are presented. The models were also run excluding the 17 individuals with only unilateral data, and this did not change any of the results significantly. All models were checked using the score test for the proportional odds assumption, and all models were non-significant, indicating they were appropriate models. Finally, it should be noted that all models were adjusted for clustering within a participant (referred to as "wrist side"), to control for the lack of independence between two wrists in the same individual.

RESULTS

Of the 1,026 wrists that were evaluated, 632 (61.6%) met criteria for "no CTS," 346 (33.7%) met criteria for "possible CTS," and 48 (4.7%) met criteria for "CTS." After controlling for age, sex, and BMI, it was found that four wrist variables were significantly different amongst the three CTS classifications: nerve area ($p < 0.001$), muscle area with the wrist in neutral position ($p = 0.017$), muscle area with the wrist in flexed position ($p = 0.020$), and any muscle within the tunnel ($p = 0.003$) (Table 1). This shows that those with CTS had more muscle within the tunnel with the wrist in the neutral and flexed positions, and they were more likely to have any muscle entering into the tunnel. All of the participants meeting criteria for "CTS" had some muscle entering into the tunnel, whereas 9.1% of those defined as "no CTS" had no muscle intrusion at all.

Of the 363 wrists with no CTS at baseline, at one year follow-up 312 (86.0%) continued to meet the criteria for "no CTS," 49 (13.5%) changed to "possible CTS," and 2 (0.6%) changed to "CTS" (Table 2). After controlling for participant characteristics, none of the baseline ultrasonographic measurements of muscle predicted the development of CTS at one year in the 363 wrists evaluated, in either the strict or less strict CTS definition models (Table 3).

DISCUSSION

In this study, the amount of muscle entering into the carpal tunnel was evaluated in 1,026 wrists of 513 manual laborers. Those who met criteria for "CTS" had more muscle intrusion into the carpal tunnel with the wrist in the neutral and flexed positions than those with "possible CTS," and those with "possible CTS" had more muscle intrusion than those with "no CTS." An additional finding of significance was that 100% of those with "CTS" had some degree of muscle intrusion into the tunnel, whereas 96.5% of those with "possible CTS" had some degree of muscle intrusion, and 90.9% of those with "no CTS" had some degree of muscle intrusion. These findings suggest that muscle intrusion into the carpal tunnel, with the wrist in the neutral or flexed position (resulting in lumbrical intrusion into the tunnel), is associated with CTS. Case reports dating back several decades have suggested this possibility, and there are a few other studies demonstrating lumbrical muscle intrusion into the tunnel and a possible association with CTS. Cobb and colleagues in 1994 examined

five cadaver wrists using radiopaque markers on the transverse carpal ligament and lumbrical muscles and showed that with complete finger flexion the lumbricals moved an average of 30 mm into the carpal tunnel.[11] This same group, in 1995, measured the pressure within the carpal tunnel in cadavers with the fingers flexed, before and after the removal of the lumbrical muscles, and they demonstrated a significant decrease in carpal tunnel pressure after removal of the lumbrical muscles when the fingers were fully flexed compared to when the lumbricals were in place.[12]

While the current study showed an association between lumbrical muscle intrusion and CTS, it did not show the same association between flexor digitorum muscle intrusion and CTS. Those meeting criteria for possible CTS had more flexor digitorum muscle intrusion than those with "no CTS," but those with "CTS" had less flexor digitorum than both the "no CTS" and "possible CTS" groups. This is an unexpected finding, because, similar to the literature on lumbrical muscle intrusion, there are case reports and other studies suggesting flexor digitorum intrusion into the tunnel as a cause of CTS.[6, 13] There are several possible explanations why an association between flexor digitorum intrusion and CTS was not detected in this study. First, it is possible that there is not a strong association between CTS and the intrusion of anatomically normal flexor digitorum muscle and only anomalous flexor digitorum intrusion causes CTS, as described in case reports. Second, it is possible that flexor digitorum intrusion is associated with CTS, but, once the median nerve starts to enlarge, there is no room for the muscle to enter. This might be suggested by the increased amount of muscle within the tunnel in those with "possible CTS" compared to those with "no CTS." However, this is not consistent with the lumbrical findings. Third, perhaps the participants in this study, Latino manual laborers (half being poultry processing workers), perform specific repetitive tasks that cause more damaging lumbrical intrusion than flexor digitorum intrusion. Finally, it is important to note the site of muscle measurement in this study, which was at the distal wrist crease. Lumbrical muscles measured at this site, by definition, traversed the entire length of the carpal tunnel, whereas flexor digitorum muscle at this site may have intruded only slightly into the proximal portion of the tunnel. Further investigation in other populations, and at multiple sites within the tunnel, will be needed to determine if flexor digitorum intrusion has any association with CTS.

It is worth noting that most participants in this study had some degree of muscle intrusion. We previously studied healthy volunteers with no symptoms of CTS and found that muscle intrusion occurred in only 80%, whereas in the current study 90.9% of those with "no CTS" had muscle intrusion.[5] The most likely explanation is that the current study evaluated manual laborers, so they likely had more muscle hypertrophy and intrusion than our previous group of volunteers from our medical center. To some degree, this matches the hypothesis that manual labor leads to muscle intrusion, which leads to increased carpal tunnel pressure, which results in median mononeuropathy at the wrist and CTS. It should also be noted that specific cut-offs were investigated to determine if > 15 mm^2 or > 30 mm^2 of any muscle type was associated with CTS, and they were not. This may be because these cut-offs included both lumbrical and flexor digitorum measurements and in this study only lumbrical intrusion was associated with CTS. Alternatively, it is possible that it is an issue of methodology, and these pre-determined cut-offs were not statistically important.

The second portion of the study was prospective, and followed 363 wrists (190 manual laborers) over one year to determine if muscle intrusion predicted the development of CTS. These data were examined multiple ways, and no association was detected between muscle intrusion at baseline and the development of CTS. One limitation of this portion of the study was that only 2 wrists (0.6%) developed "CTS" at one year. A larger number (49 wrists, 13.5%) developed "possible CTS" at one year, but the low number of those that converted to "CTS" likely limited the ability to create robust predictive models. A study with longer follow-up would likely result in more incident cases and improve the ability to assess the importance of muscle intrusion for the development of CTS.

Other limitations were present in this study. First, more sensitive electrodiagnostic studies are available for the detection of median mononeuropathy at the wrist, such as mixed palmar comparison studies.[14] We chose to use a peak median-to-ulnar sensory comparison because it has previously been described in large-scale screening studies of CTS, it is not technically challenging, and it is efficient, especially in a setting outside of our electrodiagnostic laboratory. However, this may have systematically decreased our ability to detected mild cases of CTS. Second, 34.5% of those without CTS at baseline did not follow-up at 1 year for repeat studies. This could have introduced bias, as perhaps those that developed CTS were more likely to stop working in

manual labor and therefore not complete follow-up. Third, this study included only Latino manual laborers, so the results may not be generalizable to all populations. Finally, it is possible that the ratio of muscle intrusion to the size of the carpal tunnel itself is even more important than the absolute amount of muscle intrusion. Measurement of the area of the entire carpal tunnel can be obtained with ultrasound, but it is often technically challenging. Given the large number of ultrasonographic evaluations performed in this study, we did not think it would be feasible from a time standpoint to measure carpal tunnel size in this study.

Overall, we found the results of this exploration to be quite interesting. Further studies, perhaps of longer duration, with measurement at more sites within the tunnel, and with measurement of the area of the tunnel itself, should be considered to more extensively explore the relationship between idiopathic CTS and muscle intrusion into the carpal tunnel. Since CTS is a common and costly condition,[1, 2] a thorough understanding of this relationship is important and could lead to novel preventive and therapeutic approaches for CTS.

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Table 1. Muscle Intrusion into the Carpal Tunnel in 1,026 Wrists of Latino Manual Workers

Parameter	No CTS N = 632 (61.6%) Mean (SD)	Possible CTS N = 346 (33.7%) Mean (SD)	Definite CTS N = 48 (4.7%) Mean (SD)	p-value
Age	32.7 (9.8)	37.6 (10.2)	41.4 (12.3)	< 0.001[c]
Sex (% female)	44.8 %	46.0 %	58.3%	0.390[c]
Height (cm)	158.5 (8.6)	156.8 (7.9)	155.0 (9.3)	0.003[c]
Weight (kg)	70.7 (13.0)	73.3 (13.7)	77.5 (18.4)	0.003[c]
BMI	28.1 (4.5)	29.8 (4.8)	32.2 (7.1)	< 0.001[c]
Median Nerve Area (mm^2)	10.2 (2.3)	12.4 (3.5)	14.8 (5.6)	< 0.001[d]
Muscle Area Neutral (mm^2)	6.1 (8.7)	8.0 (10.4)	8.2 (10.6)	0.017[d]
Muscle Area Extended (mm^2) [a]	12.4 (13.2)	13.1 (14.1)	11.2 (9.4)	0.733[d]
Muscle Area Flexed (mm^2)[b]	16.6 (18.5)	20.3 (19.5)	21.0 (17.5)	0.020[d]
Muscle Area in Any Position > 15 mm^2	61.9 %	67.4 %	64.6 %	0.265[d]
Muscle Area in Any Position > 30 mm^2	28.4 %	30.8 %	29.2 %	0.537[d]
Any Muscle Intrusion	90.9 %	96.5 %	100 %	0.003[d]

a Flexor digitorum superficialis muscle

b Lumbrical muscle

c Multivariate logistic regression controlling for site, dwelling, and wrist side

d Multivariate logistic regression controlling for site, dwelling, wrist side, age, sex, and BMI

Table 2. Baseline Parameters in the 363 Wrists that Underwent One Year Follow-up

Parameters	No CTS (312 wrists)	Possible CTS (49 wrists)	CTS (2 wrists)
Age	30.5 (7.9)	31.5 (11.1)	28.0 (1.4)
Sex (% female)	47.8 %	42.9 %	50.0 %
Height (cm)	158.0 (8.1)	158.5 (9.4)	159.5 (18.8)
Weight (kg)	69.6 (12.6)	71.1 (13.4)	75.8 (9.5)
BMI	27.9 (4.7)	28.2 (4.1)	30.0 (3.3)
Muscle Area Neutral (mm2)	5.9 (8.2)	7.2 (9.5)	3.0 (4.2)
Muscle Area Extended (mm2)	12.8 (13.1)	14.8 (15.6)	0 (0)
Muscle Area Flexed (mm2)	16.0 (17.8)	17.2 (17.8)	16.0 (9.9)
Muscle Area in Any Position > 15 mm2 (%)	60.77 %	61.22 %	50.00 %
Muscle Area in Any Position > 30 mm2 (%)	27.01 %	30.61 %	0 %
Any Muscle Intrusion (%)	91.59 %	93.75 %	100 %

Table 3. Muscle Intrusion (Less Strict Model, 51 Incident Cases of Possible CTS or CTS)

Parameters	Adjusted Odds Ratio	P-Value[a]
Age	1.010	0.724
Sex		0.755
Male	1.136	
Female	---	
Height	0.913	0.416
Weight	1.106	0.356
BMI	0.795	0.395
Muscle area in neutral	1.013	0.609
Muscle area in extended	1.010	0.586
Muscle area in flexed	1.008	0.677
Muscle Area in Any Position > 15 mm^2	0.663	0.380
Muscle Area in Any Position > 30 mm^2	0.848	0.808
Any Muscle Intrusion	1.305	0.700

[a] Multivariate logistic regression controlling for site, dwelling, wrist side, age, sex, and BMI

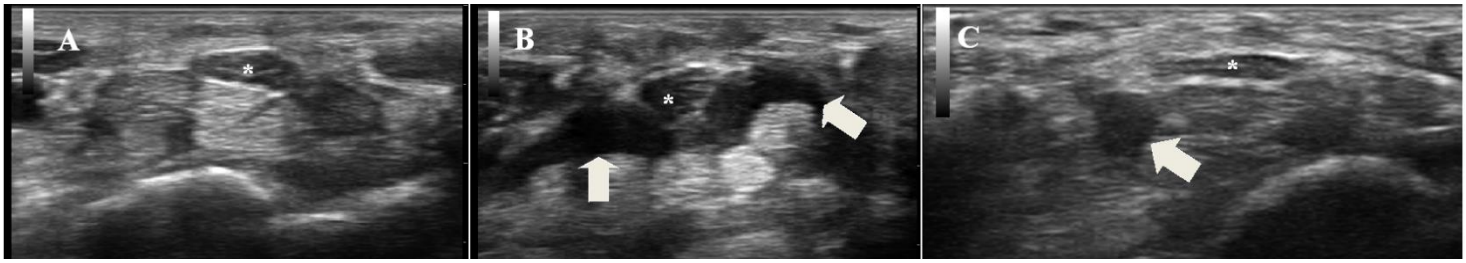

Figure 1. Images A and B are cross-sectional views obtained with ultrasound at the left distal wrist crease in an individual with lumbrical muscle intrusion into the carpal tunnel during finger and wrist flexion. Image A was obtained with the wrist in the neutral position. The nerve is marked with an asterisk (*), and deep to the nerve are the flexor tendons. Image B was obtained with the fingers and wrist flexed. Deep and lateral to the nerve, on either side, are hypoechoic and anechoic regions (arrows), which are the intruding lumbrical muscles. The tendons are the hyperechoic, round structures that are now displaced deep to the lumbrical muscles. Image C is from the left wrist of an individual with flexor digitorum muscle intrusion during finger and wrist extension, and the nerve (*) and muscle (arrow) are again marked.

1-4. The Prevalence of Bifid Median Nerves and Persistent Median Arteries and Their Association with Carpal Tunnel Syndrome in a Sample of Latino Poultry Processing and Other Manual Workers

ABSTRACT

Introduction: The prevalence of bifid median nerves and persistent median arteries, their co-occurrence and their relationship to carpal tunnel syndrome (CTS) are only partially understood.

Methods: We screened 1026 wrists in 513 Latino manual laborers in North Carolina for bifid median nerves and persistent median arteries with electrodiagnosis and ultrasound.

Results: 8.6% of wrists had a bifid median nerve and 3.7% of wrists had a persistent median artery independent of ethnicity, age, sex, or type of work. There was a borderline association with carpal tunnel syndrome. The presence of either abnormality was associated with a high likelihood of co-occurrence of another abnormality in the same or the contralateral wrist.

Conclusions: Ultrasound is a cost-effective field screening tool for median nerve anatomic variants. Persistent median arteries and bifid median nerves tend to co-occur. Manual laborers with either abnormality may have a slightly higher risk of developing CTS than workers without them.

INTRODUCTION

Knowledge of a bifid median nerve and a persistent median artery may be of importance in the diagnosis and treatment of entrapment neuropathies at the wrist. Bifid median nerves may be independent risk factors for the development of carpal tunnel syndrome (CTS) because they tend to have a relatively higher cross-sectional area than non-bifid median nerves and occupy more room in the carpal tunnel.[1] Persistent median arteries also occupy space in the carpal tunnel and are known to cause CTS when they dilate or become thrombosed.[2-4]

The prevalence of bifid median nerves and persistent median arteries in the general population is poorly delineated. The reported prevalence of bifid median nerves has ranged from 2% to 26% per wrist.[1,5-8] This lack of consistency may result from variation in measurement technique (e.g., MRI or ultrasound) or the patient population studied (Table 1). Far more prevalence studies, many in cadavers, have focused on persistent median arteries, yet prevalence estimates remain wide, varying from 0.6% to 30% based on primary and secondary reports.[9-14] In part, this may be explained by the effect of sample population or age, in that neonatal studies have identified a high prevalence of persistent median artery.[11-13] Recent studies have used ultrasound and magnetic resonance imaging (MRI), reporting results within the broad range defined in cadaveric studies.[5,6]

In this study of a large population of Latino manual workers, we investigated the prevalence of bifid median nerve and persistent median arteries, the likelihood of the coexistence of these two anatomic variants, and their relationship to carpal tunnel syndrome through screening with high resolution ultrasound, hand diagrams, and electrodiagnostic testing.

METHODS

This study was done as part of a larger study assessing occupational health in Latino manual laborers, age 18 or older, working in poultry processing and non-poultry processing occupations at least 35 hours per week in four western counties of North Carolina. Recruitment is described in more detail elsewhere.[15] Briefly, it involved community-based sampling in areas with a high proportion of Latino residents in order to recruit self-identified adult Latino manual laborers who were divided into those working in the poultry processing industry versus other forms of manual work. Recruited participants underwent an hour long interview and subsequently attended a data collection clinic. These clinics occurred on seven Sundays in 2009 and 2010. All participants provided informed consent and the protocol was approved by the Institutional Review Board of Wake Forest School of Medicine, including participant payment of $40. Of the 1526 subjects screened, 957 were eligible for participation. Of those, 742 underwent interviews and 518 attended the data collection clinics; 5 subjects left

before undergoing nerve conduction studies. Thus, 1,036 wrists were screened with ultrasound in 518 participants, and that 1,026 wrists (513 participants) were available to analyze the relationship of bifid nerves or persistent median arteries to electrodiagnostically defined CTS.

Ultrasound Evaluations

Ultrasound evaluations were conducted with a MyLab 25 Gold Instrument (Esaote North America Inc, Indianapolis IN) using a 12-18mHz linear array transducer by examiners skilled in ultrasound imaging of the median nerve and its variants (FW, MC, and LK) and blinded to the results of other evaluations in the study. Two examiners were available at all times to review images in which questions arose. Participants were seated and placed their hands, fully supinated, on the examination table for evaluation. The nerve was examined in multiple views with the wrist and fingers in flexion, extension and the neutral position; and images of each median nerve were stored in digital files. All bifid nerves and those with persistent median arteries were identified using real time and color Doppler imaging.

Nerve Conduction Studies and Diagnosis of Carpal Tunnel Syndrome

Nerve conduction studies, performed by experienced technicians blinded to other information, were described in more detail previously.[15] After warming the hands to 32 degrees C, antidromic median and ulnar sensory studies were conducted with ring electrodes on digits 2 and 5 with wrist stimulation 140mm proximal. Onset and peak latencies were recorded. Median motor studies were conducted in participants when sensory responses were absent.

The diagnoses of possible or definite carpal tunnel syndrome were based on a combination of both symptoms (Katz hand diagram) and electrodiagnostic studies.[15] The Katz hand diagrams were scored according to standardized methods as 0 (unlikely), 1 (possible), 2 (probable), or likely (3) by two clinicians (FW and MC) blinded to NCS and ultrasound results. For this study, subjects were assigned a symptom score of 1 or when the hand diagram rating was 1, 2, or 3. All others were assigned a symptom score of 0. Subjects with a median-ulnar peak latency difference greater than 0.79 ms were given an NCS score of 2, if greater than 0.49 ms they were scored 1. All others were scored O. If the NCS and symptom score added to zero, the subject was defined as no CTS. If the scores added to 1 or 2, they were rated as possible CTS; those adding to 3 were graded as definite CTS. We developed two separate definitions of CTS for this study. The first was a strict definition of CTS, which consisted only of subjects scoring a total of 3; and a less rigorous definition of those subjects scoring 1, 2, or 3.

Statistical Analysis

The goal of the analysis was to assess the prevalence of bifid median nerves and persistent median arteries in the study population, to evaluate what personal characteristics predict the presence/absence of each anatomical trait, and to test whether these traits predict CTS. Descriptive statistics were calculated as means and standard deviations of continuous variables, and percentages and frequencies of discrete outcomes. Using information from ultrasound, a binary variable was created to reflect the presence/absence of a bifid median nerve in either (yes in right or left or both) or neither (no) wrist. The same measure was created for a persistent median artery. Bivariate associations between these two outcomes and the discrete participant characteristics of job status, sex and spoken language were calculated using a Chi Square Test of Association, whereas the continuous characteristics of age, height, weight and body mass index (BMI) were assessed using a Student's t-test. Simple and multivariate logistic regression modeling accounting for site strata (county of residence) were used to assess the relationship between the presence of a persistent median artery or bifid median nerve and CTS. Mixed effects models were also adjusted for the clustering effect of dwelling, participant, and hand to account for correlation within participant. Multivariate models included sex and age as fixed effects with adjusted odds ratios and p-values being reported. Level of significance was set at $p<0.05$, and all analyses were performed using SAS version 9.2 (Cary, NC USA).

RESULTS

This study showed a prevalence of a bifid median nerve in 8.6% of wrists and a persistent median artery in 3.7% of wrists. Ten patients had bilateral bifid median nerves, so the prevalence per individual was 13.3%. Four patients had bilateral persistent median arteries, so the prevalence per individual was 5.8%. No significant differences in the frequency of a median artery or bifid median nerve were noted between manual laborers in poultry and in non-poultry occupations. Likewise, no significant differences were noted with age, sex, weight, height, or ethnicity (as evidenced by self-identified native language) (Table 2).

The presence of either a bifid median nerve or persistent median artery in one wrist increased the likelihood of encountering similar variants in the same or other wrist (Figure 1). The effect was pronounced, particularly with median arteries. A left bifid median nerve almost tripled the probability of having a right bifid median nerve or a left persistent median artery; it quintupled the probability of having a persistent median artery on the right. Significantly more persistent left median arteries (n=22) were found than right (n=16); p=.0032.

Two common patterns of bifid nerve and median arteries were seen in this population. In one, the nerve is split by the median artery, and in the other, the median artery is located on the periphery of the nerve (Figure 2). The bifid nerve can be divided by a large fibrous tissue barrier, or a small septum.

We examined the incidence of carpal tunnel syndrome in participants with either an ipsilateral persistent median artery or a bifid median nerve compared to those without these anatomic findings. With a strict definition of CTS, there was no association. However, with the less rigorous definition of CTS, the difference neared statistical significance (p=.0547). A multivariate analysis accounting for body weight, sex, and age showed that the difference was still in the borderline range (p=.0695) (Table 3).

DISCUSSION

In this study of over 1,000 wrists with ultrasound and electrodiagnostic testing we found a bifid median nerve prevalence of 8.6% per wrist and a persistent median artery prevalence of 3.7% per wrist. These rates are within ranges of persistent median artery and bifid median nerve found in prior studies (Table 1). [1-14] The ranges reported have been wide and vary significantly with technique (MRI, ultrasound, dissection) and population studied (neonatal and adult cadavers, healthy subjects by ultrasound, or patients imaged for non-CTS disorders). Some evidence suggests that the prevalence of persistent median arteries is higher in neonates, but other factors that influence the prevalence of either persistent median artery or bifid median nerve have not been identified. This study shows no consistent effect of adult age or sex on the occurrence of persistent median arteries, but a slightly lower occurrence in the right hand. This finding is of uncertain significance, and may reflect the small number of affected hands overall. However, similar trends are not reported in other populations that have been studied with persistent median arteries. It is possible that those engaged in heavy manual labor may be more prone to thrombosis and involution of a persistent median artery, an effect that might be exaggerated in the most commonly dominant hand.

The population we studied, adult Latino manual workers, may be of some relevance in that certain anatomic variants in the forearm vary widely in different ethnic populations. An absent Palmaris tendon, for example, occurs in 65% of Turkish, 25% of European, and 4.4% in East African populations[16-19]. Further studies are needed to ascertain whether ethnic differences influence the wide range of reported prevalence of persistent median artery and bifid median nerve. Of interest, the Latino population we studied consists of a more Native American group, in whom the primary language is indigenous, and a mixed European/Native American group. We did not see significant differences in the occurrence of persistent median artery or bifid median nerve in these two groups, but neither did we evaluate other anatomic variants of the forearm in this study.

Our study does suggest a robust relationship between the presence of a persistent median artery and a contralateral median artery and either ipsilateral or contralateral bifid median nerves. There is a somewhat less robust relationship between a bifid median nerve and a contralateral bifid nerve and either ipsilateral or contralateral persistent median arteries. The association of a right bifid median with a left persistent median artery appears somewhat equivocal. However, given the overall findings, and the multiple comparisons, it would be difficult to drawn firm conclusions about this relationship. Bifid nerves were about twice as frequent as persistent median arteries, and the co-occurrence of these traits suggests that they share a common embryological or genetic origin. It may be that later resorption of median arteries during embryogenesis or

maturation, particularly those which split the median nerve, tend to leave a residual small fibrous partition or gap. If so, this could help explain why the median arteries and bifid nerves are interrelated.

It is difficult to compare prevalence findings regarding median arteries and bifid median nerves from prior studies using MRI angiography or cadaveric dissection with those using ultrasound. For example, it is possible that ultrasound is more sensitive to detecting persistent median arteries that are patent, than those that are non-patent; e.g., a non-patent or thrombosed median artery can have the appearance of a small nerve fascicle.[4] It is not known if one of these techniques is more sensitive than another for detecting these anatomic variants. Furthermore, MRI studies suggest that bifid nerves may be categorized into those apparent in the palm versus those apparent in the carpal tunnel.[7] Since our studies concentrated on the proximal 1/3 of the carpal tunnel, studies looking at more distal portions of the nerve may find a somewhat higher incidence of this anomaly. Absolute percentages of persistent median arteries or bifid median nerves may vary with the techniques used to detect them.

The relationship of bifid median nerves and persistent median arteries to CTS is also of interest. Our study suggests that an ipsilateral median artery or bifid nerve may slightly increase the risk of the disorder, but that the effect, if present, is small. Previous studies and many single case reports have suggested a stronger relationship between CTS and wrist anomalies of this type.[1-14] It should be noted, however, that these studies looked at patients referred to a physician for evaluation of suspected carpal tunnel syndrome in contrast to the general worker population that was screened in our study. The presence of a persistent median artery or bifid median nerve does not seem to substantially increase the risk of carpal tunnel syndrome in manual laborers. Previous analysis in this population, however, showed that type of work had a significant impact on the prevalence of CTS. 8.7% of poultry workers had definite CTS compared to only 4.0% of other types of manual work (odds ratio 2.51, 95% confidence interval 1.8-3.5, $p<0.0001$).[15]

This study has the limitations of other large epidemiological studies of carpal tunnel syndrome in terms of extrapolating findings to patients seen in the context of typical office or diagnostic laboratory setting. Unlike patients, these study participants were an unselected sample of a Latino manual workers not specifically seeking medical attention. Furthermore, the clinical and electrodiagnostic evaluations were less complete than those typically performed in a traditional medical setting. Nonetheless, there is considerable epidemiological precedent that establishes the reliability and validity of the approach chosen for screening the incidence and prevalence of carpal tunnel syndrome in this population. The use of ultrasound to detect bifid median nerves and persistent median arteries may have some limitations with respect to other modalities. For example, cadaveric dissection under magnification may be more sensitive than ultrasound imaging in detecting anatomic anomalies. However cadaveric studies are not representative of a healthy, working population and neither are retrospective radiologic studies. Prospective, high resolution MRI studies might be desirable, but the cost would be prohibitive.

Strengths of this study include its large numbers of participants; the defined population investigated; and the consistency, availability, cost effectiveness, and validity of the measures chosen. The study provides robust evidence that age, sex, and type of manual labor performed are unrelated to the presence of persistent median arteries or bifid median nerves, and establishes the feasibility of using ultrasound in the field to identify the prevalence of anatomic variants at the wrist and their associations with work-related disorders. The discovery of either a bifid median nerve or a persistent median artery significantly increases the likelihood of identifying a persistent median artery in either hand or a bifid median nerve in the contralateral hand. Although the presence of either a bifid median nerve or a persistent median artery may slightly increase the likelihood of developing carpal tunnel syndrome in a large population of Latino manual laborers, other factors in this population, such as type of work performed, are more likely to influence the occurrence of this problematic disorder.

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Table 1. Bifid Median Nerve Prevalence and Persistent Median Artery

Author / Yr	Population Studied	Technique	Number of Individuals/ Wrists	BMN† Prevalence I/W§	PMA‡ Prevalence I/W§
Ahn D[13] 2000	CTS patients	Intraoperative Observation	NA¶ / 294	NA¶	0 / 0.6%
Kopuz C[11] 1997	Neonatal Cadavers	Dissection	30 / 60	NA¶	20% / 10%
Coleman[9] 1961	Adult Cadavers	Dissection	NA¶/ 650	NA¶	NA¶ / 9.9%
Olave[12] 1997	Adult Cadavers	Dissection	51 / 102	NA¶	16% / 23%
Rodriquez[10] 1999	Adult Cadavers	Dissection	120 / 240	NA¶	20% / 12.9%
Pierre-Jerome[5] 2010	Wrist Scans of Patients	MRI	194 / 194	NA / 6.1%	NA¶ / 11%
Gassner[14] 2002	Healthly Subjects	Ultrasound	50 / 100	NA¶	26% / 13%
Bayrak[1] 2008	Patients sent for US	Ultrasound	120 / 240	9% / 5%	NA¶
Granata[6] 2011	Healthly Controls	Ultrasound	52 / 104	25% / 15.4%	NA¶
Walker* 2012	Latino Manual Workers	Ultrasound	518 / 1036	13.3% / 8.6%	5.8% / 3.7%

*Current study
†BMN - Bifid Median Nerve
‡PMA - Persistent Median Artery
§I/W – Individuals/Wrists
¶NA = Not Applicable/Available

Table 2.
Prevalence of Bifid Nerves and Persistent Median Arteries (PMA) in Latino Manual Laborers (N=518).

	Bifid Either	Bifid Neither		PMA Either	PMA Neither	
	N (%)	N (%)	p-value	N (%)	N (%)	p-value
Overall	78 (15.1)	440 (84.9)		33 (6.4)	485 (93.6)	
Job status			0.9050			0.1936
Poultry Workers	44 (15.2)	245 (84.8)		22 (7.6)	267 (92.4)	
Non-poultry workers	34 (14.8)	195 (85.2)		11 (4.8)	218 (95.2)	
Spoken Language			0.6879			0.6592
Non-Indigenous	62 (14.8)	343 (85.2)		25 (6.2)	380 (93.8)	
Indigenous	15 (13.8)	94 (86.2)		8 (7.3)	101 (92.7)	
Gender			0.2549			0.7257
Male	38 (13.4)	245 (86.6)		19 (7.3)	264 (92.7)	
Female	40 (17.0)	195 (83.0)		14 (6.0)	221 (94.0)	
	Mean (SD)	Mean (SD)	p-value	Mean (SD)	Mean (SD)	p-valu
Height (cm)	157.1 (7.8)	157.9 (8.5)	0.4268	157.3 (9.9)	157.8 (8.3)	0.7405
Weight (kg)	73.2 (13.7)	71.7 (13.6)	0.3679	73.0 (13.8)	71.9 (13.6)	0.6431
BMI	29.6 (4.8)	28.7 (4.8)	0.1364	29.5 (4.6)	28.8 (4.9)	0.4711
Age	35.2 (10.4)	34.6 (10.4)	0.6575	37.4 (11.7)	34.5 (10.3)	0.1244

Table 3.
Association of Bifid Median Nerve or Persistent Median Artery with Carpal Tunnel Syndrome

Presence of *Bifid Nerve* to Predict CTS

Definite CTS		Definite CTS/Mutivar*		Possible CTS		Possible CTS/Multivar*	
odds ratio	p-value	odds ratio	p-value	odds ratio	p-value	odds ratio	p-value
0.955	0.9315	0.944	0.9163	1.512	0.1022	1.548	0.0921

Presence of *PMA* to Predict CTS

Definite CTS		Definite CTS/Mutivar*		Possible CTS		Possible CTS/Multivar*	
odds ratio	p-value	odds ratio	p-value	odds ratio	p-value	odds ratio	p-value
2.524	0.0933	2.287	0.1465	1.636	0.1798	1.505	0.2687

Presence of *Bifid Nerve or PMA* to Predict CTS

Definite CTS		Definite CTS/Mutivar*		Possible CTS		Possible CTS/Multivar*	
odds ratio	p-value	odds ratio	p-value	odds ratio	p-value	odds ratio	p-value
1.201	0.6839	1.151	0.7614	1.555	0.0547	1.536	0.0695

*Multiv - Multivariate Analysis

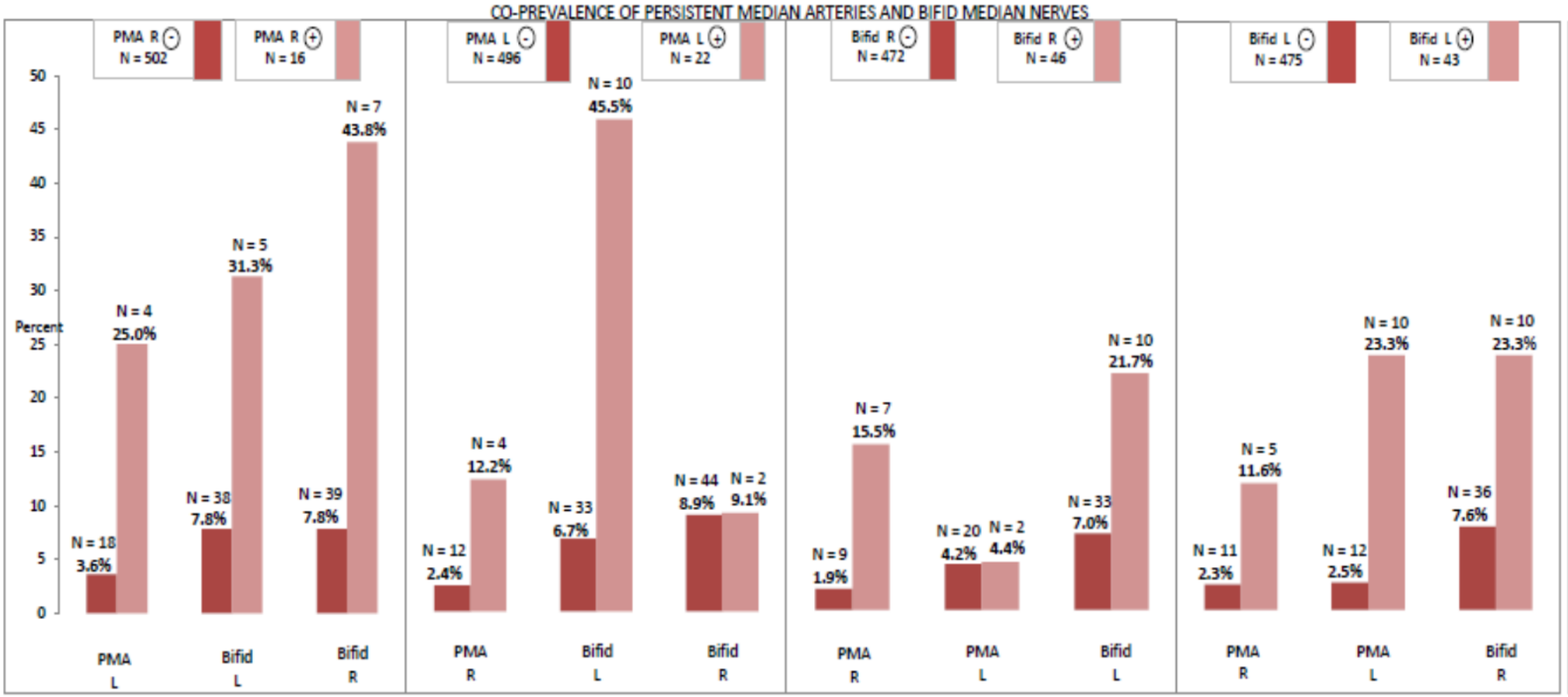

Figure 1. This figure shows the degree to which bifid median nerves and persistent median arteries co-segregate. At the top of the figure are the numbers of study participants with each specific abnormality. Below, the bar graph illustrates the frequency of co-occurrence of this abnormality with the other abnormalities listed. For example, there are 16 participants who have a right persistent median artery (PMA). Of these, 7 also have a bifid right median nerve (7/16 or 44%). There are 502 participants without a right persistent median artery, and in this group, 39 subjects have a right bifid median nerve. (39/502 or 7.8%). (PMA=persistent median artery, bifid=bifid median nerve).

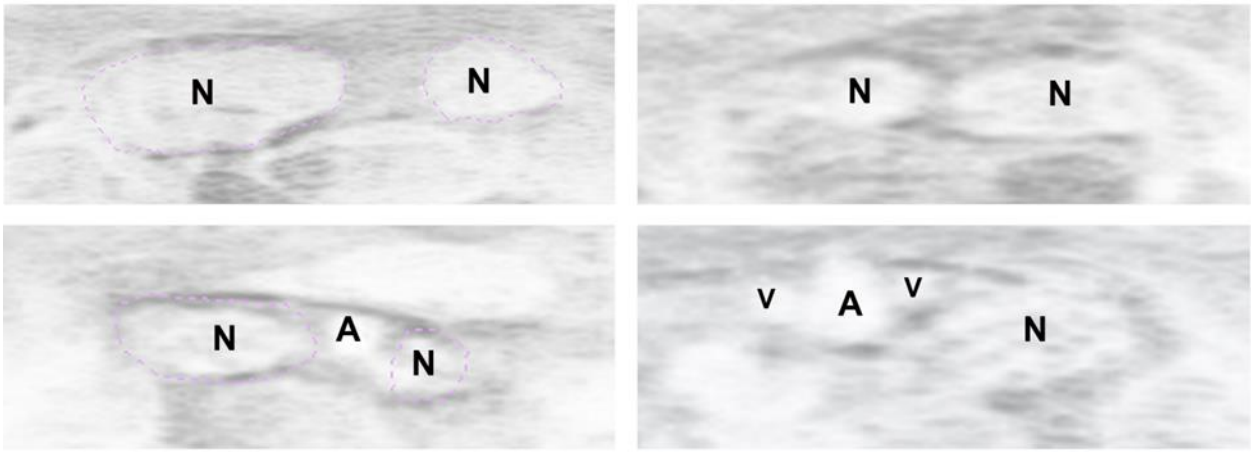

Figure 2. Figure 2A is a composite image of 4 separate median nerves from the wrists of 4 different participants in the study, cropped and aligned to display the most common variations of bifid median nerves and persistent median arteries. Figure 2 B is a negative image of these structures, labeled to show the different types of splitting seen with bifid median nerves. In the upper left image, the two branches of the nerve (N) are divided by a thick fibrous tissue barrier, in the upper right image, this barrier is much narrower; in some cases this barrier is a very thin partitioning membrane. In the lower right image, the barrier contains a persistent median artery (A). In the lower right image, the artery flanks the nerve, which is not bifid, but the artery (A) is accompanied by two smaller veins (V). Although a flanking artery is a common finding with persistent median arteries, it is rare to see persistent median veins.

1-5. Prevalence of Epicondylitis, Rotator Cuff Syndrome, and Low Back Pain in Latino Poultry Workers and Manual Laborers

ABSTRACT

Background: The goal of this study is to improve understanding of immigrant Latino manual workers' occupational health, focusing on upper body musculoskeletal injury.

Methods*:* Physical exams were conducted with a representative sample of 516 Latino poultry workers and manual laborers in western North Carolina; outcome measures were prevalence of epicondylitis, rotator cuff syndrome, and low back pain.

Results*:* Low back pain (n=89; 17.2%) and rotator cuff syndrome (n=76; 14.7%) indicated by physical exam was common. Epicondylitis was less common, but still frequent (n=30; 5.8%). Prevalence of each outcome did not differ between poultry processing workers and other manual workers. Workers > 40 years old had greater incidence of rotator cuff syndrome and epicondylitis.

Conclusions: Epicondylitis, rotator cuff syndrome, and low back pain are common in immigrant Latino workers, and may negatively impact long-term health and contribute to occupational health disparities.

INTRODUCTION

Immigrant Latino workers experience elevated rates of occupational fatality and injury. The occupational fatality rate of foreign-born Latinos between 2003 and 2006 was 5.9/100,000 workers compared to 3.5/100,000 for Latinos born in the US [Forst et al., 2010]. The occupational injury rate for non-agricultural immigrant Latino workers was 12.2/100 workers compared to an expected 7.1 injuries/100 workers in the general population [Pransky et al., 2002]. Excessive occupational fatality among foreign-born Latinos relative to US-born Latinos and elevated injury among Latino workers suggest that immigrant status and Latino ethnicity each pose independent risk for poor occupational health outcomes.

Immigrant workers frequently find themselves in the most dangerous occupations. For example, agriculture is frequently among the most dangerous occupations in terms of non-fatal occupational injury and illness [NIOSH, 2004], and over 70% of agricultural crop workers are Latinos from Mexico [Carroll et al., 2005]. Similarly, occupational injuries are consistently elevated in construction, particularly among roofers [CPWR, 2008], and this industry and occupational group is increasing comprised of Latino workers [Dong et al., 2009]. Poultry processing is another high-risk occupational group with a large percentage of immigrants [Government Accountability Office, 2005]. The most recent estimates from the Bureau of Labor Statistics [2011a] suggest that 4.4% of poultry processing workers experience some type of injury or illness, frequently caused by exposure to slippery floors, small work spaces with hindered movement, manual movement of objects, and repetitive motions [Government Accountability Office, 2005]. Since 1975 the observed injury and illness rate in poultry processing has been twice the national all-industry average [OSHA, 2005].

The organization of the modern poultry processing enterprise creates distinct occupational exposures [Government Accountability Office, 2005]. Poultry processing work applies high-speed assembly line technology to the killing and butchering of animals. Large trucks carrying hundreds of cages, each containing 10-12 birds per cage, arrive at the processing plant throughout the day. Birds are taken from their cages, stunned, and hung by their feet on hooks on an overhead moving belt, and they are subsequently killed, plucked, eviscerated, butchered, often de-boned, and packaged – all at a speed of more than one bird per worker per second. This efficiency requires employees to work at high rates of speed for long periods, frequently without breaks. Workers' experiences in the poultry processing plants have been documented [Marín et al., 2009; Lipscomb et al., 2007], and associated with self-reported occupational health outcomes

[Grzywacz et al., 2007; Lipscomb et al., 2005; Quandt et al., 2006]. In contrast to other, less automated types of occupations that employ immigrant Latinos, the exposures resulting from modern poultry processing may contribute to elevated upper-body musculoskeletal problems [Government Accountability Office, 2005].

A significant limitation of previous occupational health research with immigrant Latino workers is the general absence of studies using clinical outcomes. The paucity of clinical data from immigrant workers is driven by several factors. Employers may be reticent to allow occupational health researchers to screen their workforce [Lipscomb et al., 2005; Quandt, et al., 2006]. Immigrant workers are frequently characterized as "hard to reach" because many may not have documents allowing legal residence in the US, thereby encouraging workers to remain invisible [Quandt et al., 2006]. The combination of poor access to immigrant worker groups provided by employers and the desire of individual workers to remain invisible poses substantial challenges to the systematic collection of clinical occupational health data.

Challenges to obtaining high quality and objective clinical indicators of occupational health from immigrant Latinos has resulted in heavy reliance on self-reported measures [Grzywacz et al., 2007; Lipscomb et al., 2005; Quandt et al., 2006]. Unfortunately, self-reported symptom inventories are subject to a wide variety of potential biases and shortcomings. Some suggest that language barriers and fear of reprisal may contribute to systematic under-reporting of illness or injury, thereby underestimating the burden of poor occupational health among immigrant workers [Premji, et al., 2010]. By contrast, others suggest that immigrant Latinos tend to use extreme responses to questions about symptoms and illness, which may contribute to over-estimation of poor occupational health outcomes [Escobar et al., 1987]. The ability to advance occupational health research with immigrant Latinos requires clarifying the extent to which self-reported musculoskeletal symptoms correspond with objective clinical findings.

The goal of this study is to improve understanding of the burden of poor occupational health among immigrant Latino manual workers. To accomplish this goal we use self-reported musculoskeletal symptoms and clinical exam findings from a large cohort of immigrant Latino poultry processing workers and other manual workers in western North Carolina to achieve three primary aims. Specifically this analysis seeks to (1) determine the prevalence of selected upper-body musculoskeletal impairments (i.e., rotator cuff syndrome, epicondylitis, and low back pain) (2) delineate variation in selected upper-body musculoskeletal impairments by age, sex, and job type (poultry versus other manual labor, differences among occupational groups, and differences among distinct poultry processing tasks), and (3) document the sensitivity and specificity of self-reported symptoms suggestive of musculoskeletal impairment relative to physical exam findings.

METHODS

Study design

The data for this study are from a larger study focused on occupational illness and injury among manual immigrant workers. The larger project involved a structured interviewer-administered survey questionnaire, followed by a physical exam conducted at a community-based data collection clinic held within one month of the interview. Previous papers from this project have described the prevalence of carpal tunnel syndrome [Cartwright et al., 2012] and respiratory outcomes [Mirabelli et al., 2012; Schulz et al., 2012].

Study site

Data were collected in Burke, Surry, Wilkes, and Yadkin Counties in western North Carolina. These counties are rural and considered "new settlement" areas for Hispanic/Latino residents. [Fry, 2008]. The total population of the four counties was 272,331, with 19,310 (7%) of that Hispanic [US Census, 2010].

Sampling

The issues that Latino immigrants face in the United States make them a complex population with whom to conduct research because they are often "hidden" and difficult to reach. The research team did not have access to workplaces, and no census existed of Latino manual workers in the area. Therefore, community-based sampling was used to assure that a representative sample would be selected [Arcury and Quandt,

1999]. A sample frame was developed of dwellings where Latinos lived in the study area. The study team and a community-based organization partnered to map areas mostly populated by Latino residents (enclaves). The research team also surveyed other areas of the counties to identify other dispersed dwellings that were likely inhabited by Latino residents. To identify such dwellings, surveyors looked for cultural or behavioral indicators known to characterize Latino residents (e.g., car decals, bicycles, particular satellite dishes). The lists of enclaves and dispersed dwellings contained 4,376 possible Latino dwellings, with about two-thirds in residential enclaves. The lists were randomized, and assigned proportionately to recruit two-thirds from enclaves and one-third from dispersed dwellings.

Recruitment

Members of the Latino community were hired as recruiters; 2 to 4 recruiters worked in each study county. Recruiters visited randomly selected dwellings in order. If no one was home, recruiters returned at different times and on different days. Residents were screened for inclusion criteria: self-identified as being Latino or Hispanic, worked 35 hours or more per week in a manual labor job, and 18 y**ear**s or older. Manual labor jobs were defined as employment in non-managerial jobs in industries such as landscaping, construction, hospitality (e.g., restaurants, hotel), personal services (e.g., child care), or manufacturing. Non-poultry manual workers with previous work in poultry only qualified if lifetime employment in poultry production or processing was 6 months or less, and not within the past 2 years. Work in poultry processing was defined as any type of non-supervisory work in a poultry processing plant with job categories from receiving through sanitation. Employees of poultry production farms were excluded. More than one resident per dwelling could be recruited, if eligible. Of 1681 dwellings selected, 965 were screened, for a screening rate of 57%. A total of 1,526 residents were screened. Of the 957 eligible residents, 742 (77.5%) were interviewed and 518 (69.8%) of those interviewed attended the data collection clinic. Two individuals left the clinic prior to completing the physical exam, resulting in a final sample of 516.

Data collection

Data collection involved two distinct encounters with participants. The first encounter was an interviewer-administered survey questionnaire that took place in participants' homes. During the in-home interview participants were asked basic demographic information (e.g., age, preferred language), as well as detailed questions about the types of work performed for pay and specific physical and psychosocial occupational exposures (e.g., chemicals, biological fluids, opportunities to control type of work). The second encounter, a "data collection clinic", took place on Sundays at seven different locations within the study area during the data collection period. Participants were scheduled for a clinic that occurred within 30 days of the in-home interview. On the day of the clinic, a short questionnaire was administered to assess any changes in occupation or health since the in-home interview and if any self-reported pain at the elbows, shoulders, or low back on two or more days in the last month. Two board-certified physicians with fellowship training in sports medicine conducted all of the musculoskeletal examinations. Examiner 1 examined 92.6% of the subjects. Rates of positive findings were comparable between the two examiners suggesting no evidence of examiner effects. Those who attended the clinic were given $30. All procedures were approved by the Wake Forest School of Medicine Institutional Review Board. Signed informed consent was obtained from each participant.

Measurement

Case definitions were similar to criteria outlined by Sluiter [Sluiter et al., 2001] but rather than requiring multiple exam findings in addition to self-reported pain this study required only one positive exam finding. Epicondylitis was defined as self-reported pain at either epicondyle area on two or more days in the previous month and one of the following on exam: presence of pain at the lateral epicondyle with resisted active wrist extension, pain at the medial epicondyle with resisted active wrist flexion, or tenderness to palpation over the medial and lateral epicondyle regions physical exam [Werner et al., 2005] . Rotator cuff syndrome was defined as self-reported pain at the shoulder on two or more days in the previous month and one of the following on exam: presence of pain with resisted abduction, internal rotation, external rotation, or forward flexion of the shoulder, or tenderness to palpation over the bicipital groove or lateral shoulder. Low back pain was defined as self-

reported low back pain on two or more days in the previous month and one of the following on exam: presence of pain with active flexion, extension, side-bending to right or left, or twisting to right or left, or tenderness to palpation anywhere in the lumbar region [Strender et al., 1997].

Participants were categorized into Standard Occupational Classification (SOC) groups using data obtained from self-reported descriptions of jobs and job title. The SOC is a coding structure used by the U.S. Bureau of Labor Statistics to encompass all occupations in the U.S. economy. Occupations are identified and defined so that each occupation includes workers who perform similar job tasks [Bureau of Labor Statistics, 2010]. Because some poultry worker participants reported multiple poultry processing activities, specific poultry jobs were combined into three categories corresponding to main production areas [OSHA, 2005]: those jobs likely to emphasize fine movements of hands and wrists (cutting, evisceration, wash-up, trimming, deboning), jobs requiring lifting of whole birds (receiving, hanging, killing, plucking), and other tasks with more varied physical demands (packing, sanitation, chilling). Subjects who reported performing job tasks in more than one category were placed in a fourth classification labeled “multiple”.

Gender and *age* were asked during the in-home interview with age classified into one of three groups (<30, 30-39, ≥40). *Indigenous language* (e.g., Quiche, Aguacateco) was assessed by asking individuals the language spoken by adults in the household when the participant was a child. *Educational attainment* was assessed based upon the grading system used in Latin American countries (i.e., Primaria, Secundaria, Preparatoria, Universidad) and responses were classified as either 0 to 6 years (Primaria), 7 to 9 years (Secundaria) or >10 years (Preparatoria or Universidad). *Years in the US* was asked and responses were classified as 0 to 4, 5 to 9, 10 to 14, or 15 or more years.

Statistical methods

Descriptive statistics (frequencies and percentages) were used to describe the study sample. Bivariate associations between injury prevalence and risk factors (such as age, sex, and work type) were examined using chi-square tests while adjusting for the clustering of multiple participants from the same dwelling units and recruitment sites. Statistical significance was not assessed where there were small or empty cells in a two-way contingency table. Otherwise, a p-value of less than 0.05 was considered statistically significant. The agreement between self-reported pain symptoms and the diagnosis of a condition based on physical exam was examined using Kappa values. In addition, we used McNemar’s tests to evaluate whether or not the estimated prevalence based on self-reported symptoms is different from that based on any positive finding from exams. Finally, sensitivity and specificity for self-reported symptoms were calculated using any positive finding from exam as the criterion. All analyses were performed using SAS 9.2 (Cary, NC).

RESULTS

Most participants were less than 40 years of age (Table I). There were more males (54.7%) than females. Spanish was the dominant spoken language for most participants; nevertheless, 21% reported an indigenous primary language. A majority of the participants reported less than 10 years of schooling (81.6%) and having lived in the United States for at least five years (81.6%).

There were 289 poultry workers and 227 non-poultry workers in the sample. The composition of the two groups was similar in terms of sex and primary language (Table I). The poultry worker group included a larger number of older participants with 15.4% more falling in the ≥ 40 years category and was less educated as 11.3% more participants reported 0-6 years of schooling compared to the non-poultry workers. A larger number of poultry workers had lived in the US ≥ 15 years (34.6 vs. 17.6%). As expected, all but two of the poultry workers were classified as having jobs in “production,” while all ten of the major Standard Occupational Categories were represented in the non-poultry worker group, with production being most common (24.7%), followed by personal care and service (18.1%), and construction and extraction (15.9%).

Low back pain was the most common injury (Table II). Physical exam identified 89 participants (17.2%) affected by low back pain, followed by 76 (14.7%) with rotator cuff syndrome and 30 (5.8%) with epicondylitis. Medial epicondylitis was more common than lateral epicondylitis (22 vs. 13). Of the 30 subjects with epicondylitis 11 had it bilaterally. Of the 76 subjects with rotator cuff syndrome 28 had it bilaterally. Multiple diagnoses were found in 8.7% of subjects with 1.7% having all three. There were no differences between poultry and non-poultry workers in any of the clinical outcomes, nor were there differences in the outcomes among poultry workers with different types of work. There was a significant association for rotator cuff syndrome ($P = 0.036$) and epicondylitis ($P = 0.001$) with age ≥ 40.

Looking specifically at poultry workers (Table III), rotator cuff syndrome was the most common injury (17.0%), followed closely by low back pain (15.6%) and then epicondylitis (6.6%). Rotator cuff syndrome was associated with female gender. Low back pain was elevated for workers performing receiving, hanging, killing and plucking ($P = 0.038$).

Table IV compares self-report of elbow, shoulder, and low back pain for 2 consecutive days within the last 30 days prior to the exam to presence or absence of epicondylitis, rotator cuff syndrome, or lower back pain by physical exam. The estimated prevalence was significantly different between self-report and exam for elbow pain and shoulder pain but not for low back pain. Kappa values were similar between self-report and exam for low back pain but not for elbow pain/epicondylitis and shoulder pain/rotator cuff syndrome. Using exam as the gold standard, self-report of symptoms for two consecutive days within the last 30 days had specificity ranging from 86.7% for back pain to 92.3% for rotator cuff syndrome to 98.7% for epicondylitis. Sensitivity ranged from 25.9% for elbow pain to 47.6% for rotator cuff syndrome to 62.2% for back pain. The self-reported symptoms had positive predictive values ranging from 87.5% for epicondylitis to 66.9% for back pain.

DISCUSSION

Immigrants in developed countries frequently are employed in dangerous manual labor occupations [Guthrie and Quinlan, 2005; Toh and Quinlan, 2009]. In the US, Latino immigrants frequently find themselves in agriculture, construction, and other occupations like poultry processing that pose substantial risk for a variety of injuries, including musculoskeletal injury [Carroll et al., 2005; CPWR 2008; Dong et al., 2009; NIOSH 2004]. Research on immigrant Latino workers is expanding, but previous research has relied almost exclusively on self-reported musculoskeletal symptoms [Grzywacz et al., 2007; Lipscomb et al., 2005; Quandt et al., 2006]. This study used data obtained from clinical exam to measure prevalence of upper body musculoskeletal injuries in Latino manual laborers in North Carolina. The results make several contributions to the literature, particularly the occupational health disparities literature.

The prevalences of three upper body musculoskeletal injuries found in this study suggest that the 2010 non-fatal occupational injury rates of 3.4/100 full time workers for private industry and 5.0/100 full time workers for food manufacturing reported by the US Bureau of Labor and Statistics [Bureau of labor Statistics, 2011b] underestimate the burden of injury experienced by immigrant Latino workers. We found that 5.8% of workers in this group had evidence of epicondylitis, with 2.5% having lateral involvement and 4.3% medial. By contrast, reported prevalence of lateral epicondylitis in the general working age population of the United Kingdom is 0.7-1.9% [Walker-Bone et al., 2004; Walker-Bone et al., 2012] and 0.6% for medial epicondylitis [Walker-Bone et al., 2012]. Rotator cuff syndrome was identified in 14.7% of our sample compared to 4.5-6.1% in the general population of the United Kingdom [Walker-Bone et al., 2004]. Prevalence rates for upper extremity disorders in our sample were lower than those reported in other clinical exam studies of manual laborers. Epicondylitis was found in 14.5% of Taiwanese fish processing workers [Chiang et al., 1993] and 8.9% of Finnish meat cutters [Roto and Kivi, 1984] while 30.9% of fish processing workers [Chiang et al., 1993] and 24.7% of Danish slaughterhouse workers [Frost and Andersen, 1999] had shoulder problems. These studies are over a decade old and are based on non-US and non-immigrant samples which makes direct comparison difficult. Low back pain was identified in 17.2% of our participants, which is similar to the 1-year prevalence self-reported by construction workers in Germany [Latza et al., 2002].

Expected sources of variation in upper-body musculoskeletal impairment were found by age for rotator cuff syndrome and epicondylitis. The association between epicondylitis and rotator cuff syndrome with older age is consistent with other studies [Lipscomb et al., 2007; Nordander et al., 2009]. Speculative explanations for the increased risk in older workers include greater accumulated exposure volume and greater mismatch between task force requirement and physical strength. These results extend the literature by documenting similar effects in an exclusively immigrant cohort and suggest that the processes contributing to age and sex differences in impairment are not ethnic specific.

We found no differences between poultry workers and non-poultry workers for upper-body musculoskeletal impairment by major occupational group. This is consistent with recent government reports that overall injury rates for poultry processing are similar to those in other manual labor categories [Bureau of labor Statistics, 2011b]. Lipscomb and colleagues [2007], however, found that female Black poultry workers had more than twice the prevalence of upper extremity and neck symptoms than was reported by a community comparison group. The similarity of injury rates found in our study for poultry and non-poultry workers may be explained in part by the wide range of physically challenging tasks performed by both groups. Nearly half (104/227) of the non-poultry workers were in the manual labor job categories of production, construction, or installation / maintenance / repair. Activities outside of the workplace in this culturally and socioeconomically uniform group could be similar and possibly account for the lack of differences in injury rates. The sample size may not have been large enough to detect a difference for these injury types. Additional research is needed to determine if poultry workers are at greater risk for upper-body musculoskeletal injuries than other manual laborers.

A final contribution of this study is results from the comparison of self-reported symptoms in the last 30 days with one positive finding on clinical exam as the reference. Results indicated that self-reported symptoms had excellent specificity (ranging from 86.7% to 98.7%), suggesting that the use of self-reported symptoms is an effective tool for identifying apparently healthy or impairment-free individuals. However, questions about self-reported symptoms lasting two or more days had poor sensitivity: in the best case scenario, only 62% of individuals with observed impairment self-reported having experienced symptoms for two consecutive days. In some cases, sensitivity was as low as 25.9%, and previous research has found that 25% of poultry workers had abnormal objective signs of disorder yet denied having symptoms [Young et al., 1995]. The low sensitivity of self-reported symptoms to impairment observed via physical exam is noteworthy because it is in stark contrast to concerns that have been expressed that Latino workers may over-report symptoms or health concerns [Escobar et al., 1987], and it further reinforces arguments that occupational illness and injury rates obtained from self-reported symptoms may substantially underestimate the actual burden of disease [Quandt et al., 2006].

Additional limitations of this study must be acknowledged. While physical exam represents increased measurement precision compared to self-report, imaging studies or pathology specimens would provide more definitive confirmation of tendinopathy of the elbow or shoulder. Performing the exams on Sundays when participants were off-duty for the day means that injuries that flared only while or very shortly after working would not have been detected. This study did not address injury severity so impact on worker health and productivity cannot be determined. Comparing exam findings to self-report within this study is difficult because the self-report time window of the previous 30 days was fairly broad. Also, the injuries diagnosed may be due to recreational or household activities and not related to a participant's occupation. Sample sizes were too small to allow for analysis of injury by specific job duties.

CONCLUSION

Epicondylitis, rotator cuff syndrome, and low back pain are prevalent injuries among Latino poultry workers and manual laborers in western North Carolina. Further study of factors related to immigrant status such as language, education, documentation, and financial vulnerability could identify interventions aimed at improving work related health in this group.

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Table I. Demographics of study sample (% are for column)

	Non-Poultry N (%)	Poultry N (%)	Total N (%)
Age			
< 30	91 (40.1)	90 (31.1)	181 (35.1)
30-39	90 (39.6)	96 (33.2)	186 (36.0)
40 +	46 (20.3)	103 (35.7)	149 (28.9)
Gender			
Female	105 (46.3)	129 (44.6)	234 (45.4)
Male	122 (53.7)	160 (55.4)	282 (54.6)
Language			
Non-indigenous	183 (81.0)	220 (76.9)	403 (78.7)
Indigenous	43 (19.0)	66 (23.1)	109 (21.3)
Education			
0-6 years schooling	118 (52.0)	183 (63.3)	301 (58.3)
7-9 years schooling	60 (26.4)	60 (20.8)	120 (23.3)
10 + years schooling	49 (21.6)	46 (15.9)	95 (18.4)
Years in US			
0-4	34 (15.0)	61 (21.1)	95 (18.4)
5-9	74 (32.6)	68 (23.5)	142 (27.5)
10-14	79 (34.8)	60 (20.8)	139 (26.9)
15 +	40 (17.6)	100 (34.6)	140 (27.1)
SOC major*			
Arts, design, entertainment, sports, media	1 (0.4)	0 (0.0)	1 (0.2)
Food preparation and serving related	25 (11.0)	0 (0.0)	25 (4.8)
Building / grounds cleaning, maintenance	19 (8.4)	0 (0.0)	19 (3.7)
Personal care and service	41 (18.1)	0 (0.0)	41 (8.0)
Sales and related	1 (0.4)	0 (0.0)	1 (0.2)
Farming, fishing, forestry	15 (6.6)	0 (0.0)	15 (2.9)
Construction and extraction	36 (15.9)	0 (0.0)	36 (7.0)
Installation, maintenance, and repair	12 (5.3)	0 (0.0)	12 (2.3)
Production	56 (24.7)	287 (99.3)	343 (66.5)
Transportation and material moving	21 (9.3)	2 (0.7)	23 (4.5)

*Standard Occupational Classification system major categories

Table II. Injury prevalence for all subjects by age, sex, work type, and Standard Occupational Classification (SOC) system major categories

	Total N	Epicondylitis N (%)	Rot. Cuff Syndrome N (%)	Low Back Pain N (%)
Age				
< 30	181	5 (2.8)	18 (9.9)	26 (14.4)
30-39	186	9 (4.8)	28 (15.1)	38 (20.4)
40 +	149	16 (10.7)*	30 (20.1)*	25 (16.8)
Sex				
Female	234	13 (5.6)	38 (16.2)	48 (20.5)
Male	282	17 (6.0)	38 (13.5)	41 (14.5)
Work type				
Poultry	289	19 (6.6)	49 (17.0)	45 (15.6)
Non-poultry	227	11 (4.9)	27 (11.9)	44 (19.4)
SOC major				
Arts, design, entertainment, sports, media	1	0 (0.0)	1 (100.0)	0 (0.0)
Food preparation and serving related	25	1 (4.0)	1 (4.0)	3 (12.0)
Building/grounds cleaning and maintenance	19	0 (0.0)	1 (5.3)	3 (15.8)
Personal care and service	41	3 (7.3)	3 (7.3)	13 (31.7)
Sales and related	1	0 (0.0)	0 (0.0)	1 (100.0)
Farming, fishing, forestry	15	1 (6.7)	3 (20.0)	3 (20.0)
Construction and extraction	36	0 (0.0)	4 (11.1)	3 (8.3)
Installation, maintenance, and repair	12	0 (0.0)	1 (8.3)	2 (16.7)
Production	343	25 (7.3)	58 (16.9)	55 (16.0)
Transportation and moving materials	23	0 (0.0)	4 (17.4)	6 (26.1)

***** $P < 0.05$

Table III. Poultry-only injury prevalence by age, sex, and job task

	Total N (%)	Epicondylitis N (%)	Rot. Cuff Syndrome N (%)	Low Back Pain N (%)
Age				
< 30	90	3 (3.3)	11 (12.2)	11 (12.2)
30-39	96	5 (5.2)	16 (16.7)	18 (18.8)
40 +	103	11 (10.7)	22 (21.4)	16 (15.5)
Sex				
Female	129	9 (7.0)	31 (24.03)*	24 (18.6)
Male	160	10 (6.3)	18 (11.3)	21 (13.1)
Job Task				
Pack/Sanitation/Chill/Other	107	8 (7.5)	19 (17.8)	12 (11.2)
Cut/Evisc**eration**/Wash/Trim/Debone	128	6 (4.7)	17 (13.3)	18 (14.1)
Receive/Hang/Kill/Pluck	22	2 (9.1)	4 (18.2)	7 (31.8)*
Multiple jobs	32	3 (9.4)	9 (28.1)	8 (25.0)

* P < 0.05

Table IV. Self report of any pain for 2 days in last 30 days vs. **any positive** exam finding

		Exam					
		Yes (%)	No	p-value	sensitivity	specificity	Kappa values
Self-Report	**Elbow***						
	Yes	35 (6.8)	5 (1.0)	<0.0001	25.9%	98.7%	0.44
	No	100 (19.4)	375 (72.8)				
	Shoulder*						
	Yes	79 (15.3)	27 (5.2)	<0.0001	47.6%	92.3%	0.44
	No	87 (16.9)	322 (62.5)				
	Back						
	Yes	97 (18.8)	48 (9.3)	0.29	62.2%	86.7%	0.50
	No	59 (11.4)	312 (60.5)				

*One response was missing

1-6. Employer Differences in Upper-Body Musculoskeletal Disorders and Pain Among Immigrant Latino Poultry Processing Workers.

ABSTRACT

Background
Between-employer-differences in working conditions may lead to variable injury rates. The objective of this manuscript is to assess the difference in the prevalence of epicondylitis, rotator cuff syndrome, and low back pain among immigrant Latino poultry workers at plants of three different employers.
Methods
Data were collected from a cross-sectional study among 286 poultry processing workers. Community-based sampling was used to recruit participants in western North Carolina.
Results
Rotator cuff syndrome (26.7%) and low back pain (27.9%) were more prevalent among employees of one specific employer. Multivariate analysis showed significant associations of low back pain and rotator cuff syndrome with age, task performed in the processing line, and employer.
Conclusions
Employer is a major predictor of musculoskeletal disorders and pain. Linespeed and workpace may account for these differences, and provide an opportunity for regulation and intervention to protect the health of workers.

INTRODUCTION

In the United States, approximately 36,643 million pounds of chicken are produced every year, the majority of it in southern states.[1] Chicken processing has gained importance as the consumption of further processed chicken versus whole chicken has exponentially increased over the past decades. The increased marketing and consumption of processed chicken has led to the vertical integration and mechanization of the poultry industry. Such mechanization requires employees to work at high rates of speed for long periods, frequently without breaks. The result is a relatively high risk of injury, with a reported annual rate of 5.7 injuries per 100 full-time workers.[2] In contrast to other less automated occupations that employ immigrant Latinos, the exposures resulting from modern poultry processing may contribute to elevated upper-body musculoskeletal problems.[3-7]

Despite the changes in the poultry processing industry there are still differences among processing plants that leads to different levels of mechanization throughout the industry. [8] The potential for within-industry differences in injury and illness is substantial. Smaller plants may be less mechanized and have fewer safety precautions in place compared to larger plants. Small profit margins can influence company decisions about training, line speed, protective equipment, and general commitment to safety, all of which can affect injury rates. External monitoring of companies by OSHA is extremely limited, as less than 1% of workplaces are inspected annually,[9] and selection criteria may miss at-risk plants.[3] Ergonomic and line-speed standards are voluntary, and their enforcement is variable. Worker perception of safety climate varies significantly between poultry processing companies,[5,10] reflecting the cumulative effect of such company-specific factors.

A major obstacle to determining within-industry differences in injury risk is corporate underreporting of injuries.[11,12] Management incentives are often tied to injury rates, a situation which encourages underreporting of injuries.[9] The reporting process must be initiated by the poultry workers themselves, many of whom are immigrant Latinos.[5, 13] Their reporting is likely limited by language barriers, fears based on their vulnerable immigration status, and need to work.[5]

Studies designed to circumvent these obstacles in order to accurately assess injury burden across companies in poultry are challenging to execute. Employers are reticent to allow occupational health researchers to screen

their workforce.[5, 14] Immigrant workers are frequently characterized as “hard to reach” because many lack documents allowing legal residence in the US, thereby encouraging workers to remain invisible.[5, 12]

The goal of this study is to assess differences in the prevalence of epicondylitis, rotator cuff syndrome, and low back pain among immigrant Latino workers at three poultry processing plants in western North Carolina by 1) determining employer differences in exposures, 2) determining if there are employer differences in organization of work, 3) determining if there are employer differences in clinical outcomes, and 4) assessing whether differences in work exposure or organization explain differences in clinical outcomes.

METHODS

Study design

The data for this study are from a larger cross-sectional study focused on occupational illness and injury among manual immigrant workers. Previous papers from this project have described the prevalence of carpal tunnel syndrome,[7] respiratory outcomes,[15] and disability,[16] as well as procedures for sampling and recruitment.

Sampling

Data were collected in four rural counties in western North Carolina that are considered “new settlement” areas for Hispanic/Latino residents.[17] The issues that Latino immigrants face in the United States make them a complex population with whom to conduct research. The research team did not have access to workplaces, and no census existed of Latino manual workers in the area. Therefore, community-based sampling was used to assure that a representative sample would be selected.[18] A sample frame of dwellings where Latinos lived in the study area was developed. The list of enclaves was created with the help of trusted Latino members of the communities where the participants were recruited that knew the areas that were highly populated by Latinos. Other areas within those communities were also surveyed to identify other areas likely inhabited by Latinos. To identify those areas cultural and behavioral indicators that characterized Latino residents (i.e., Virgen de Guadalupe decals on vehicles, particular satellite dishes.) were surveyed. A total of 1,526 residents were screened. Inclusion criteria were: self-identified as being Latino or Hispanic, worked 35 hours or more per week in poultry processing or other manual labor job, and 18 years or older. Work in poultry processing was defined as any type of non-supervisory work in a poultry processing plant with job categories from receiving through sanitation. More than one resident per dwelling could be recruited, if eligible. Of the 957 eligible residents, 742 (77.5%) were interviewed and 518 (69.8%) of those interviewed attended a data collection clinic. Two individuals left the clinic prior to completing the physical exam, for a final sample size of 516, of these 286 were poultry workers, which is the group analyzed for this paper.

Data collection

Data collection involved two distinct encounters with participants. The first encounter was an interviewer-administered survey that took place in participants’ homes. During the in-home interview participants were asked basic demographic information (e.g., age, preferred language), as well as detailed questions about the types of work performed for pay, specific physical occupational exposures (e.g., chemicals, biological fluids), and work organization (e.g., job demands, decision latitude, and support). They received an incentive of $10. The second encounter, a “data collection clinic”, took place on a Sunday at seven different locations within the study area during the data collection period. Participants were scheduled for a clinic that occurred within 30 days of the in-home interview. On the day of the clinic, a short questionnaire was administered to assess whether any self-reported pain at the elbows, shoulders, or low back had been experienced on two or more days in the last month. Two board-certified physicians with fellowship training in sports medicine conducted 92.6% and 7.4%, respectively, of the musculoskeletal examinations. Rates of positive findings were comparable between the two examiners, suggesting no evidence of examiner effects. Those who attended the clinic that included collection of other physical data were given $30. All procedures were approved by the

Wake Forest School of Medicine Institutional Review Board. Signed informed consent was obtained from each participant.

Measures

Outcome measures were diagnoses of epicondylitis, rotator cuff syndrome, and low back pain. Case definitions were similar to criteria outlined by Sluiter et al. (2001).[19] Rather than requiring multiple exam findings in addition to self-reported pain, this study required only one positive exam finding. Epicondylitis was defined as self-reported pain at either epicondyle area on two or more days in the previous month and one of the following on exam: presence of pain at the lateral epicondyle with resisted active wrist extension, pain at the medial epicondyle with resisted active wrist flexion, or tenderness to palpation over the medial or lateral epicondyle regions.[20] Rotator cuff syndrome was defined as self-reported pain at the shoulder on two or more days in the previous month and one of the following on exam: presence of pain with resisted abduction, internal rotation, external rotation, or forward flexion of the shoulder; or tenderness to palpation over the bicipital groove or lateral shoulder. Low back pain was defined as self-reported low back pain on two or more days in the previous month and one of the following on exam: presence of pain with active flexion, extension, side-bending to right or left; or twisting to right or left; or tenderness to palpation anywhere in the lumbar region.[21]

Because some poultry worker participants reported multiple poultry processing activities, specific poultry jobs were combined into three categories corresponding to main production [22] areas: those jobs likely to emphasize fine movements of hands and wrists (cutting, evisceration, trimming, deboning), jobs requiring lifting of whole birds (receiving, hanging, killing, plucking), and other tasks with more varied physical demands (packing, sanitation, wash-up). Tasks performed by participants were assessed by asking them if, at the time of interview, they were working in receiving, hanging, plucking, cutting, evisceration, wash-up, trimming, deboning, chilling, packing, sanitation, or other task within the poultry processing plant. The tasks performed in poultry processing were taken from an ergonomic tool published by the US Occupational Safety and Health Administration.[22]

Work organization was measured using three domains: job demands (heavy load, awkward posture, psychological demand), decision latitude (job control), and support (perceived supervisor power, work safety climate). All the variables used for work organization are presented as continuous variables. Heavy lifting and awkward posture were measured with a physical workload instrument[23] that has been used in previous research with immigrant Latino populations. [24] Response options ranged from “seldom/never” (1) through “almost always” (4). Heavy load was assessed with the average of 12 items ($\alpha = 0.70$), and awkward posture was assessed by with the average of 6 items ($\alpha = 0.80$), coded such that higher values indicate greater exposure.

Psychological demand and job control were assessed using items modified from the Job Content Questionnaire. [25] The response options range from “seldom/never” (1) through “almost always” (4). Psychological demand is the mean of four items ($\alpha = 0.74$). Job control is the mean of three items ($\alpha = 0.81$). Higher values indicate greater levels for each concept. Each of these measures has been used with immigrant Latino worker populations. [26, 27]

Perceived supervisor control was assessed with seven items from an established instrument.[28] The items ask the participant to judge whether their supervisor had control over pay, benefits, promotions, job assignments, and making work difficult. Response ranged from “strongly disagree” (1) through “strongly agree” (4). Used previously,[24] perceived supervisor control is the mean of the seven items ($\alpha = 0.74$) coded such that higher scores indicate greater perceived control. Work safety climate was measured using the Perceived Safety Climate Scale.[29] Nine of the items in the scale used a four-point Likert format. The tenth item included three response categories. After an analysis of internal consistency, one of the nine four-point Likert format items was discarded due to lack of fit within the scale. A total Work Safety Climate was calculated by summing the

remaining nine items (α = 0.73). Values for the scale ranged from 9 to 39, with higher values indicating better work safety climate. These measures had been used in previous research with immigrant Latino worker populations. [26, 27, 30]

Gender and age were asked during the in-home interview with age classified into one of three groups (<30, 30-39, ≥40). Indigenous language (e.g., Quiche, Aguacateco) was assessed by asking individuals the language spoken by adults in the household when the participant was a child. Educational attainment was assessed based upon the grading system used in Latin American countries (i.e., Primaria, Secundaria, Preparatoria, Universidad) and responses were classified as either 0 to 6 years (Primaria), 7 to 9 years (Secundaria) or >10 years (Preparatoria or Universidad). Years lived in the US was asked and responses were classified as 0 to 4, 5 to 9, 10 to 14, or 15 or more years. Employer was assessed by asking participants the name of the primary company participants worked for, and creating a category for each of the three poultry companies reported.

Statistical methods

Descriptive statistics (frequencies and percentages) were used to describe the overall study sample by employer. The organization of work by employer was described using means and standard deviations and tested using F-tests. The association between employer and the prevalence of musculoskeletal disorders and pain and job type was assessed using Rao-Scott chi-square tests. Next, we fit multivariable logistic regression models to examine the bivariate associations between the prevalence of rotator cuff syndrome and low back pain and risk factors (such as age, sex, work organization, and work type). Adjusted odds ratios (OR) with 95% confidence intervals (CI) were reported. Pairwise differences among three different employers (Employer 1 versus 2, 3 versus 2, and 3 versus 1) were estimated using contrasts. Epicondylitis was not analyzed further because there were not enough events to obtain reliable parameter estimates in multivariable models. Finally, because the study adopted a community based sampling strategy for recruitment, there was clustering among dwelling units within a stratum as well as clustering among participants within a dwelling unit. Therefore, all statistical analyses were adjusted for this stratified cluster sampling design of the study. A p-value of less than 0.05 was considered statistically significant. All analyses were performed using SAS 9.3 (Cary, NC).

RESULTS

Age of participants was fairly evenly distributed across the three categories. Between-company differences were evident (Table I); 51.4% of Employer 1 workers were over 40, while 62.8% of Employer 3 workers were younger than 30. There were more males (55.6%) overall, but Employer 1 had 58.6% females. A majority of participants spoke a non-indigenous language (76.7%), but Employer 3 had 64.0% who listed an indigenous language. Most reported less than 10 years of schooling (83.9%) and having lived in the US for 5 or more years (79.0%). Most participants had worked in poultry processing for 4 years or less (57.8%), but this was even more pronounced for Employer 3 (88.2%; none with 10 or more years of experience).

About 8% of the participants had epicondylitis. Rotator cuff syndrome was the most common diagnosis in the overall sample (48 cases) closely followed by low back pain (45 cases) (Table II). There was a significant association between these two injuries and employer. These injuries were more prevalent among those who worked for Employer 3 and least prevalent among those who worked for Employer 2.

Work organization variables for the overall sample and by employer are described in Table III. Participants employed by Employer 3 were more likely to be exposed to lifting heavy loads (2.2 ± 0.53), reported greater perceived supervisor control (2.58 ± 0.44), and greater psychological demand (3.17 ± 0.64). In contrast, participants employed by Employer 2 reported better safety climate (26.6 ± 2.23). Participants employed by Employer 1 reported higher exposure to awkward postures (2.49 ± 0.85).

Job type for the overall sample and by employer is described in Table IV. The largest job type category overall was cutting/eviscerating/trimming/deboning with 47.9%, while packing was second highest with 23.8%. The

largest proportion of participants working in packing (38.7%), and wash-up and other tasks (14.4%) worked for Employer 1. The largest proportion of participants in sanitation (19.1%) and cutting/eviscerating/trimming/deboning (62.9%) were employed by Employer 2. Employer 3 had the largest proportion of workers performing tasks in receiving/hanging/killing/plucking (12.8%).

There was no difference between employers for epicondylitis prevalence after multiple logistic regression analysis. Age persisted with logistic regression modeling as a significant association with epicondylitis (P=0.01). The final logistic regression models for rotator cuff syndrome and low back pain are presented in Table V. For rotator cuff syndrome, age (OR=1.06, CI=1.01-1.10), receiving/hanging/killing/plucking (OR=3.84, CI=1.01-14.61), and Employer 3(vs. Employer 2 OR=6.2, CI=4.44-27.23; vs. Employer 1 OR=5.63, CI=1.43-22.11) remained significant risk factors. For low back pain, receiving/hanging/killing/plucking (OR=4.68, CI=1.11-19.77), and Employer 3 (OR=4.86, CI=1.13-20.92) when compared to Employer 2 remained significant risk factors. Female gender was a significant protective factor for both rotator cuff syndrome (OR=0.17, CI=0.06-0.50) and low back pain (OR=0.24, CI=0.08-0.72).

DISCUSSION

The mechanization of the poultry processing industry has led to increasing line speeds and, therefore, higher musculoskeletal disorders and pain rates among poultry workers. Nevertheless, the musculoskeletal disorders and pain rates can vary by plant. The differences in plant size and production capability may affect the quality of the equipment and the worker safety guidelines implemented at each plant. Evidence exists that there is a correlation among implemented safety practices and injury rates of workers.[31] The findings of this manuscript show that, even though there were no clear differences in organization of work among the three poultry processing employers, there are significant associations of rotator cuff syndrome and lower back pain with age, gender, task performed in the processing line, and employer.

Working in receiving/hanging/killing/plucking increased the odds of having rotator cuff syndrome or lower back pain injuries. These tasks require workers to continuously make movements above shoulder level which could cause rotator cuff syndrome. These findings are supported by previous studies that show a strong correlation among industrial workers working above shoulder level and diagnosis of rotator cuff syndrome.[32, 33] Working in some of these tasks also requires workers to flex forward, which has been associated with lower back pain.[34]

Female gender was a protective risk factor for both rotator cuff syndrome and low back pain, while age was an independent risk factor for epicondylitis and rotator cuff syndrome. Previous studies have shown a correlation between rotator cuff syndrome and low back pain among women mainly attributed to differences in the work load.[35, 36] The results in this manuscript may differ from previous studies due to the difference in tasks that men and women have within the processing line (i.e., men are more likely to work hanging chickens which requires repetitive over the shoulder movement and forward extension of the lower back). Association between epicondylitis and age is consistent with other studies.[37] Older workers may simply have had greater time for exposure volume to accumulate both on the job and with leisure time activities. For older workers, there may be a greater mismatch between task force requirement and physical strength.

Employer was a major predictor of musculoskeletal disorders and pain. Rotator cuff syndrome and low back pain were more prevalent among participants who worked for Employer 3. This association could not be explained by demographic data, reported exposure to heavy load or difficult posture, or job type differences between these plants. Several factors not accounted for in this study could account for why working for Employer 3 was a risk factor for rotator cuff syndrome and low back pain. Number of hours worked by employees may have been higher for Employer 3. Cumulative exposure to repetitive activity, which is a known risk factor for tendinopathy/rotator cuff and low back,[32, 38-42] could be another reason why disorders and pain were more prevalent among Employer 3 workers. Assembly line speed is also known to be directly proportional to worker injury in the manufacturing sector and food processing industry in particular.[43, 44] In addition to higher volume of repetitive work, faster line speeds may increase risk of musculoskeletal disorders and pain in other

ways. For example, workers may not be able to take the time to sharpen knives as frequently, resulting in more force needed to accomplish cutting tasks. Mental and physical fatigue could lead to poor posture and technique, which can increase stress on the upper body. Workspace differences could also explain disorders and pain risk, as manual labor within confined areas is associated with musculoskeletal disorders and pain. [37] Workers positioned closely to each other may not be able to assume positions that create the best leverage for cutting or lifting.

Only 11.8% of participants at Employer 3 had worked in poultry processing for more than four years, and none had worked 10 years or more. This might be the result of turnover as employees leave due to injury or bad working conditions. Higher worker turnover at a given plant could increase risk of overuse injury, as less experienced workers may not know optimum techniques and precautions, and lower numbers of experienced workers are available to teach and model these proper behaviors. Employer approach to training of new workers can also influence how likely workers are to use proper techniques and safety precautions.

It is also possible that unmeasured cultural factors play a role in the within-company similarities of workers. It is well established in international migration that individuals often follow others from the same region to a new worksite.[45] To the extent that such individuals share beliefs and practices related to work, health, and symptom recognition, they may exhibit similar illness and injury patterns.

Findings of this study should be taken in light of its limitations. The study is cross-sectional, so no temporal relationships among work, symptoms, and epicondylitis, rotator cuff syndrome, and lower back pain can be established. The generalizability of the findings is limited, as the workers were recruited from one area in the United States. The sample is not a population-based random sample, as this a hard-to-reach population; and community-based sampling was used. Even though participants were assured that the information they provided would be anonymous, some eligible workers might have declined participation for fear of retaliation. Lastly, the categorization of task within poultry work is not precise; some workers have multiple tasks along the production line, but workers were classified under one task if that task was performed more than 50% of the time.

Nonetheless, this study provides important findings of injury rates in a hard-to-reach worker population. The results of this study are especially relevant because the US Department of Agriculture is moving forward a proposal to privatize line inspections, allowing poultry processing companies to increase speed lines without accounting for the safety and health of poultry processing employees.[46] Through this proposal poultry processing companies would be entirely responsible for conducting inspection of chicken carcasses for disease. Since the companies will provide the inspectors, they argue that it is feasible to increase line speeds. If this change takes place, the risk of having a musculoskeletal disorder and pain is likely to increase due to increasing line speeds, ignoring the health and safety of the workers. Future research should assess how other factors, such as working hours, line speed, and workspace differences among employers, correlate with musculoskeletal disorders and pain of poultry processing workers. Since access to worksites is often limited, a possible way to access some of the worksite factors is to use methods such as those used by Lipscomb et al. where an industry specific job exposure matrix was constructed using general knowledge of the industry combined with the information provided by the poultry processing workers.[14] Policy changes such as standardized line speed that take into account the safety of the workers, and proper reporting of injuries should be implemented to prevent injuries.

CONCLUSION

Poultry processing is an industry that has high injury rates. Mechanization and vertical integration have contributed to the high injury rates among poultry processing workers. Since access to the industry to conduct occupational health research is limited, our study team through community-based sampling sought to gain knowledge on possible factors associated with prevalent musculoskeletal disorders and pain. The results of our study showed that employer is a predictor of musculoskeletal disorders and pain. These results contribute

to the limited literature on immigrant Latino processing workers because they could serve as precedence for further research examining possible causes of injury in greater detail.

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Table I. Employee Personal Characteristics by Employer: Poultry Processing Workers

	Total N (%)	**Employer 1 N (%)**	**Employer 2 N (%)**	**Employer 3 N (%)**
Age				
< 30	89 (31.1)	15 (13.5)	20 (22.5)	54 (62.8)
30-39	95 (33.2)	39 (35.1)	32 (36.0)	24 (27.9)
40 +	102 (35.7)	57 (51.4)	37 (41.6)	8 (9.3)
Gender				
Female	127 (44.4)	65 (58.6)	33 (37.1)	29 (33.7)
Male	159 (55.6)	46 (41.4)	56 (62.9)	57 (66.3)
Language				
Non-indigenous	217 (76.7)	104 (95.4)	82 (93.2)	31 (36.1)
Indigenous	66 (23.3)	5 (4.6)	6 (6.8)	55 (64.0)
Education				
0-6 years schooling	182 (63.6)	61 (55.0)	48 (53.9)	73 (84.9)
7-9 years schooling	58 (20.3)	25 (22.5)	23 (25.8)	10 (11.6)
10 + years schooling	46 (16.1)	25 (22.5)	18 (20.2)	3 (3.5)
Years in US				
0-4	60 (21.0)	3 (2.7)	15 (16.9)	42 (48.8)
5-9	68 (23.8)	15 (13.5)	23 (25.8)	30 (34.9)
10-14	58 (20.2)	27 (24.3)	19 (21.4)	12 (14.0)
15 +	100 (35.0)	66 (59.5)	32 (35.9)	2 (2.3)
Years in Poultry Processing				
0-4	163 (57.8)	39 (35.1)	49 (57.0)	75 (88.2)
5-9	79 (28.0)	49 (44.2)	20 (23.2)	10 (11.8)
10-14	25 (8.9)	14 (12.6)	11 (12.8)	0 (0.0)
15 +	15 (5.3)	9 (8.1)	6 (7.0)	0 (0.0)

Table II. Diagnosis of Musculoskeletal injuries among Poultry Processing Workers by employer

	Total N (%)	Employer 1 N (%)	Employer 2 N (%)	Employer 3 N (%)	P-value*
Epicondylitis	17 (5.9)	9 (8.1)	2 (2.3)	6 (7.0)	0.2203
Rotator cuff Syndrome	48 (16.80	19 (17.1)	6 (6.7)	23 (26.7)	0.0012
Low back pain	45 (15.7)	14 (12.6)	7 (7.9)	24 (27.9)	0.0007

*Rao-Scott chi-square tests

Table III. Association of Organization of Work Variables and Employer among Poultry processing worker

	Total n=286	**Employer 1 n=111**	**Employer 2 n=89**	**Employer 3 n=86**	
	Mean, ±SD	**Mean, ±SD**	**Mean, ±SD**	**Mean, ±SD**	**P-value***
Heavy load	2.00, ±0.54	1.98, ±0.59	1.83, ±0.41	2.2, ±0.53	<0.0001
Awkward posture	2.31, ±0.75	2.49, ±0.85	2.09, ±0.64	2.32, ±0.65	0.0012
Abusive supervision	2.34, ±0.48	2.08, ±0.49	2.42, ±0.31	2.58, ±0.44	<0.0001
Safety climate	24.9, ±3.05	24.00, ±2.21	26.16, ±2.23	24.74, ±4.14	<0.0001
Job control	1.68, ±0.78	1.69, ±0.84	1.79, ±0.77	1.55, ±0.68	0.1050
Psychological demand	2.75, ±0.88	2.84, ±0.96	2.23, ±0.7	3.17, ±0.64	<0.0001

*F tests were used to test differences between the means

Table IV. Task Performed by Poultry Processing Worker and Employer *

	Total n=286	**Employer 1 n=111**	**Employer 2 n=89**	**Employer 3 n=86**
Job types	**N (%)**	**N (%)**	**N (%)**	**N (%)**
Receiv/hang/kill/pluck	23 (8.0)	10 (9.01)	2 (2.25)	11 (12.79)
Cut/evisc/trim/debone	137 (47.9)	32 (28.83)	56 (62.92)	49 (56.98)
Packing	68 (23.8)	43 (38.74)	8 (8.99)	17 (19.77)
Sanitation	34 (11.9)	10 (9.01)	17 (19.1)	7 (8.14)
Wash-up/other	24 (8.4)	16 (14.41)	6 (6.74)	2 (2.33)

*Rao-Scott chi-square p-value < 0.0001

Table V. Multivariate Analysis of Associations of Muscled Skeletal Injuries and Personal Characteristics, Task Performed at Poultry Processing Plan, Work Organization, and Employer.

	Rotator cuff syndrome		**Low back pain**	
	OR	**CI**	**OR**	**CI**
Age	**1.06**	**1.01-1.10***	1.01	0.97-1.05
Gender				
Male	Ref	Ref	Ref	Ref
Female	**0.17**	**0.06-0.50***	**0.24**	**0.08-0.72***
Yrs Poultry	1.07	0.97-1.18	1.02	0.92-1.13
Education				
0-6 years	Ref	Ref	Ref	Ref
7-9 years	0.66	0.18-2.36	0.56	0.18-1.75
10+ years	1.80	0.61-5.34	0.60	0.17-2.10
Indigenous Language				
No	Ref	Ref	Ref	Ref
Yes	2.41	0.62-9.40	0.54	0.15-1.94
Task				
Cut/evisc/trim/debone	Ref	Ref	Ref	Ref
Receive/hang/kill/pluck	**3.84**	**1.01-14.61***	**4.68**	**1.11-19.77***
Packing	1.31	0.51-3.38	0.82	0.28-2.41
Sanitation	1.53	0.31-7.61	2.45	0.56-10.73
Wash-up	2.68	0.70-10.21	0.65	0.09-4.75
Work organization				
Heavy load	1.26	0.55-2.90	1.73	0.67-4.50
Posture	1.04	0.52-2.08	1.63	0.83-3.19
Abusive supervision	0.70	0.33-1.48	1.26	0.51-3.12
Safety climate	0.99	0.88-1.12	1.05	0.93-1.17
Job control	2.00	0.63-1.90	0.97	0.54-1.73
Psychological demand	1.25	0.73-2.15	0.93	0.53-1.63
Employer†				
Emp 1 vs Emp 2	1.11	0.33-3.73	1.17	0.36-3.79
Emp 3 vs Emp 2	**6.23**	**1.44-27.23***	**4.86**	**1.13-20.92***
Emp 3 vs Emp 1	**5.63**	**1.43-22.11***	4.15	0.86-19.48

†Adjusted for age, gender, yrs in poultry, education, language, task, work organization, and employer.
*p-value <0.05

1-7. Dermatologist-Diagnosed Skin Disease Among Immigrant Latino Poultry Processors and Other Manual Workers in North Carolina

ABSTRACT

Background: Immigrant Latino workers are an expanding workforce in rural areas of the United States, concentrated in occupations such as poultry processing that entail chemical, infectious, and mechanical skin exposures. Occupational skin illnesses in this vulnerable population are not well characterized.
Aim: This study was designed to describe the prevalence of skin diseases among Latino immigrant poultry processing and other manual workers in North Carolina.
Methods: Community-based sampling was used to recruit 742 Latino immigrant workers; 518 underwent a physical examination supervised by a board-certified dermatologist. The presence or absence of skin disease on the face, neck, arms, hands, and feet was recorded.
Results: Workers ranged in age from 18 to 68, with slight over-representation of males (54.6%). Poultry workers represented 55.8% of the study sample. Infectious skin diseases were the most common diagnosis, present in 52.6% of workers. Inflammatory skin diseases were present in 28.4% and pigmentary disorders in 21.9%. The most common skin conditions were tinea pedis (37.9%), onychomycosis (32.0%), scars (13.8%), acne (11.9%), and melasma (9.3%). Age, sex, language spoken, and whether a poultry processing worker helped explain prevalence of these diseases.
Conclusions: Several skin diseases are highly prevalent in Latino immigrant workers and may relate to work environment. These may cause impairment of life quality and predispose workers to further illness.

INTRODUCTION

Skin is the biologically active barrier between the individual and the environment. While skin is designed to adjust to a wide range of external changes, environmental stressors may predispose skin to disease. Such exposures are a part of the daily working conditions in a number of jobs. The Bureau of Labor Statistics[1] reported that the incidence of skin disease requiring missed work days among all private industry workers in 2009 was 2.9 per 10,000. Irritant contact dermatitis is the most common form of occupational skin disease, estimated to constitute 70% to 80% of all occupational skin disorders.[2]

Latino populations have become the largest minority in the United States.[3] The Latino workforce is growing rapidly due to immigration from Mexico and the rest of Latin America, expanding into "new settlement" communities that previously had few Latinos.[3] The southern US, in particular has experienced significant in-migration. Latinos in these new settlement communities are now concentrated in jobs that place them at high risk for occupational injuries and illnesses.[4] These jobs include poultry processing, where immigrant Latinos make up the largest proportion of the more than 250,000 workers in the US[5], as well as construction, farm work, and hotel and food service jobs. The occupational hazards to which these workers are exposed include chemicals (such as pesticides and cleaners), extreme temperatures, humidity, long hours, and repetitive motions.[6]

Studies documenting skin disease in Latino immigrant workers have been largely limited to farmworkers. In a study of 304 farmworkers that employed a structured interview and a standard set of ten digital photographs reviewed by a board-certified dermatologist, high levels of inflammatory skin disease (57.2%) and infectious skin diseases (73.8%) were found.[7] A study of 79 farmworkers in the same area visiting a clinic for non-skin conditions found infectious and inflammatory skin diseases to be the most common, with the most frequent diagnoses being contact dermatitis (33%), melasma (12.7%) and tinea (defined as any dermatophytosis except onychomycosis, 12.7%).[8] A small study to assess skin conditions among 25 male Latino poultry workers found infections to be the most common ailments (onychomycosis 76%; tinea pedis 72%), followed by inflammatory diagnoses (acne or folliculitis 64%).[6] Among workers in other manual occupations such as butchers, fish

processing workers, and construction workers, the prevalence of skin disease has been found to be high. [9-12] However none of these studies have shown the prevalence among Latino immigrants. Few studies have looked at the prevalence of dermatoses among poultry processing workers[6,13,14] and of those, the majority have focused mainly on the prevalence of warts among poultry processing workers. Aside from the farmworker studies, there have been virtually no systematic examinations of occupational skin disease among Latino immigrants. Lack of such data prevents developing evidence-based occupational health and safety interventions, as well as identifying changes in work practices to prevent skin-related illnesses.

The purpose of this paper is to provide a description of the prevalence of skin diseases diagnosed by skin examination among Latino immigrant poultry workers and other manual workers in western North Carolina. The value of this study is its large size and its community sampling approach. The study focuses on poultry workers because of their large number[5]; existing self-report data, which suggest high levels of skin injuries and illnesses; and the known exposures in poultry processing to wet, cold conditions, animal meat and by-products; and repetitive work.[6] We compared the rates of skin disease in this group to immigrant Latino non-poultry manual workers to distinguish the impact of poultry work from the background rate of skin disease in the Latino immigrant manual workforce.

METHODS

Study Design

The study was a cross-sectional survey to document the prevalence and predictors of selected occupational injuries and illnesses among Latino poultry and non-poultry manual workers. Data were collected in Burke, Surry, Wilkes, and Yadkin Counties in western North Carolina, which are "new settlement" areas for Hispanic/Latino residents in the US.[3] The total population of the four counties is 272,331, with 19,310 (7%) being Hispanic.[15] Data collection, which occurred from June 2009 to November 2010, included an initial in-home interview and a subsequent physical examination.

Sampling

Community-based sampling was used to assure that a representative sample would be selected.[16] A sample frame of 4,376 dwellings likely inhabited by Latino immigrants was developed in collaboration with a community-based organization serving the local Latino population. Some dwellings were in known Latino enclaves, and others were dispersed throughout the counties. The lists were enumerated and stratified, and then specific dwellings were randomly selected for potential recruitment to the study. Dwellings were selected so that approximately two-thirds were from Latino enclaves and one-third from dispersed dwellings.

Recruitment

Well-known members of the Latino communities were hired as recruiters; 2 to 4 recruiters worked in each study county. Recruiters visited randomly selected dwellings in order, returning at different times and on different days if no one was home. Residents were screened for inclusion criteria: self-identified as being Latino or Hispanic, worked 35 hours or more per week in a manual labor job, and were 18 years or older. Manual labor jobs were defined as employment in non-managerial jobs in poultry processing or industries such as landscaping, construction, restaurant work, hotel work, childcare, or manufacturing. Non-poultry manual workers with previous work in poultry only qualified if lifetime employment in poultry production or processing was 6 months or less, and not within the past 2 years. Work in poultry processing was defined as any type of non-supervisory work in a poultry processing plant with job categories from receiving the live chickens through sanitation, including hanging, killing plucking, cutting, evisceration, wash-up, trimming, deboning, chilling and packing (for details on these tasks, see the OSHA e-tool[17]). Employees of poultry production farms were excluded. More than one resident per dwelling could be recruited, if eligible. Of 1,681 dwellings selected, 965 were screened, for a screening rate of 57%. A total of 1,526 residents were screened, 957 were eligible, and, of these, 742 workers (78%) agreed to participate in the initial in-home interview and 518 of those later

attended a data collection clinic for a physical examination. The data collection clinics occurred on seven Sundays evenly dispersed throughout the study period.

Data Collection

The in-home interview was interviewer-administered. It included demographic information (i.e., age, country of origin, educational attainment, language preference) and current work characteristics. The physical examination included a skin examination, supervised by a Spanish-speaking, board-certified dermatologist. Signed informed consent was obtained for each of the participants; $10 was given to the participant at the time of the in-home interview and $30 was given to the participant at the time of the physical examination. Participant recruitment and data collection procedures were approved by the Wake Forest School of Medicine Institutional Review Board.

Physical Examination

The skin examination was focused on the face, neck, arms, hands, and feet, in order to capture the areas most at risk of occupational exposure. Presence or absence of disease was recorded in the following categories: inflammatory diseases, pigmentary disorders, infections, malignant and pre-malignant tumors, and trauma. Specific occupational skin diseases that were included in the data collection instrument included folliculitis, atopic dermatitis, irritant and allergic contact dermatitis, onychomycosis, tinea pedis, tinea corporis, warts, and traumatic skin and nail lesions. Neither the sites nor the location of involvement were recorded except in the case of tinea, where foot versus other was recorded. An individual could have more than one specific diagnosis in a category. Completely benign disorders such as dermatofibroma, benign nevi, keratosis pilaris, birthmarks, cysts and hemangiomas (less than 1 cm), as well as androgenetic alopecia, were ignored.

Analysis

The objectives of the statistical analysis were to describe the prevalence of various skin diseases among Latino immigrant workers in NC and to evaluate whether personal characteristics predict the presence of observed skin diseases. Descriptive statistics such as percentages and frequencies were calculated for discrete personal characteristics and the presence of various skin diseases. Bivariate associations between demographics and diseases of interest were examined with Chi square tests or Fisher's exact tests. Dichotomous outcomes of skin diseases of interest (i.e., coded as 1 for presence of disease and 0 for absence) were modeled with multivariate logistic regression. Predictor variables in the models included gender, type of work (poultry workers, non-poultry workers), age (17-24 yrs, 25-30 yrs, 31-40 yrs, 41 yrs and older), educational attainment (0-6 yrs, 7-9 yrs, 10 or more yrs), and primary language spoken (indigenous, non-indigenous language). Adjusted odds ratios (AOR) and 95% confidence intervals (CI) were estimated. Significance was accepted at $p<0.05$ and all analyses were performed using SAS version 9.2 (Cary, NC, USA).

RESULTS

Poultry workers represented 55.8% of the sample (Table 1). Participants ranged in age from 18 to 68 years of age (mean=33.8, SD=10.2). Almost three quarters (73.9%) were 40 years of age or less. Slightly over half (54.6%) were male. Over half (58.3%) had six of fewer years of education; 21.2% spoke a non-Spanish indigenous language as a primary language. Most of these languages were Mayan languages found in southern Mexico and Guatemala.

Infectious skin diseases were the most common diagnosis, present in 52.6% of the participants. Inflammatory skin diseases were present in 28.4%, and pigmentary disorders in 21.9% (Table 2). Overall, the ten most common skin conditions were tinea pedis (37.9%); onychomycosis (32.0%); scars (13.8%); acne (11.9%); melasma (9.3%); post–inflammatory changes (8.5%); contact dermatitis (8.2%); acanthosis nigricans (6.6%); callus (5.4%), and folliculitis (4.1%).

Bivariate analyses found tinea pedis was not associated with poultry work (Table 3). It was associated with being male, having lower levels of education, and speaking an indigenous language. Onychomycosis was associated with poultry processing work (62.4% vs. 37.6%). It was also associated with older age, being male, and speaking an indigenous language. Acne was not associated with poultry processing work, but was associated with younger age, higher education, and speaking a non-indigenous language. Melasma was associated with poultry processing (72.9% vs. 27.1%). It was also associated with being female.

In multivariate logistic regression analyses, the overall results were unchanged from the bivariate analyses except that education was no longer a significant predictor of any skin condition (Table 4). For tinea pedis, males had an almost 3 times higher odds than females (OR = 2.96; 95% CI 2.0, 4.4), and indigenous language speakers had almost twice the odds of non-indigenous speakers (OR = 1.86; 95% CI 1.1, 3.0, p=0.0124). The odds of onychmycosis were slightly higher for poultry processing workers (OR=1.52; 95%CI 1.1, 2.3), males (OR=1.76; 95%CI 1.2, 2.6), and moderately higher for indigenous language speakers (OR=2.82; 95% CI 1.7, 4.6), but lower for workers aged 18-24 (OR=0.35; 95% CI 0.2, 0.7). For acne, participants between the ages of 17 and 24 were almost 13 times more likely to have acne (OR 12.95; 95%CI 4.1, 40.9), while those who spoke an indigenous language were less likely to have acne (OR=0.26; 95% CI 0.1, 0.7). The predicted odds of having melasma for poultry workers was twice as high for non-poultry workers (OR 2.03; 95% CI 1.0, 4.0) and was less likely to occur among males (OR=0.43; 95%CI 0.2, 0.8).

DISCUSSION

Skin disease is common among all Latino immigrant workers in western North Carolina. Most of the workers examined had infectious diseases, inflammatory diseases, or pigmentary disorders. Tinea pedis, onychomycosis, acne, and melasma were the most commonly diagnosed conditions. Of these, onychomycosis and melasma were 1.5 and 2.0 times higher, respectively, in poultry processing workers compared to other Latino manual workers.

The reason for excess onychomycosis in poultry workers is not clear. The higher frequency of fungal nail infection may be related to factors particular to poultry. Poultry workers are often exposed to work environments that can be cold or hot and humid and which require the use of occlusive footwear that may cause fungal nail infection. However, no relationship with type of work was found for tinea pedis. This may reflect overall poor and crowded living conditions in this economically disadvantaged population. We found that age is a protective factor against onychomycosis for those 17-24 years old compared with those 41 years and older. Age is a well-recognized risk factor for onychomycosis due to slower rates of nail growth, cumulative trauma and microtrauma to the nail, and greater likelihood of peripheral vascular disease in older adults.[18] Males' odds of having onychomycosis were 1.76 higher than that for females. Being a male has been associated with higher risk as a result of more trauma on the nail (e.g., from sports activities) and more common use of occlusive foot wear. The role of progesterone and related steroids as a protective factor has been proposed as well.[18,19]

The finding of increased risk of melasma in poultry workers is also unexplained. Melasma was more common among women as is described in the literature.[20-26] Unlike our previous study that used a small convenience sample of male poultry workers[27], melasma was not associated with indigenous language, a possible proxy for Native American ancestry. A previous study[27] has suggested that artificial sources of light used in factories may play a role in this hyperpigmentation. Because environmental factors are more homogeneous among poultry workers, their link to melasma should be further investigated. Our previous research shows that melasma, at least in men, is associated with decreased life quality.[27]

It is difficult to compare the overall levels of skin disease observed in this study with previous research among Latinos in the US due to differences in data sources and research designs. For example, Sanchez[24] reported the most commonly observed conditions among US Latino population were acne vulgaris (12.3%), eczema (20.1%), warts/condyloma (17.5%) and fungal infections (9.3%). However, these findings were obtained from a dermatologic clinic setting, while our results reflect population-based sampling.

We found a lower frequency of contact dermatitis than might be expected among manual workers. Because the physical examinations were all conducted on Sunday, some workers may not have been exposed to work conditions for over 24 hours. This may explain the relatively low level of contact and atopic dermatitis apparent in the study. Other possibilities include healthy worker effect, that is workers with severe involvement dropping out of these occupations.[28] Workers with less sensitivity may have developed resistance or other strategies for avoiding exposures or controlling their impact.

The most common dermatological conditions in our sample were tinea pedis (37.6%) and onychomycosis (31.8%). The prevalence of tinea pedis and onychomycosis has been assessed in the general population in different countries. However, the results vary depending on the population studied, size of the sample, type of clinical assessment (medical examination versus patients self diagnosed), and microbiological studies (identification of the responsible pathogen versus no microbiological examination).[29-32] Prevalence varies from 2.1 to 12% for onychomycosis and 3.8 to 61% for tinea pedis. Data reviewed and summarized for the professional dermatological association in the United States reports that onychomycosis affects 12% of US population.[33]

Skin disease is common in the general population as well as among Latino immigrant workers in North Carolina.[19,24] The conditions recorded in this cohort are similar to those of the general population, such as acne and tinea pedis. Melasma is also known to be prevalent among Latino populations.[24] Acne, as expected, was more common among the younger group of workers, but also less frequent among the indigenous population.

The results of this study should be interpreted in light of limitations. Diagnoses were based on physical examination alone. The diagnoses of fungal skin and nail infections were not confirmed with either potassium hydroxide-treated scrapings or fungal culture. This limitation was required as a trade off for the large sample size and difficulty recruiting this population. The physical examination focused on head, neck, arms, hands, and feet, without a total skin examination. The latter might have revealed additional skin conditions. However these are the areas most likely to exhibit effects of occupational exposures. Nevertheless, the study has several strengths. Data were gathered by direct physical examination supervised by a board-certified, Spanish-speaking dermatologist. This ensured appropriate diagnoses, as well as an ability to query study participants for additional information concerning their skin conditions. Although a sizable proportion of the sample reported speaking an indigenous language, all knew enough Spanish to be examined and interviewed using that language. The sample size is large, and participants were enrolled without regard to skin conditions. Data were obtained from a sample recruited using a strategy designed to enumerate and recruit a sample representative of a hard-to-reach population. Both these aspects of the sample make this study unique among occupational skin disease investigations, providing a future basis for studies that might incorporate greater use of laboratory testing.

The novel results of this study suggest that this understudied, difficult to reach population should be monitored for fungal skin and nail infections of the feet. These infections can predispose to more serious infections, particularly in individuals with diabetes, a condition that is common among the Latinos in the US.[34] Evaluation of the sanitary and living conditions of these economically disadvantaged populations may also be needed, as well as further research on possible educational and engineering measures to reduce the prevalence of these conditions. Findings from such research may indicate the need for intervention.

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Table 1. Description of the Sample N=518

Personal Characteristics		N	%
Type of work			
	Poultry processing worker	289	55.8
	Other manual worker	229	44.2
Age			
	18 to 24 years	85	16.4
	25 to 30 years	126	24.3
	31 to 40 years	172	33.2
	41 years and older	135	26.1
Sex			
	Female	235	45.4
	Male	283	54.6
Educational attainment			
	0 to 6 years	302	58.3
	7 to 9 years	121	23.4
	10 or more years	95	18.3
Language spoken			
	Non-indigenous language	404	78.8
	Indigenous language	109	21.2

Table 2. Most prevalent skin conditions in Latino immigrant workers, North Carolina. (N=518).

Skin Disease	N	%
Infections		
Any infections	271	52.62
Tinea pedis	195	37.86
Onychomycosis	165	32.04
Warts	17	3.30
Tinea (all other types)	8	1.55
Tinea versicolor	6	1.17
Inflammatory diseases		
Any inflammatory disease	146	28.35
Acne	61	11.87
Contact dermatitis	42	8.16
Folliculitis	21	4.08
Atopic dermatitis	20	3.88
Seborrheic dermatitis	8	1.55
Stasis dermatitis	7	1.36
Pigmentary disorders		
Any pigmentary disorder	113	21.94
Melasma	48	9.32
Post inflammatory changes	44	8.54
Acanthosis nigricans	34	6.60
Trauma		
Any trauma	95	18.45
Scars	71	13.79
Traumatic skin lesion	15	2.91
Traumatic nail lesion	13	2.52
Others		
Callus	28	5.44

Table 3. Bivariate association between skin conditions and personal characteristics N=518

Characteristic	Total Sample	Tinea Pedis		Onychomycosis		Acne		Melasma	
	N (%)	N (%)	p-value*	N (%)	p-value*	N (%)	p-value*	N (%)	p-value*
Type of work			.389		.031		.103		.011
Poultry processing	289 (55.8)	113 (57.9)		103 (62.4)		28 (45.9)		35 (72.9)	
Other manual	229 (44.2)	82 (42.0)		62 (37.6)		33 (54.1)		13 (27.1)	
Age			.234		.039		<.001		.135
18-24 years	85 (16.4)	24 (12.3)		16 (9.7)		22 (36.1)		5 (10.4)	
25-30 years	126 (24.3)	52 (26.7)		45 (27.3)		19 (31.2)		11 (22.9)	
31-40 years	172 (33.2)	67 (34.4)		59 (35.8)		16 (26.2)		13 (27.1)	
41+ years	135 (26.1)	52 (26.7)		45 (27.3)		4 (6.6)		19 (39.6)	
Sex			<.001		<.001		.082		.005
Male	283 (54.6)	139 (71.3)		108 (65.5)		27 (44.3)		17 (35.4)	
Female	235 (45.4)	56 (28.7)		57 (34.5)		34 (55.7)		31 (64.6)	
Education			.010		.244		<.001		.403
0-6 years	302 (58.3)	127 (65.1)		103 (62.4)		22 (36.1)		32 (66.7)	
7-9 years	121 (23.4)	44 (22.6)		38 (23.0)		17 (27.9)		8 (16.7)	
10+ years	95 (18.3)	24 (12.3)		24 (14.6)		22 (36.1)		8 (16.7)	
Language			<.001		<.001		.009		.721
Indigenous	109 (21.2)	57 (29.4)		53 (32.5)		5 (8.3)		9 (19.1)	
Non-indigenous	404 (78.8)	137 (70.6)		110 (67.5)		55 (91.7)		38 (80.9)	

* p-values from Fisher's Exact test are reported when cell frequency < 6.

Table 4. Multivariate logistic regression analysis for selected conditions

	Tinea pedis		Onychomycosis		Acne		Melasma	
Characteristic	OR** (95% CI)	p-value	OR** (95% CI)	p-value	OR** (95% CI)	p-value	OR** (95% CI)	p-value
Type of work								
Poultry processing	1.14 (0.8, 1.7)	0.5170	1.52 (1.1, 2.3)	0.0407	0.97 (0.5, 1.7)	0.9157	2.03 (1.0, 4.0)	0.0420
Other manual worker*								
Age		3 df p=0.1550		3 df p=0.0146		3 df p=<.0001		3 df p=0.3532
18-24 years	0.54 (0.3, 1.03)	0.0231	0.35 (0.2, 0.7)	0.0013	12.95 (4.1, 40.9)	<.0001	0.44 (0.1, 1.3)	0.3341
25-30 years	1.06 (0.6, 1.8)	0.2603	0.91 (0.5, 1.6)	0.9657	6.60 (2.1, 20.6)	0.0487	0.62 (0.3, 1.5)	0.9830
31-40 years	1.01 (0.6, 1.7)	0.3467	1.00 (0.6, 1.7)	0.0757	3.01 (1.0, 9.4)	0.2739	0.57 (0.3, 1.2)	0.7300
41+ years*								
Sex								
Male	2.96 (2.0, 4.4)	<.0001	1.76 (1.2, 2.6)	0.0059	0.67 (0.4, 1.2)	0.1785	0.43 (0.2, 0.8)	0.0100
Female*								
Education		2 df p=0.2049		2 df p=0.9416		2 df p=0.0517		2 df p=0.7355
0-6 years*								
7-9 years	0.78 (0.5, 1.3)	0.9652	1.09 (0.7, 1.8)	0.7460	1.69 (0.8, 3.5)	0.7899	0.72 (0.3, 1.7)	0.5849
10+ years	0.62 (0.4, 1.1)	0.2003	1.01 (0.6, 1.8)	0.9023	2.38 (1.2, 4.8)	0.0645	0.84 (0.4, 2.0)	0.9720
Language spoken								
Indigenous	1.86 (1.1, 3.0)	0.0124	2.82 (1.7, 4.6)	<.0001	0.26 (0.1, 0.7)	0.0084	1.04 (0.4, 2.4)	0.9252
Non-indigenous*								

* Reference category

** Odds ratio adjusted for all other predictors

1-8. **Comorbidity of Tinea Pedis and Onychomycosis and Evaluation of Risk Factors in Latino Immigrant Poultry Processing and Other Manual Laborers**

ABSTRACT

Objectives: Latino immigrant workers experience elevated rates of skin disease that result from both their working and living conditions. Work in manual occupations exposes workers to a variety of challenges, including occlusive shoes, vigorous physical activity, and wet conditions. These challenges predispose workers to fungal infection. The objectives of this manuscript are to 1) examine the comorbidity of tinea pedis and onychomycosis, and to 2) identify possible risk factors among Latino immigrant poultry and non-poultry workers in western North Carolina.

Methods: Data were obtained from a cross-sectional study conducted in rural western North Carolina among 518 manual Latino immigrant workers to assess occupational injuries.

Participants completed a face-to-face interview, as well as a dermatological examination.

Results: Nearly a third of the participants (32%) were diagnosed with onychomycosis. Over a third of the participants were diagnosed with tinea pedis (37.8%). Men showed a greater prevalence of tinea pedis than women (71.3% vs. 28.7%). Evaluating the comorbidity of tinea pedis and onychomycosis, of the 518 participants, 121 (23.5%) had both conditions. Men and those who reported use of occlusive shoes as "always/most of the time" had a higher prevalence of comorbid onychomycosis and tinea pedis.

Conclusions: Comorbidity of tinea pedis and onychomycosis is common in Latino immigrant manual workers. Further studies confirming the presence and type of dermatophyte should be conducted.

INTRODUCTION

Dermatophytoses are some of the most common infectious diseases in the world [(1)]. It has been estimated that 20-25% of the world population is infected with dermatophytes, and the incidence continues to increase [(2)]. The distribution of dermatophytes varies greatly around the world. The epidemiology of dermatophyte infection is affected by migration patterns, increase in tourism, and changes in socioeconomic conditions. In Africa and several countries in Latin America and the Middle East, there are geographical/regional associations in the pattern of dermatophytic infections [(3)]. Changes in the dermatophyte spectrum have also been noticed in the United States during the past decades. A detailed survey on the causative agents of fungal infections in the United States from 1999 to 2002 found that dermatophytes were the most common fungal pathogens [(4)]. *Trichophyton rubrum* was the most prevalent pathogen, and an increased incidence of this dermatophyte was observed in finger and toe onychomycosis, tinea corporis, tinea cruris, and tinea manuum or tinea pedis. A similar distribution was reported from Mexico [(5)].

Human mobility has been associated with the spread of infection. Mobility of nonimmigrant visitors and temporary residents to the United States is increasing, from approximately 12 million in 1987 to 37 million in 2007 [(6)]. Such mobility has contributed to Latino populations becoming the largest minority in the United States. The southeastern states, in particular. have experienced a recent significant increase in Latino population [(7)]. Latinos in the Southeast are concentrated in communities where work is available in manual occupations such as poultry processing, construction, farmwork, and service industry jobs [(8)].

Poultry processing workers experience the sixth highest incidence rate of nonfatal occupational illness of any industry [(9).] This industry is concentrated in southern states with Georgia, Arkansas, Alabama, North Carolina, Mississippi, and Texas producing two thirds of US broiler poundage [(10)]. Latino immigrant workers experience high rates of skin disease that result from their working and living conditions [(11)].The poultry-processing environment exposes workers to a variety of challenges that may predispose workers to fungal infections, including occlusive shoes, vigorous physical activity, and wet conditions [(12).] Quandt et al. reported fungal

infections were among the most common self-reported conditions among poultry processing workers, with 68% reporting foot fungus and 28% reporting nail fungus [13]. Even though the literature shows high prevalences of these skin conditions, little research including dermatological examination has been conducted to assess possible risk factors among this underserved, hard-to-reach population.

In a prospective study of 2,761 patients with toenail onychomycosis, evaluating the prevalence and factors influencing the presence of comorbid dermatomycoses, tinea pedis was the most common fungal infection, found in 933 patients (33.8%). [14] Another cross-sectional study compared athletes and non-athletes from a northern region of Rio Grande do Sul (Brasil). After a clinical examination, samples were taken from individuals presenting signs of onychomycosis and/or tinea pedis for direct microscopic examination and culture. Among the athletes and non-athletes, the comorbidity of tinea and onychomycosis was 4% and 3%, respectively [15]. The objectives of this manuscript are to extend research on the comorbidity of tinea pedis and onychomycosis by examining a large general worker population sample. We 1) examine the comorbidity of tinea pedis and onychomycosis, and 2) identify possible related risk factors among Latino immigrant poultry and non-poultry workers in western North Carolina.

METHODS

Sample and Data Collection

Data came from a cross-sectional study conducted among 518 manual Latino immigrant workers to assess occupational injuries. The study took place in rural western North Carolina; among Latino immigrant manual workers which belonged to an isolated hard to reach population of which no census existed. Community-based sampling was used to recruit the sample [16]; trusted members of the community helped the study team identify and recruit workers. To be eligible for the study, participants had to self-identify as Hispanic or Latino, work more than 35 hours per week, be a manual worker, and be 18 years of age or older. Manual occupations were defined as any non-managerial jobs such as work in production (i.e., poultry processing), babysitting, lawn care, farmwork, and construction. Further details of the recruitment methods are described elsewhere [17]. Participants provided informed consent, and all procedures were approved by the (Name of Institution) School of Medicine Institutional Review Board.

Once participants were recruited, a face-to-face interview and a physical examination were conducted to assess skin illnesses, demographics, work environment, and possible exposures of these workers. The interview was conducted approximately one month prior to the physical examination. A sample frame of dwellings where Latinos lived in the study area was developed. A total of 1,526 residents were screened. Of the 957 eligible residents, 742 (77.5%) were interviewed and 518 (69.8%) of those interviewed attended a clinic where the physical examination took place. Only those who attended the clinic are included in these analyses.

Measures

Physical Exam

Participants were examined by two board-certified dermatologists. The skin examination focused on areas most often subject to occupational exposures (face, neck, arms, hands, and feet). The presence or absence of disease was recorded, Further details are described elsewhere [18].

Covariates

Age, education, and household occupancy were collected as continuous variables and each was classified into ordered categories. Diabetes status was assessed at the time of the physical examination with the question, “Has a doctor ever diagnosed you with diabetes?” The answers were coded 0 for no and 1 for yes. Exposure to wet surfaces was assessed by asking participants, “How many hours per week do you do wet work?” Answers

were coded in categories: 0 hrs = 0, < ½ hr. = 1, ½ to 2 hrs. = 2, > 2 hrs. = 3. To assess the use of occlusive shoes, participants were asked, “How often do you use non-slip, steel-toed, or closed top footwear?” Their response choices included none of the time, some of the time, most of the time, and all of the time. For this manuscript, use of occlusive shoes was dichotomized into “all of the time/most of the time” and “some of the time/none of the time”.

Analysis

The objectives of the statistical analyses were to: 1) estimate the prevalence of onychomycosis, tinea pedis and the comorbidity of the two skin conditions among Latino manual laborers; and 2) test for associations between demographic/cultural characteristics and the three skin conditions. Descriptive statistics were calculated as frequencies and percentages of discrete measures. Bivariate associations between dichotomized outcomes and risk factors were examined using Chi-Square tests of association and Fisher’s exact tests. Multivariate logistic regression modeling adjusting for clustering by dwelling and site strata was used to assess the relationship between outcomes and sample characteristics. Predictors that reached a level of significance (p-value < 0.05) in the bivariate analysis were used in the multivariate modeling for the onychomycosis and tinea pedis only outcomes. All predictors used in either the onychomycosis or tinea pedis models were used in the modeling of participants with both skin conditions. In the interest of study design, poultry work (yes/no) was included in all models. Adjusted odds ratios, 95% confidence intervals and p-values were estimated. Significance was accepted at $p<0.05$ and all analyses were performed using SAS version 9.3 (Cary, NC).

RESULTS

Among those examined by the dermatologist, three-fourths were younger than 40 years (74%) (Table 1). By design, about half were poultry workers (55.8%) and half male (54.6%). A little more than 80% of the workers had 9 years of education or less. Poultry workers had fewer years of formal education and were older compared to non-poultry workers.

Nearly a third of the participants (32%) had signs of onychomycosis (Table 2). The majority of those were poultry workers (63%). Onychomycosis was more prevalent among men, workers between 31-40 years, and those who reported using occlusive shoes “all of the time/most of the time”. Over a third of the participants (37.8%) were diagnosed with tinea pedis. Men showed a greater prevalence of tinea pedis. Tinea pedis was more prevalent among those with 6 years of education or less.

Evaluating the comorbidity with tinea pedis and onychomycosis, 121 (23.5%) had both tinea pedis and onychomycosis (Table 2). Of the 195 patients who had tinea pedis, 62.05% also had onychomycosis. Of the 165 patients who had onychomycosis, 73.3% had tinea pedis (Table 2). Men and those who reported use of occlusive shoes as “always/most of the time” had higher prevalence diagnoses with both onychomycosis and tinea pedis.

In multivariate analyses (Table 3), the effect of gender remained strongly associated with having onychomycosis, tinea pedis, or both. Men had a 73% increased odds of having onychomycosis (Adjusted odds ratio (AOR) 1.73; CI 1.13, 2.66), an almost 3 times greater odds of having tinea pedis (AOR 2.9; CI 1.91, 4.40), and greater than twice the odds of having both diagnoses (AOR 2.25; CI 1.38, 3.69). Age and the use of occlusive shoes were significantly associated with onychomycosis. Young age (17-24 years of age) was protective with a lesser odds of having onychomycosis (AOR 0.46; CI 0.22, 0.94) than workers 41 years and older. Age was not predictive of having tinea pedis or having both skin disorders. Workers who wore occlusive shoes had an 82% increased odds of having onychomycosis (AOR 1.82; CI 1.16, 2.87), as compared to workers who used occlusive shoes only some or none of the time. Even though educational attainment was not associated with having onychomycosis or tinea pedis, there were marginal effects for individuals having both conditions. Those with 7 or more years of education had lower odds of having both disorders simultaneously (AOR 0.61; CI 0.35, 1.05 and AOR 0.54; CI 0.27, 1.09 respectively), compared with

workers having 0-6 years of formal education. Workers who used occlusive shoes all of the time or most of the time had an 80% increased odds of having both skin conditions (AOR 1.8; CI 1.09, 2.97), compared to workers who wore occlusive shoes some or none of the time. Being involved with poultry work versus other manual labor was not a significant predictor of either condition individually or having both conditions.

DISCUSSION

The literature related to prevalence of skin illnesses and their possible risk factors among manual workers is limited. This study sought to assess the prevalence and possible risk factors for the comorbidity of onychomycosis and tinea pedis among manual Latino workers.

Our findings are supported by the existing literature on comorbid tinea pedis and onychomycosis [19]. Among the contributing factors causing these diseases are humidity and occlusive footwear, and the comorbid conditions are more common among men [6]. In some occupations, workers are at a higher risk of developing fungal infections [20]. Athletics, farmwork, and forestry are among those occupations where fungal infections are prevalent [15,20, 21]. Farmers are at higher risk of developing fungal infections, both due to contact with many potential sources of fungal infection and to conditions in the workplace (wet work, rubber boots) that promote infection with dermatophytes [22]. In our study, bivariate analysis does show that onychomycosis is more prevalent among poultry workers compared to other manual laborers; however, in the multivariate analysis the association disappears; this might be because the sample was made up of manual workers who, like those in poultry are exposed to strenuous environments that put them at higher risk to develop a fungal illness.

Although unrelated work-wise and geographically, risk factors for the occurrence of tinea pedis and onychomycosis have been studied in a Muslim population who perform their prayers in the mosques in the city center of Adana Province, Turkey; these findings were similar to our findings in manual Latino workers. Of the 461 subjects studied, 30% had tinea pedis, 5% had tinea unguium, and 5% had both infections simultaneously. The prevalence of the foot dermatomycoses was high among those who practiced ablution 3-5 times a day and did not dry their feet immediately, and who used rubber shoes [23]. The latter, like our study, shows that the use of occlusive shoes is associated with higher risk of developing fungal infections such as tinea pedis and onychomycosis. The majority of workers in our sample worked in industries such as production and agriculture, where workers are required to use occlusive shoes.

The reason the comorbidity of onychomycosis and tinea pedis is more prevalent among men is unknown; however, it is believed that it could be because men are more likely to have nail trauma and wear occlusive shoes more often than women, who are more likely to wear sandals or other open-toe footwear when not at work [24]. This cultural practice may explain why men present with a 73% increased odds of having onychomycosis, an almost 3 times greater odds of having tinea pedis, and greater than twice the odds of having both diagnoses.

Among the limitations of our study was the absence of confirmation of the dermatophytes either on potassium hydroxide (KOH) examination or culture. However, a study by Amichai et al showed that a trained dermatologist can correctly diagnose onychomycosis by clinical examination [26]. Lack of access to the workplace of these workers was another limiting factor, as it prevented direct assessment of variables related to work exposure. Nonetheless, to our knowledge, this is the only study that has been able to assess comorbid onychomycosis and tinea pedis among an underserved, hard to reach working population. As such, it adds to the literature on skin disease in underserved populations.

In conclusion, the results of this clinical-epidemiologic study in Latino immigrant workers showed that the comorbidity of these dermatophyte infections is common in this population; and that its prevalence is significantly higher than that of the overall population. Further studies confirming the presence and type of dermatophyte by examination with KOH, a test which is done to rapidly diagnose fungal infections of the hair, skin or nails, or culture should be conducted. Further research is needed to identify specific variables in the

workplace that might be increasing the risks of infection with tinea pedis and onychomycosis and therefore help prevent the development of these fungal infections among manual workers.

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Table 1. Descriptive Characteristics of Study Sample (N=518)

Characteristic	**Overall** N=518 N (col %)	**Poultry Workers** N=289 (55.8%) N (col %)	**Non-poultry Workers** N=229 (44.2%) N (col %)
Age			
17-24 yrs	85 (16.4)	42 (14.5)	43 (18.8)
25-30 yrs	126 (24.3)	64 (22.2)	62 (27.1)
31-40 yrs	172 (33.2)	90 (31.1)	82 (35.8)
> 40 yrs	135 (26.1)	93 (32.2)	42 (18.3)
Gender			
Male	283 (54.6)	160 (55.4)	123 (53.7)
Female	235 (45.4)	129 (44.6)	106 (46.3)
Education Level			
0 - 6 yrs	302 (58.3)	183 (63.3)	119 (52.0)
7 - 9 yrs	121 (23.4)	60 (20.8)	61 (26.6)
10+ yrs	95 (18.3)	46 (15.9)	49 (21.4)

Table 2. Prevalence and Bivariate Associations of Onychomycosis and Tinea Pedis with Sample Characteristics

	Onychomycosis N (col %)			Tinea Pedis N (col %)			Both Onychomycosis & Tinea Pedis N (col %)		
Characteristic	**Diseased**	**Non-diseased**	**p-value**	**Diseased**	**Non-diseased**	**p-value**	**Diseased**	**Non-diseased**	**p-value**
Overall	165 (32.0)	350 (68.0)		195 (37.9)	320 (62.1)		121 (23.5)	394 (76.5)	
Poultry Work Status			**0.0220**			0.3296			0.3391
Poultry	104 (63.0)	183 (52.3)		114 (58.5)	173 (54.1)		215 (54.6)	72 (59.5)	
Non-poultry	61 (37.0)	167 (47.7)		81 (41.5)	147 (45.9)		179 (45.4)	49 (40.5)	
Age			**0.0395**			0.2340			0.1081
17-24 yrs	16 (9.7)	69 (19.7)		24 (12.3)	61 (19.1)		12 (9.9)	73 (18.5)	
25-30 yrs	45 (27.3)	80 (22.9)		52 (26.7)	73 (22.8)		32 (26.5)	93 (23.6)	
31-40 yrs	59 (35.8)	112 (32.0)		67 (34.4)	104 (32.5)		47 (38.8)	124 (31.5)	
>40 yrs	45 (27.3)	89 (25.4)		52 (26.7)	82 (25.6)		30 (24.8)	104 (26.4)	
Gender			**0.0007**			**<.0001**			**<.0001**
Male	108 (65.5)	173 (49.4)		139 (71.3)	142 (44.4)		86 (71.1)	195 (49.5)	
Female	57 (34.5)	177 (50.6)		56 (28.7)	178 (55.6)		35 (28.9)	199 (50.5)	
Education Level			0.2438			**0.0099**			**0.0086**
0 - 6 yrs	103 (62.4)	196 (56.0)		127 (65.1)	172 (53.7)		84 (69.4)	215 (54.6)	
7 - 9 yrs	38 (23.0)	83 (23.7)		44 (22.6)	77 (24.1)		24 (19.8)	97 (24.6)	
10+ yrs	24 (14.6)	71 (20.3)		24 (12.3)	71 (22.2)		13 (10.7)	82 (20.8)	
People in Household †			0.8425			0.8681			0.7700
1 - 2	15 (9.1)	28 (8.0)		17 (8.7)	26 (8.1)		12 (9.9)	31 (7.9)	
3 - 5	102 (61.8)	225 (64.3)		121 (62.1)	206 (64.4)		75 (62.0)	252 (64.0)	
> 5	48 (29.1)	97 (27.7)		57 (29.2)	88 (27.5)		34 (28.1)	111 (28.2)	
Diabetes Diagnosis			0.6719			0.9247			0.7324
Yes	15 (9.1)	36 (10.3)		19 (9.7)	32 (10.0)		11 (9.1)	40 (10.2)	
No	150 (90.9)	314 (89.7)		176 (90.3)	288 (90.0)		110 (90.9)	354 (89.8)	
Work Wet Surfaces			0.2405			0.8849			0.8837
None	59 (35.8)	143 (40.9)		75 (38.5)	127 (39.7)		48 (39.7)	154 (39.1)	
Less than 2 hrs/day	14 (8.5)	39 (11.1)		19 (9.7)	34 (10.6)		11 (9.1)	42 (10.7)	
More than 2 hrs/day	92 (55.8)	168 (48.0)		101 (51.8)	159 (49.7)		62 (51.2)	198 (50.2)	
Use Occlusive Shoes			**0.0006**			0.0934			**0.0034**
All /Most of the time	110 (71.9)	173 (55.4)		120 (65.6)	163 (57.8)		82 (72.6)	201 (57.1)	
Some/None of the time	43 (28.1)	139 (44.6)		63 (34.4)	119 (42.2)		31 (27.4)	151 (42.9)	

* P-value from Chi Square Test of Association or Fisher's Exact Test

Table 3. Multivariate Logistic Regression Models of Demographic and Work-related Predictors of Onychomycosis and Tinea Pedis (N=515)

	Onychomycosis (N=165; 32%)			**Tinea Pedis** (N=195; 38%)			**Both Onychomycosis and Tinea Pedis** (N=121; 23.5%)		
Characteristic	**AOR***	**95% CI**	**p-value**	**AOR***	**95% CI**	**p-value**	**AOR***	**95% CI**	**p-value**
Poultry Work Status									
Poultry	1.34	(0.86,2.09)	0.1967	1.08	(0.71,1.64)	0.7197	0.98	(0.61,1.59)	0.9371
Non-poultry†	--						--		
Age									
17-24 yrs	**0.46**	**(0.22,0.94)**	**0.0323**				0.53	(0.24,1.21)	0.1331
25-30 yrs	1.35	(0.77,2.36)	0.2949				1.44	(0.77,2.67)	0.2530
31-40 yrs	1.15	(0.68,1.93)	0.6109				1.46	(0.82,2.60)	0.1961
>41 yrs †	--						--		
Gender									
Male	**1.73**	**(1.13,2.66)**	**0.0121**	**2.90**	**(1.91,4.40)**	**<.0001**	**2.25**	**(1.38,3.69)**	**0.0013**
Female	--			--			--		
Education Level									
0 - 6 yrs†				--			--		
7 - 9 yrs				0.73	(0.46,1.16)	0.1848	0.61	(0.35,1.05)	0.0732
10+ yrs				0.63	(0.36,1.11)	0.1087	0.54	(0.27,1.09)	0.0850
Use Occlusive Shoes									
All /Most of the time	**1.82**	**(1.16,2.87)**	**0.0099**	1.10	(0.72,1.68)	0.6668	**1.80**	**(1.09,2.97)**	**0.0218**
Some/None of the time†	--			--			--		

* Adjusted Odds Ratio

† Reference Category

1-9. Pachydermodactyly from Repetitive Motion in Poultry Processing Workers: A Report of Two Cases

ABSTRACT

Background: Pachydermodactyly is a rare, benign, acquired form of digital fibromatosis. The etiology of pachydermodactyly is unknown, but is believed to be due to repeated mechanical injury of the skin. We report two cases of pachydermodactyly identified in poultry processing workers, and we review other conditions associated with these cutaneous findings.

Observations: The two workers in this report were employed as a chicken catcher and a chicken hanger. On examination, both workers had marked lateral thickening of the digits, with associated pain and pruritus. The workers' skin condition developed despite the use of protective gloves and their symptoms improved when removed from work. However, the swelling due to fibromatosis persisted.

Conclusions: Similar cutaneous findings have been reported in other occupations exposing individuals to repetitive skin trauma, and many patients demonstrating a compulsive habit of hand manipulation. This supports the conclusion that pachydermodactyly in these patients reflects repeated skin trauma. Repetitive mechanical injury in the poultry processing environment can result in considerable compensatory tissue changes. Preventive measures are needed to protect workers.

INTRODUCTION

Pachydermodactyly is a rare, benign, acquired form of digital fibromatosis. It is clinically characterized by an asymptomatic soft tissue swelling of the lateral aspects of the proximal interphalangeal joints of the fingers. The majority of reported cases involve young, otherwise healthy males, with a mean age of 21.2 years. [1-5] However, reported ages have ranged from 5 to 69 years.[1]

The pathogenesis of pachydermodactyly is unknown, but is believed to be due to repeated mechanical injury of the skin.[2,3] Poultry processing workers are exposed to repetitive minor trauma. In this manuscript, we report two men with marked changes of the fingers identified in a study of occupational skin diseases in poultry processing workers, and we review other occupations associated with pachydermodactyly. These cases were observed in a community-based survey of poultry processing workers. The data presented in this paper were collected from a physical examination and a questionnaire provided to the workers. Pichardo et al. describe in more detail the data collection process.[6] All the data collection and informed consent procedures were approved by Wake Forest School of Medicine Institutional Review Board.

The illness and injury rate in poultry processing is among the highest in food manufacturing.[7] To meet the demand the industry has been vertically integrated and mechanized.[8] The capacity to meet the demand for chicken is dependent on the ability to make the production lines as efficient as possible. The process starts in the chicken houses where 10,000- 25,000 chicks are raised for about 6-8 weeks until they are grown and ready to be taken to the processing plant.[9-11] To be transported to the processing plant, chicken catchers gather the chickens and put them into small cages. After arrival at the plant, the live chickens are dumped on a conveyor belt that takes them into a dark and humid room where workers hang them by their feet on shackles. Next, the birds are stunned and beheaded by a machine, and then taken to another machine that removes the feathers. Finally, the birds are eviscerated, deboned, and packed. Each stage of the process is completed at an average speed of one bird per worker every 2 seconds.[12] The average plant in the United States processes 250,000 chickens per day.[9] The magnitude at which production takes place exposes workers to different animal byproducts, extreme environments, repetitive movements, prolonged periods of standing, and employer pressure to perform the job at a fast pace.[13]

CASE 1

A 33-year old Hispanic employee of a poultry processing plant reported a history of chronic pain, pruritus, erythema, paresthesias, and urticaria of his hands. The pain was located diffusely in his hands and was worse when performing specific activities. On a scale of 1-5 with 5 being the most severe, the cumulative severity of his hand symptoms was subjectively noted to be a 4 at its worst. His symptoms had interfered with his normal social activities, and were noted to be a problem at work. He also reported bilateral wrist, elbow, and shoulder discomfort. On examination, the subject was observed to have marked lateral thickening of the digits (figure 1).

Occupationally, he has worked as a chicken catcher for a poultry processing plant 9 hours a day for the past 8 years. His job requires him to perform repetitive tasks with his hands and fingers. Protective gloves are worn at all times in attempt to minimize hand trauma. The worker also reports having washed his hands several times per day. His symptoms improve when he does not work for several days.

CASE 2

A 42-year old Hispanic employee of a poultry processing plant reported a history of pain and pruritus of his hands and similar trophic changes of the digits (figure 2). These symptoms were associated with mild paresthesias, weakness, and stiffness, and were worse with job related activities. On a scale of 1-5 with 5 being the most severe, the patient subjectively reported the severity of his cumulative symptoms to be a 3 at their worst. His symptoms limited his ability to do his job, and interfered with social and leisure activities. He also reported bilateral wrist, shoulder, and lower back pain.

Occupationally, this person has worked as a chicken hanger 8 hours a day for the past 3 years. His job requires him to perform repetitive tasks with his hands and spend all 8 hours per day working with chickens. Despite wearing protective gloves, contact with live chickens at work exacerbated his skin condition. The worker reportedly washed his hands several times per day. The worker noted improvement in his symptoms of pain, pruritus, and paresthesias when he was removed from work for several days.

DISCUSSION

Pachydermodactyly is a rare benign form of digital fibromatosis characterized by a painless symmetrical swelling of the tissues surrounding the proximal interphalangeal joints. The first reported case of pachydermodactyly was by Bazex in 1973, and the condition was later named by Verbov in 1975.[3,14] Pachydermodactyly mostly occurs in young people with a mean age of 21.2 years and a male/female ratio of 3:2.[1,3] Though, the male/female ratio has been reported as high as 5:1. [2,15] The male predominance may reflect the gender distribution of the causative occupations and medical conditions associated with tics. However, some authors believe the female prevalence may be underestimated.[16,17] The affected individuals are usually otherwise healthy, although pachydermodactyly has been associated with Dupuytren's contracture, Asperger syndrome, carpal tunnel syndrome, and tuberous sclerosis.[16,18-20]

Histologically, pachydermodactyly is characterized by ortho- or parakeratotic hyperkeratosis, acanthosis, and thickening of the dermis due to an increased amount of fibroblasts and collagen types III and V.[17] Electron microscopy has found the collagen to be of a finer-diameter in comparison to its appearance in normal tissues. There is usually minimal or no inflammation.

The etiology of pachydermodactyly is unknown. However, several authors believe the cause to be repetitive exogenous minor traumas.[1-5] Occupations that involve repetitive mechanical injury, such as chicken catchers and chicken hangers, therefore may predispose to this condition. As pachydermodactyly is characteristically asymptomatic, the pain, pruritus, and paresthesias reported by these workers are likely the result of this repetitive trauma, and not directly from the pachydermodactyly itself.

Chicken catchers, the occupation of the worker in case 1, are responsible for grasping the legs of 5-7 live chickens in each hand, and subsequently loading them into metal crates for transportation to a processing center. This is accomplished by a team of 7-10 catchers, who first hoard the chickens into a small area of the

wet, dirt-floored chickenhouse. Afterwards, the catchers pick up as many chickens as possible by scooping their hands underneath the chickens, allowing for the chickens' legs to insert between their fingers (figure 3). The catchers then carry the chickens inverted to the transport cage, while the chickens peck and scratch their hands. A team catches a total of 30,000 – 60,000 chickens per day.[11] The job is fast paced, and the workers are paid per barn rather than per hour. Although the catcher in our report wore gloves, he still developed cutaneous lesions. Often catchers do not wear any hand protection, as they believe it makes catching the chickens more difficult, and thus more time-consuming. The difficulty of quickly carrying and loading multiple live chickens creates the opportunity for repetitive mechanical injury to the catchers' hands.

Chicken hangers, the occupation of the worker in case 2, are responsible for suspending live chickens on an overhead conveyor. This is accomplished by grabbing the birds by their feet, and sliding their legs into W-shaped metal shackles on an overhead moving conveyor belt (figure 4). The job is fast-paced, as hangers are expected to hang on average 1 chicken every 2 seconds[12] for 2 hours. After every 2 hour work shift, they receive a break. This work-break cycle is continued until the completion of their 8 hour work day. The chicken hanging task subjects workers' knuckles to repetitive contact with the metal shackles and trauma inflicted by the live birds. Despite the use of protective gloves by the worker, he still developed cutaneous lesions. However, as with chicken catchers, chicken hangers do not always wear finger protection, as it can interfere with their ability to perform the job.

A pseudo-knuckle pad is a term that has been used to describe a callosity that develops after repeated skin irritation.[21]In contrast, knuckle pads are not believed to be linked to trauma. The distinction between pseudo-knuckle pads and pachydermodactyly is the location of skin swelling; whereas pachydermodactyly involves predominantly the lateral proximal interphalangeal joint surface, pseudo-knuckle pads involve the dorsal surface. [22] Due to the similarity, pachydermodactyly has been hypothesized to be a variant of knuckle pads.[4] The precise pathogeneses of these cutaneous conditions remain largely unknown.

Richards et al. reported a 56% prevalence of painless knuckle pads, in live-chicken hangers in a poultry processing plant.[23] The most common locations were the proximal interphalangeal joints and metacarpophalangeal joints, with 96% being bilateral and 83% involving symmetric locations. Despite the use of protective cotton gloves, the authors attributed these cutaneous findings to repetitive trauma endured from contacting workers' fingers against the W-shaped metal shackles. Although the term knuckle pad was used to describe the lesions, they were attributed to trauma and thus in current terminology would be classified as pseudo-knuckle pads.

Pseudo-knuckle pads have also been reported in tailors, granite cutters, barbers, leather stackers, gardeners, and boxers.[24] These occupations represent additional lines of work that expose individuals to repetitive mechanical injury. Thus, pseudo-knuckle pads and pachydermodactyly may represent two cutaneous conditions with similar etiologies.

Pachydermodactyly has been reported in individuals demonstrating a compulsive habit of hand manipulation.[1,3,5,16,17,25,26] Pereira et al. reported an individual with pachydermodactyly who affirmed his lesions were the result repetitive hand in hand contact.[1] Finger interlacing, gripping, and rubbing represent habits that expose the index, middle, and ring fingers to exogenous friction. These motions are more prominent in people with obsessive-compulsive disorder, and thus those individuals may be at higher risk for pachydermodactyly. Calikoglu reported a case of an adolescent male who presented with diffuse cutaneous thickening and hyperpigmentation along the metacarpophalangeal joints.[25] These findings were attributed to repeated mechanical injury secondary to a tic-like habit of rubbing his hands together. In light of the apparent association of pachydermodactyly with ritualistic behaviors, physicians should consider these lesions as a possible sign of an underlying psychiatric condition.

In this report we presented two cases of pachydermodactyly in poultry processing plant employees. We believe the dramatic morphologic changes in the digits that we observed to be indicative of the degree of repetitive trauma inherent in poultry work and of the body's adaptive response to that trauma. If our hypothesis is true,

analysis of how different workers perform these tasks is warrant. If these workers are typical, possible preventive measures to decrease the incidence of this cutaneous condition include decreasing the amount of chickens handled per day, and modifying the surfaces that the employees' hands repetitively contact. Such modifications may include changing the shape of the W-shaped metal shackles, decreasing the speed of the conveyor belt, enlarging the chicken crate openings, or adding a soft protective liner to commonly contacted surfaces. These modifications may limit repetitive mechanical injury to the skin, and thus impede the development of pachydermodactyly. Because the demands of production in poultry processing likely limit the possibility of reducing line speeds or reducing chickens handled per day, job rotation could be considered as a way of limiting repetitive trauma. In conclusion, poultry processing represents one occupation that predisposes employees to pachydermodactyly.

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Figure 1. Chicken catcher, has worked in poultry processing for 8 yrs. Soft tissue swelling of the lateral aspects of the proximal interphalangeal joints of the middle and ring fingers.

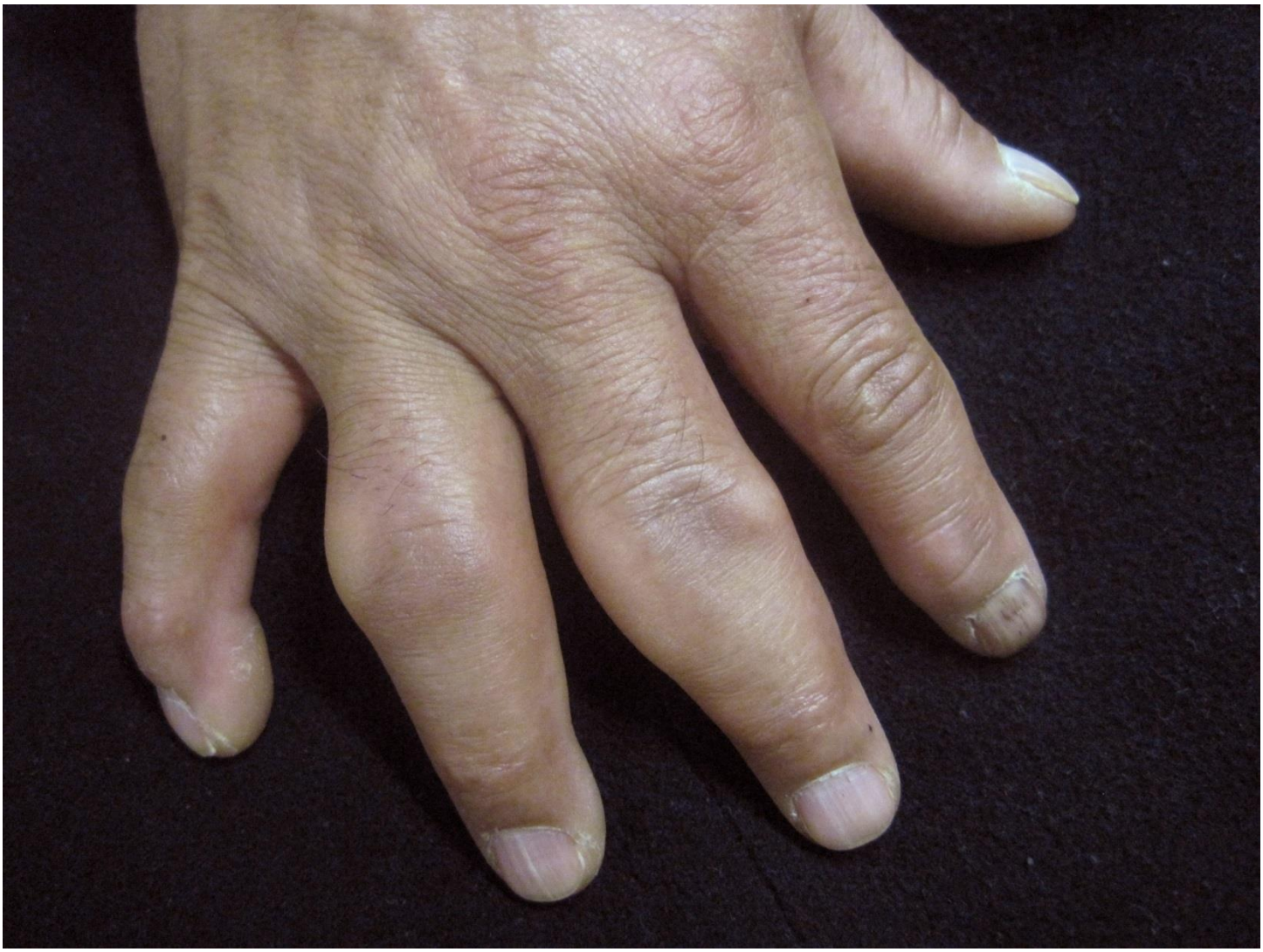


Figure 2. Chicken hanger, has worked in poultry processing for 3 yrs. Soft tissue swelling of the lateral aspects of the proximal interphalangeal joints of the middle and ring fingers.

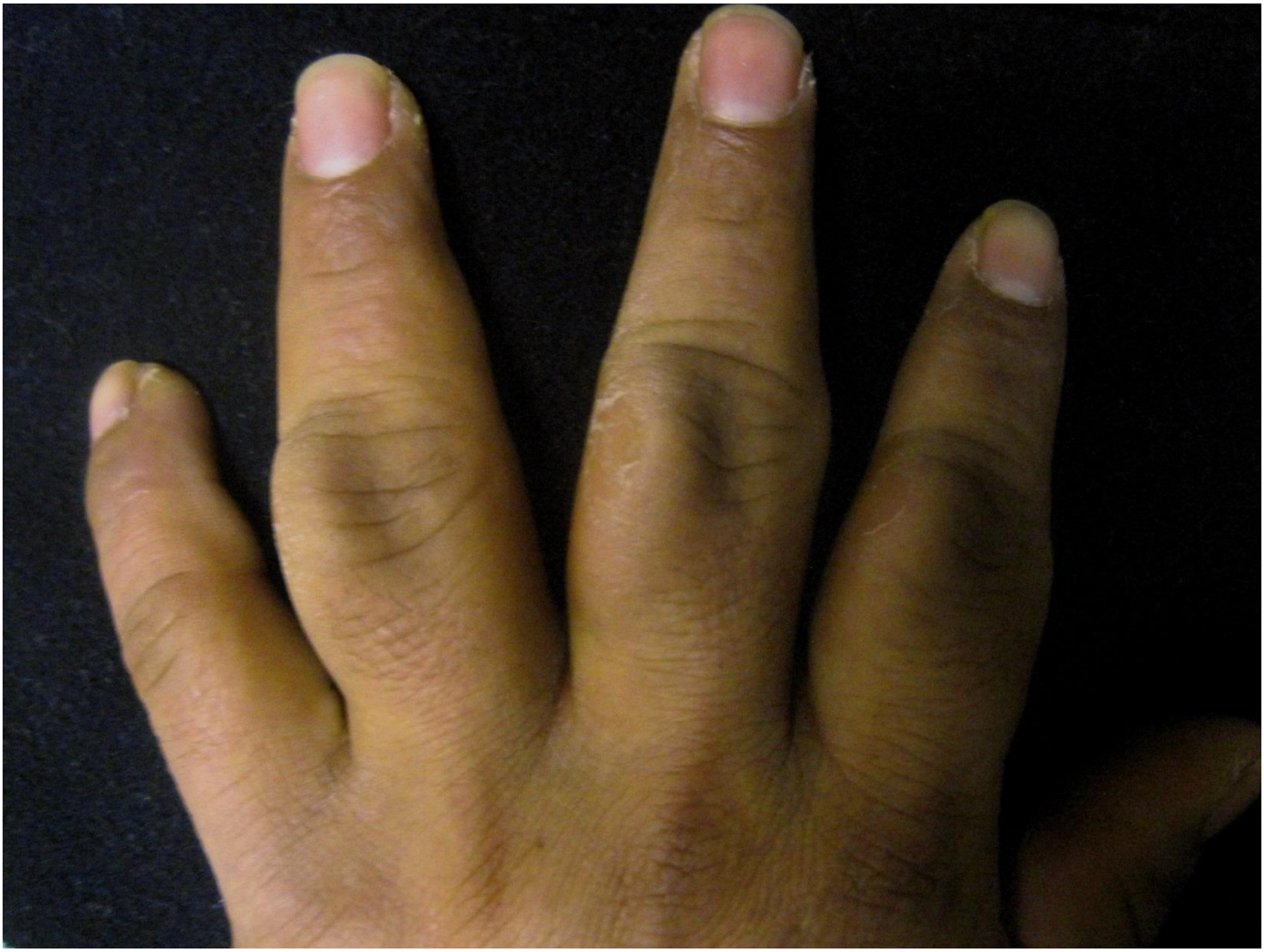


Figure 3. Illustration of interaction of chicken catcher hands with chickens.

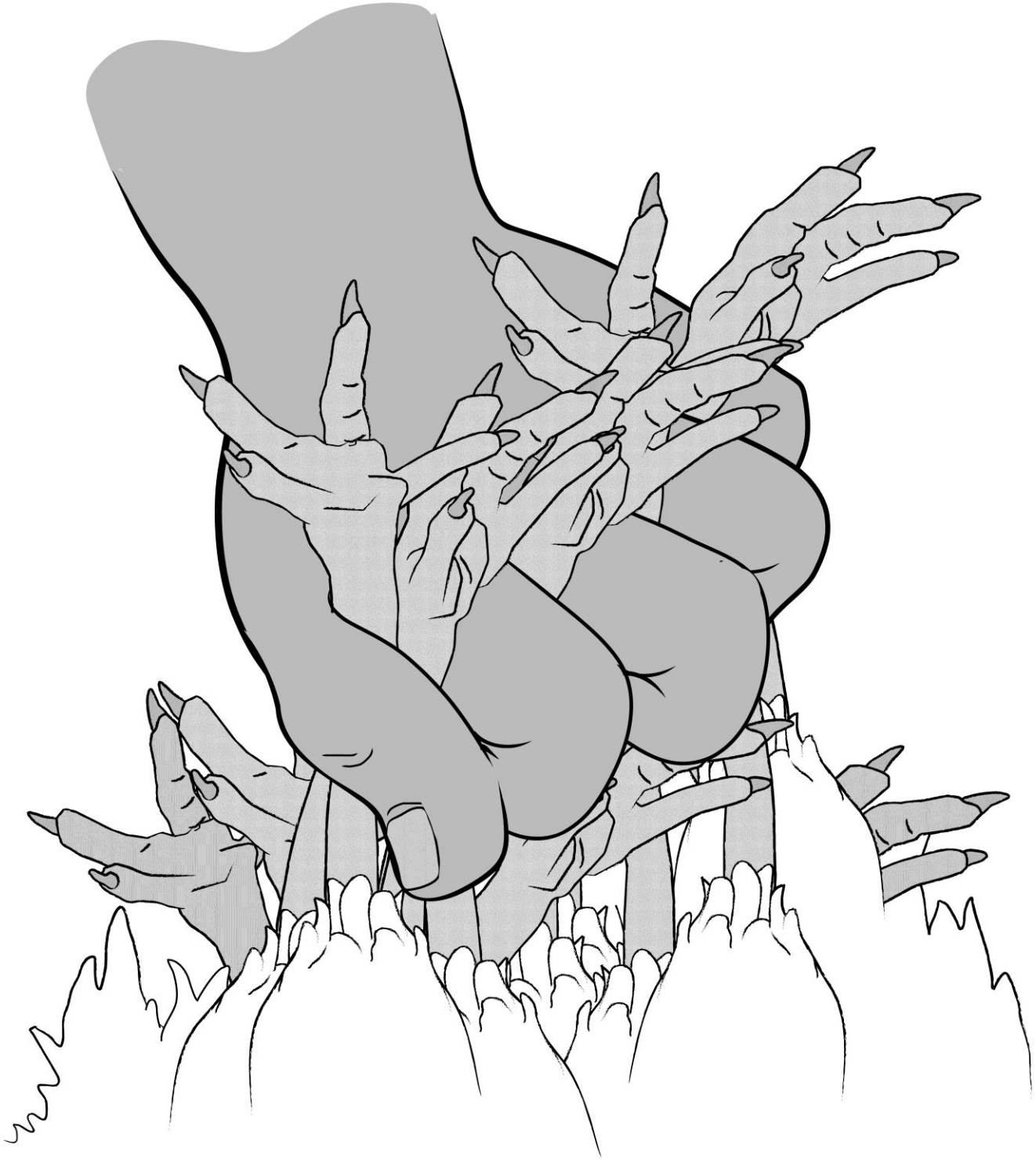
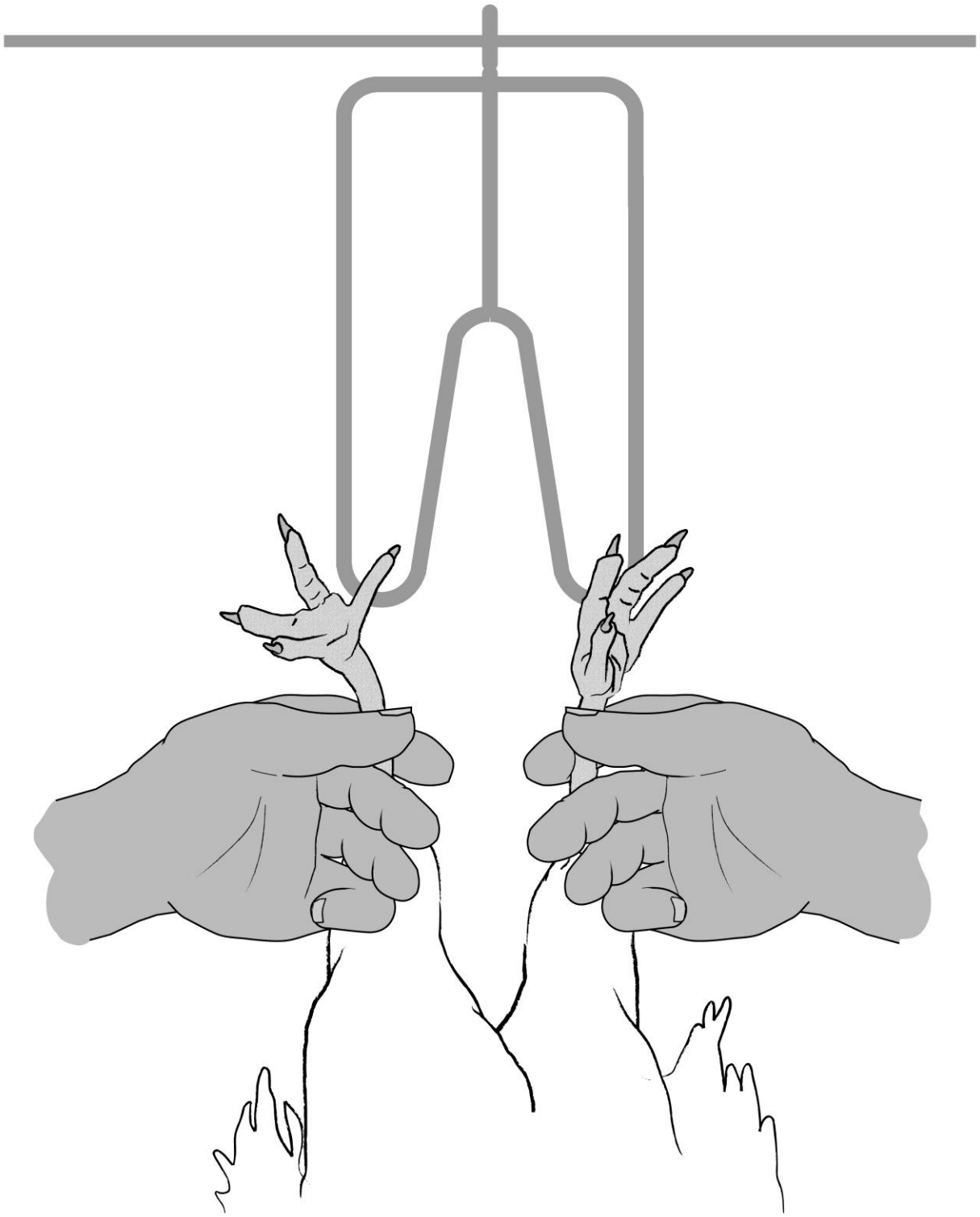


Figure 4. Illustration of interaction of chicken hanger hands with chicken and equipment.



1-10. Poultry Processing Work and Respiratory Health of Latino Men and Women in North Carolina

ABSTRACT

Objective: To evaluate associations between poultry processing work and respiratory health among working Latino men and women in North Carolina.

Methods: Between May 2009 and November 2010, 402 poultry processing workers and 339 workers in a comparison population completed interviewer-administered questionnaires. Of these participants, 279 poultry processing workers and 222 workers in the comparison population also completed spirometry testing to provide measurements of forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC).

Results: Nine percent of poultry processing workers and 10% of workers in the comparison population reported current asthma. Relative to the comparison population, adjusted mean FEV_1 and FVC were lower in the poultry processing population, particularly among men who reported sanitation job activities.

Conclusions: Despite the low prevalence of respiratory symptoms reported, poultry processing work may affect lung function.

Clinical Significance

Exposures associated with specific job activities may affect the lung function of men and women employed in poultry processing jobs. These findings justify efforts to evaluate and monitor the health of new employees and to reduce exposures to inhalation hazards in poultry processing.

INTRODUCTION

Exposure to organic and inorganic dusts and other allergens is a well-recognized cause of airway disease among men and women employed in the agricultural industry (1-4). In large-scale poultry production, workers inside poultry barns and processing plants encounter high levels of ammonia, bacteria, and dust on the job (5-8). Due to the high concentrations of the exposures and their irritant properties, bronchial hyperresponsiveness (9), coughing (9, 10), wheezing (10), nasal symptoms (11, 12), and changes in lung function (5, 8-10) have been investigated extensively among poultry barn workers.

In contrast, relatively few data are available to describe inhalation exposures and respiratory health symptoms among individuals employed in poultry processing plants (i.e., slaughterhouses, abattoirs), where live birds are received and then moved through the processing facility on a production line. Along the line, workers hang, kill, defeather, clean, eviscerate, and cut the poultry into parts that are then packaged, boxed, and shipped (13, 14). In addition to working on the line, employees clean machinery and floors; inspect and repair equipment; assemble boxes; and load, stack, and move pallets of packaged poultry. Throughout the facilities, workers may encounter cold temperatures and high humidity, and potential inhalation exposures include aerosolized chlorine compounds, cleaning agents, and machining and other fluids; airborne allergens, bacteria, dusts, endotoxin, and fungi; and carbon dioxide. The extent to which appropriate personal protective equipment or mechanical ventilation systems are used in the poultry processing industry is unknown, though outbreaks of psittacosis and pneumonia (15-17) and reports of eye and respiratory tract irritation (5, 13, 18) suggest that workers' airways may not be sufficiently protected.

Previous epidemiologic research conducted in North Carolina has reported depressive symptoms (19), dermatologic conditions (20), and musculoskeletal problems (18, 19, 21) in the largely minority and immigrant poultry processing workforce, indicating that workers may be vulnerable to a range of occupational hazards. Our analyses build on these findings and the strong evidence of an association between poultry barn work and respiratory health by assessing self-reported respiratory symptoms and measurements of lung function among

workers in the Latino poultry processing workforce in western North Carolina. We used these data to evaluate associations between poultry processing activities and respiratory health.

MATERIALS AND METHODS

Study Population

Between May 2009 and November 2010, we conducted a cross-sectional study among men and women living in communities surrounding three poultry processing plants in North Carolina. Potential participants were recruited in person by Spanish-speaking study personnel who visited homes selected randomly from a comprehensive listing developed by community-based and study personnel to identify housing units with Spanish-speaking residents. Recruitment began with an original goal of enrolling 552 participants (276 poultry processing workers and 276 workers in other manual jobs), with equal numbers of men and women in each group. Recruitment of more than one participant from each housing unit was allowed. In order to meet the enrollment target for subsequent follow-up of the cohort, recruitment continued beyond the original goal. In total, 1,681 housing units were visited and 1,526 adults in 965 housing units were screened for eligibility; 957 of the individuals screened were eligible for participation.

Potential participants were eligible for inclusion if they were adults who self-identified as Latino or Hispanic (hereafter referred to as 'Latino') and were employed and working in poultry processing or other manual labor jobs ≥35 hours per week at the time of recruitment. Poultry processing was defined as non-supervisory work in a poultry processing plant. The comparison population included individuals employed in a range of other jobs and recruited from the same communities. To be included in the comparison population, participants had to be employed for pay in manual jobs, excluding jobs in poultry processing or poultry production. Manual jobs included those in childcare, construction, hotels, landscaping, manufacturing, restaurants, and other service jobs. Quality control workers in poultry processing plants and chicken catchers were excluded from both groups.

After screening for eligibility, trained data collectors successfully enrolled 742 (78%) individuals who completed face-to-face, interviewer-administered questionnaires. We excluded 1 (<1%) participant with missing information for the covariates included in our analysis, resulting in a final study population of 741 participants for analysis of questionnaire-based respiratory symptoms. Of these participants, 518 completed spirometry testing, which was conducted at data collection clinics scheduled in each of the communities within one month of when participants in the community completed the questionnaires. We excluded 17 (3%) participants whose spirometry testing yielded unusable results and our final population for the analysis of spirometry data includes 501 participants. The study methods and materials were approved by the Wake Forest University Health Sciences Institutional Review Board and all participants provided written informed consent.

Occupational Exposures

In this analysis, the main exposure of interest was employment in poultry processing. In addition, each participant in the poultry processing population responded to survey questions designed to identify poultry-related activities that were part of his/her job. The list of activities included receiving, hanging, killing, plucking, cutting, evisceration, wash-up, trimming, deboning, chilling, packing, sanitation, and other activities. Participants who reported performing other activities were asked to specify their job activities; the reported activities included operating the production line, performing mechanic and utility-related tasks, sharpening knives, and performing other tasks as needed. Because of the small number of participants reporting several of the individual poultry processing activities, some activities were combined into groups (i.e., receiving, hanging, killing, and plucking; cutting and evisceration; chilling and packing) corresponding to main production areas (13), and each participant was categorized according to whether he/she performed any of the grouped activities.

Other potential inhalation hazards were identified using responses to a series of questions about participants' jobs and the materials that they handled at work. First, participants responded to a question about how frequently they worked in areas where they were exposed to dusts, smoke, gas, fumes, fibers, or other air pollutants (seldom/never, sometimes, often, or almost always/always). Participants then reported the hours per day, on average, that they worked with each of the following: animals; cleaning agents; dusts (e.g., wood dust); glues or adhesives; oils or cutting fluids; paints and lacquers; plants; sealants; soil; or solvents (0, >0 to <½ hour, ½ to 2 hours, >2 hours) (22). We categorized those respondents who reported the frequency that they worked in areas with dusts, smoke, gas, fumes, fibers, or other air pollutants as "sometimes," "often," or "almost always/always" and those who reported working with any of the individual materials or exposures >0 hours per day as having other inhalation exposures. The use of respiratory protection at work was assessed using the following survey question: "how often do you use dust masks or respirators?"

Respiratory Health

Respiratory health outcomes were assessed using questions from the Spanish translation of the European Community Respiratory Health Survey (23). Participants were categorized as having a lifetime history of allergies if they responded positively to any of three allergy-related questions: "has a doctor ever diagnosed you with an allergy?", "have you ever had hay fever or other symptoms of nasal allergy (e.g., from pollens or animals)?", "have your eyes ever shown allergic symptoms like tears or redness from pollens or animals?" All participants with positive responses to the question "have you ever had asthma?" were categorized as having asthma and those with positive responses to the follow-up question, "has it been diagnosed by a doctor?" were categorized as having diagnosed asthma.

Participants also reported whether they experienced nasal allergies, wheezing or whistling in the chest, waking with a feeling of tightness in the chest, or being awoken by an attack of shortness of breath or coughing in the last 12 months; sought medical care for breathing problems such as these in the last 12 months; wheezed in the last month; were currently taking medication for breathing problems; and whether their breathing problems worsen when they work. We categorized participants as having nasal symptoms if they reported experiencing nasal allergies, including hay fever, in the last 12 months. We categorized participants as having current asthma if they gave positive responses about any of the following: (1) wheezing or whistling in the chest in the absence of a cold in the last 12 months, (2) waking due to an attack of shortness of breath at any time in last 12 months, (3) seeking medical care for breathing problems in the last 12 months, (4) currently using medicine for breathing problems.

Spirometry was performed using EasyOne diagnostic spirometers connected to laptop computers running EasyWare 2008 version 2.11.6.0 and EasyWare 2010 version 2.21.0.0 (ndd Medical Technologies, Zurich, Switzerland). The spirometers were calibrated prior to each day of testing and spirometry methods followed the 2005 American Thoracic Society/European Respiratory Society guidelines (24). Experienced technicians performed all spirometry testing with the assistance of study personnel who explained in Spanish, as needed, the purpose of the test and the testing procedures. Testing was performed with the participants seated. Data from all maneuvers were saved and later reviewed by study personnel (ABC and MCM). Spirometry measurements used in this analysis include forced expiratory volume in one second (FEV_1, in mL), forced vital capacity (FVC, in mL), and the ratio FEV_1/FVC. Predicted values of FEV_1 and FVC were calculated using equations for Mexican-American men and women published by Hankinson et al. (25), and are presented as percentages of predicted FEV_1 and FVC volumes.

Statistical Analysis

Characteristics of the study population and prevalences of self-reported symptoms and conditions were assessed separately for poultry processing workers and the comparison population. We evaluated the associations of poultry work with nasal symptoms and current asthma using generalized estimating equations (GEE), specified with a binomial error distribution, a logit link, and an exchangeable structure for the correlation attributable to the recruitment of multiple participants within the same housing unit and clustered recruitment

sites. We assessed age, allergy history, country of birth, respiratory protection use, sex, smoking status, and other inhalation exposures as potential confounders using a stepwise regression strategy in separate models evaluating the odds of nasal symptoms and current asthma, respectively, among all poultry processing workers relative to those in the comparison population. Variables that were statistically significant at $\alpha<0.05$ were retained in our final models. Final models of associations between poultry work and nasal symptoms were adjusted for age and allergy history; final models of associations between poultry work and current asthma were adjusted for age, allergy history, sex, smoking status, and other inhalation exposures. Measures of association are reported as adjusted odds ratios (ORs) with 95% confidence intervals (CIs). We conducted a sensitivity analysis to evaluate the effect of using $\alpha<0.10$ to select covariates to be included in our final models. This change resulted in sex and other inhalation exposures being added to models of the association between poultry work and nasal symptoms and country of birth being added to models of the associations with current asthma.

Associations between poultry work and FEV_1, FVC, and the FEV_1/FVC ratio were evaluated for men and women separately using GEE models specified with a normal error distribution, an identity link, and an independent structure for the correlation of data from participants recruited within housing units and recruitment sites. The sex-stratified models were adjusted for age, age squared, allergy history, height, height squared, smoking status, and other inhalation exposures. Associations of poultry work with FEV_1 and FVC as percentages of sex-specific predicted values were evaluated using similar models, adjusted for allergy history, smoking status, and other inhalation exposures.

For each symptom and lung function measure, we evaluated one model for the effect of poultry processing work overall, eight for the poultry processing activities, and one for the number of poultry processing activities reported (categorized as one activity or 2 or more activities). Models evaluating the poultry processing activities include only the poultry processing workers who reported the activity (or activities) and the comparison population; for example, models of the odds of nasal symptoms among workers who reported sanitation included 48 poultry processing workers and 339 members of the comparison population. Smoking status was categorized as lifetime non-smoker, former smoker, or current smoker. One participant who did not provide smoking status information was categorized with the large majority of participants (72%) as a lifetime non-smoker. All analyses were conducted using SAS version 9.1 (SAS Institute Inc., Cary, North Carolina, USA).

RESULTS

Characteristics of the study participants are shown in Table 1. Poultry processing workers were slightly older than workers in the comparison population (mean age: 35 versus 32 years, $p<0.01$) and a larger proportion of participants in the poultry processing population reported their country of birth as Guatemala, compared to the predominantly Mexican origin reported by the comparison population. The percentage of participants who reported work-related inhalation exposures was higher in the comparison population (74%) than in the poultry processing population (51%).

Table 2 shows the prevalence of reported nasal and respiratory symptoms and conditions. Overall, the lifetime prevalences of symptoms and conditions, as well as the prevalences in the last 12 months, were each higher in the comparison population than in the poultry processing population (e.g., ever wheezing or whistling in the chest: 11% versus 8%). None of the differences, including the difference in prevalence of wheezing or whistling in the chest in the last month, current use of medication for breathing problems, and reporting that breathing problems worsen at work, was statistically different at the $\alpha=0.05$ level.

Among the 402 poultry processing workers, packing (26%) and cutting (22%) were the most frequently reported poultry processing activities. Twenty-one percent (21%) reported performing two or more of the tasks as part of their poultry processing jobs (Table 3). Overall, the prevalences of nasal symptoms (prevalence: 25%; OR: 0.91, 95% CI: 0.59, 1.40) and current asthma (prevalence: 9%; OR: 0.96, 95% CI: 0.57, 1.62) were each lower among poultry processing workers than in the comparison population. Including sex and other inhalation exposures in models of the association between poultry processing and nasal symptoms modestly

attenuated the effect estimates (including sex: OR: 0.91, 95% CI: 0.59, 1.41; including other inhalation exposures: OR: 0.97, 95% CI: 0.62, 1.52; including sex and other inhalation exposures: OR: 1.00, 95% CI: 0.63, 1.57). Adding country of birth to the final model of the association between poultry processing and current asthma resulted in a negligible change in the adjusted OR (0.95, 95% CI: 0.55, 1.63).

The small numbers of symptomatic participants limited our ability to thoroughly evaluate associations between individual poultry processing activities and nasal and respiratory symptoms. However, the highest prevalences were observed among poultry processing workers who reported receiving, hanging, killing, and plucking (nasal symptoms: 35%); cutting and evisceration (nasal symptoms: 32%; current asthma: 12%); trimming (nasal symptoms: 33%); and chilling and packing (nasal symptoms: 34%; current asthma: 11%). Of these activities, multivariate analyses generated consistently elevated point estimates for cutting and evisceration (nasal symptoms: 1.10; current asthma: 1.50), trimming (nasal symptoms: 1.41; current asthma: 1.07), and chilling and packing (nasal symptoms: 1.57; current asthma: 1.23). Point estimates below unity were consistently observed for deboning (nasal symptoms: 0.61; current asthma: 0.64) and sanitation (nasal symptoms: 0.82; current asthma: 0.46) activities.

Among participants who completed spirometry testing, unadjusted mean values of FEV_1 and FVC were both higher in the comparison population (men: FEV_1: 3,612 mL, FVC: 4,382 mL; women: FEV_1: 2,771 mL, FVC: 3,281 mL) than in the population of poultry processing workers (men: FEV_1: 3,337 mL, FVC: 4,087 mL; women: FEV_1: 2,612 mL, FVC: 3,072 mL) (Table 4). Adjusted absolute differences in mean FEV_1 and FVC were lower among poultry processing workers overall and in nearly all of the poultry processing activity groups – most notably among all men (FEV_1: -89 mL; FVC: -84 mL) and men performing sanitation activities (FEV_1: -192 mL; FVC: -206 mL). Differences in the percentages of FEV_1 and FVC predicted values and in the FEV_1/FVC ratio were modest across all categories, as were differences in FEV_1 and FVC with increasing numbers of poultry processing activities reported.

DISCUSSION

This large observational study provided us with a unique opportunity to report the prevalences of a wide range of respiratory health outcomes and measurements of lung function among working Latino men and women in rural North Carolina. In these data, employment in poultry processing was not associated with nasal symptoms or current asthma, though we observed lower prevalences of both in the poultry processing cohort than in the comparison population. In contrast, measurements of FEV_1 and FVC were modestly lower among female and male poultry processing workers and across categories of poultry processing job activities. The magnitudes of the differences were larger among men overall, and particularly among those who reported working in sanitation. Together, these findings suggest that despite the low prevalence of respiratory symptoms reported, poultry processing work may affect lung function.

The remarkably low prevalences of nasal and respiratory symptoms in the poultry processing cohort suggest that our study may be affected by a respiratory-specific healthy worker effect. If individuals who are eligible to work in poultry processing but who have allergies or respiratory health conditions that may be exacerbated by the potential exposures do not seek employment in poultry processing or have left poultry processing work, then the individuals employed in the facilities, and thus available for recruitment into this study, may be healthier than those employed elsewhere. Because of the wide range of manual labor jobs held by members of the comparison population, we do not expect the respiratory health or susceptibility profile of the comparison group to have been appreciably or systematically altered by the same phenomenon. This hypothesis is supported by the lower percentages of current smoking and lifetime histories of allergies, asthma, and wheezing in the poultry processing group than in the comparison group. Indeed, the associations between poultry work and respiratory symptoms generated in our study do not point to poultry processing work as a risk factor for adverse respiratory health.

In contrast, the consistently lower measures of FEV_1 and FVC in the poultry processing cohort suggest that despite the low prevalence of symptoms reported, poultry processing may affect lung function. Because the

differences in mean lung function measurements did not reach statistical significance among men or women, these data should be interpreted with caution. If the degree of lung function impairment observed in the poultry processing cohort was insufficient to trigger symptoms or other functional consequences, then this modest decline may indicate unrecognized respiratory disease. If participants experienced symptoms but did not report them in our survey, then our lung function findings may reveal systematic differences in the ways members of the two study populations reported symptoms. In both populations, median educational attainment was equivalent to a primary school education. Compared to other jobs available to Latino immigrants with limited education, jobs in poultry processing come with some noteworthy advantages. For example, working conditions were reported more favorably in the poultry processing cohort, where only 1% (versus 5% in the comparison population) reported having lost their job in the last year; 41% (versus 32%) reported having modified their work stations or tasks to make them safer or more comfortable; 87% (versus 60%) agreed that workers receive safety instruction when hired; 64% (versus 12%) reported having health insurance; and 25% (versus 4%) reported that the insurance was paid by their employer. If poultry processing jobs are considered more desirable than other employment opportunities available in the communities, then these jobs may be held by healthier workers, including men and women with less respiratory impairment and fewer functional consequences of the corresponding symptoms or conditions. Alternatively, individuals in these jobs may have better access to health care and fewer untreated symptoms or they may be reluctant to report symptoms that may be attributed to a relatively desirable job.

Few data about the respiratory health of poultry processing workers or rural Latino immigrants exist with which to compare our findings. Cross-shift increases in the prevalence of coughing (35% pre-shift versus 52% post-shift), shortness of breath (0% versus 9%), nasal irritation (9% versus 22%), and runny nose (4% versus 17%) as well as decreases in FEV_1 (-4.1% predicted) and FVC (-3.1% predicted) have been reported in a small cohort of poultry slaughterhouse workers (5), highlighting the importance of poultry processing exposures and the impact of the timing of symptom and lung function data collection. Thirty-day period prevalences of coughing or wheezing (11%) and shortness of breath (7%) have been reported in a poultry-working cohort that included chicken catchers and processing workers (18). In our data, 6% of the poultry processing population and 5% of the comparison population reported wheezing or whistling in the chest in the last month; these prevalences were both notably lower than that reported among Latino farmworkers (16%) (26), whose symptoms may be attributed to the wide range of outdoor exposures such as agricultural pesticides, allergens, and organic dusts encountered in farm work (3, 27-29).

In this study, assessment of potential inhalation exposures in the poultry processing plants was based on self-reported job activities. Our understanding of specific work tasks, as described by poultry processing workers in this study and by other accounts in the literature (14, 30, 31), enabled us to develop plausible hypotheses about the relationships between poultry processing workplace exposures to respiratory irritants and respiratory symptoms. For example, workers who receive and handle live birds or carcasses likely encounter allergen, bacteria, and dust exposures. Air quality measurements from the breathing zones of slaughterhouse shacklers in Sweden indicated exposures to time-weighted average concentrations of total dust ranging from 0.4 to 15.3 mg/m^3 (mean: 6.3 mg/m^3), with higher levels of airborne bacteria in the hanging and evisceration departments than in the packaging areas (5). As the birds are killed and continue along the assembly line, worker exposures to cold temperatures as well as vapors, gases, dusts, and fumes arising from disinfectants and other cleaning agents, machining fluids, and packaging materials may be expected throughout the plants. In these data, we observed lower metrics of lung function that support one task-specific hypothesis: that the use of cleaning agents in the poultry processing affects lung function. This finding supports and extends a growing body of evidence that occupational exposure to cleaning agents with irritant properties affects lung function (32, 33). If our use of self-reported work activities or groupings of activities incorrectly grouped workers with varying degrees of exposure, the resulting misclassification likely limited the ability of our analysis to detect other potential effects. Developing and implementing methods to improve the assessment of exposures, including concentrations, durations, mixtures, and the use of respiratory protection and ventilation, would improve our understanding of the degree to which workers encounter inhalation hazards in various poultry processing jobs.

These data illustrate the importance and feasibility of including spirometry as one component of a large occupational health study. In fact, on the basis of the respiratory symptoms alone, the data may be viewed as suggesting that poultry work is associated with a lower burden of respiratory symptoms, whereas in combination with the available lung function measurements, they suggest that poultry processing work may affect lung function. By presenting sex-stratified data, we also show lower lung function measurements, as a percentage of predicted values, among women than among men. This finding would be expected if women in the study experienced other inhalation exposures, such as those encountered in cooking, cleaning, gardening, and other avocational activities that were not accounted for in our data. Sex-based differences in these exposures would result in differential misclassification affecting our analysis of nasal and respiratory symptoms and may explain the lower lung function measures observed among women.

There are few large population-based surveys focused on occupational exposures and respiratory health of the Latino workforce in the United States. In this study, working Latino adults were successfully recruited and enrolled into a research study focused on the health of workers in an industry in which investigators and other public health personnel have limited workplace access. The generally low prevalence of respiratory health symptoms in the poultry processing cohort suggests the influence of the healthy worker effect. If poultry processing jobs are more desirable than other employment opportunities available, then those who leave poultry processing work due to their respiratory health may be at a unique employment disadvantage because of their health. These findings justify efforts to evaluate and monitor the health of new employees and to reduce exposures to inhalation hazards in poultry processing.

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Table 1. Characteristics of the study populations

	Poultry processing population	Comparison population
	No. (%)[a]	No. (%)
Total	402	339
Demographic Characteristics		
Age, in years		
Mean ± SD	35 ± 11	32 ± 9
Median	33	31
Minimum-Maximum	18-68	17-65
Country of birth		
Guatemala	167 (42)	114 (34)
Mexico	167 (42)	204 (60)
USA	13 (3)	4 (1)
Other	55 (14)	17 (5)
Recruitment site		
1	150 (37)	59 (17)
2	116 (29)	159 (47)
3	136 (34)	121 (36)
Sex		
Female	172 (43)	146 (43)
Male	230 (57)	193 (57)
Cigarette Use		
Smoking status		
Current smoker	42 (10)	50 (15)
Former smoker	68 (17)	47 (14)
Lifetime non-smoker	292 (73)	242 (71)
Work-related		
Other Inhalation exposures		
No	196 (49)	89 (26)
Yes	206 (51)	250 (74)
Respirator or dust mask use at work		
None of the time	312 (78)	164 (48)
Some of the time	35 (9)	74 (22)
Most of the time	4 (1)	11 (3)
All of the time	44 (11)	21 (6)
Not reported	7 (2)	69 (20)

[a] Numbers with column percents, unless otherwise specified

Table 2. Prevalence of self-reported nasal and respiratory symptoms and conditions in the poultry processing (n=402) and comparison (n=339) populations

	Poultry processing population	Comparison population
	No. (%)	No. (%)
Lifetime history		
Allergies	102 (25)	104 (31)
Asthma, not doctor diagnosed	2 (<1)	3 (1)
Asthma, doctor diagnosed	8 (2)	6 (2)
Wheezing or whistling in the chest	31 (8)	36 (11)
In the last 12 months		
Nasal symptoms	100 (25)	97 (29)
Wheezing or whistling in the chest	31 (8)	34 (10)
Wheezing or whistling in the chest after physical exertion	11 (3)	16 (5)
Wheezing or whistling in the chest in the absence of a cold	12 (3)	15 (4)
Woke with a feeling of tightness in the chest	22 (5)	17 (5)
Awoken by an attack of shortness of breath	21 (5)	18 (5)
Awoken by an attack of coughing	36 (9)	40 (12)
Sought medical care for breathing problems	8 (2)	9 (3)
In the last month		
Wheezing or whistling in the chest	24 (6)	17 (5)
Currently		
Taking medication for breathing problems	15 (4)	9 (3)
Breathing problems worsen at work	10 (2)	15 (4)

Table 3. The prevalence and associations of nasal symptoms and current asthma with poultry processing work

		Nasal Symptoms[a]		Current Asthma	
	No.	No. (%)	OR (95% CI) [b]	No. (%)	OR (95% CI) [c]
Comparison Population	339	97 (29)	1.00	33 (10)	1.00
Poultry Processing Population	402	100 (25)	0.91 (0.59, 1.40)	35 (9)	0.96 (0.57, 1.62)
Poultry Processing Activities[d]					
Receiving, hanging, killing, plucking	48	17 (35)	1.04 (0.52, 2.08)	4 (8)	1.01 (0.32, 3.16)
Cutting, evisceration	98	31 (32)	1.10 (0.61, 1.97)	12 (12)	1.50 (0.69, 3.27)
Wash-up	16	2 (13)	0.37 (0.08, 1.59)	0 (0)	--
Trimming	66	22 (33)	1.41 (0.68, 2.92)	6 (9)	1.07 (0.37, 3.07)
Deboning	81	11 (14)	0.61 (0.25, 1.47)	4 (5)	0.64 (0.19, 2.15)
Chilling, packing	107	36 (34)	1.57 (0.84, 2.91)	12 (11)	1.23 (0.56, 2.71)
Sanitation	48	12 (25)	0.82 (0.33, 2.02)	3 (6)	0.46 (0.11, 1.92)
Other	35	3 (9)	0.13 (0.04, 0.42)	1 (3)	0.31 (0.06, 1.68)
No. Activities Reported					
1	317	66 (21)	0.75 (0.47, 1.19)	29 (9)	1.05 (0.59, 1.85)
2-5[e]	85	34 (40)	1.57 (0.81, 3.03)	6 (7)	0.71 (0.28, 1.82)

[a] In the last 12 months

[b] Adjusted for age and allergy history

[c] Adjusted for age, allergy history, sex, smoking status, and other inhalation exposures

[d] The comparison population (N=339) is the referent population for all models of associations between poultry processing activities and health outcomes

[e] 85 participants reported 2 or more activities: 2 (n=73, 18%), 3 (n=10, 2%), 4 (n=1, <1%), 5 (n=1, <1%)

Table 4. Sex-stratified mean (with standard deviation) lung function measurements and adjusted differences among participants in the poultry processing population compared to participants in the comparison population.

	No.	FEV_1 (mL)[b]	FEV_1 % predicted[c]	FVC (mL)[b]	FVC % predicted[c]	FEV_1/FVC %[b]
Men						
Comparison Population[a], mean ± SD	122	3,612 ± 602	97.2 ±13.9	4,382 ± 654	97.5 ± 12.9	82.4 ± 6.4
Poultry Processing Population, mean ± SD	155	3,337 ± 590	94.2 ± 12.9	4,087 ± 686	94.9 ± 12.2	81.7 ± 6.1
		-89 (-203, 25)[d]	-2.7 (-6.0, 0.6)	-84 (-220, 53)	-2.0 (-5.1, 1.1)	-0.4 (-1.8, 1.0)
Poultry Processing Activities						
Receiving, hanging, killing, plucking	31	-81 (-233, 71)	-2.5 (-7.0, 1.9)	-130 (-311, 52)	-3.3 (-7.6, 1.0)	0.7 (-1.3, 2.6)
Cutting, evisceration	30	-118 (-286, 50)	-4.1 (-8.9, 0.6)	-93 (-290, 104)	-1.3 (-5.8, 3.2)	-0.9 (-3.1, 1.3)
Wash-up	4	-50 (-386, 286)	4.2 (-11.1, 19.6)	-96 (-636, 443)	0.9 (-15, 16.8)	1.3 (-4.3, 6.9)
Trimming	12	-237 (-445, -28)	-3.6 (-11.3, 4.1)	-264 (-529, 1)	-3.9 (-11.0, 3.2)	-0.3 (-4.1, 3.4)
Deboning	37	-16 (-212, 180)	-2.3 (-7.9, 3.2)	83 (-152, 317)	1.6 (-3.8, 7.0)	-2.0 (-4.2, 0.1)
Chilling, packing	36	-67 (-238, 104)	-2.9 (-8.0, 2.2)	-53 (-255, 149)	-1.1 (-6.0, 3.8)	-0.5 (-2.8, 1.7)
Sanitation	34	-192 (-353, -31)	-4.6 (-9.1, -0.1)	-206 (-421, 9)	-4.6 (-9.0, -0.3)	-0.5 (-2.9, 2.0)
Other	13	155 (-17, 326)	4.6 (0.4, 8.9)	137 (-103, 377)	2.7 (-2.1, 7.6)	1.0 (-1.6, 3.7)
No. Activities Reported						
1	121	-79 (-198, 41)	-2.3 (-5.8, 1.2)	-75 (-225, 71)	-2.2 (-5.5, 1.2)	-0.2 (-1.7, 1.3)
2-5	34	-126 (-288, 36)	-4.2 (-8.9, 0.5)	-113 (-293, 67)	-1.3 (-5.6, 2.9)	-0.9 (-3.1, 1.3)
Women						
Comparison Population[a], mean ± SD	100	2,771 ± 445	86.3 ± 10.4	3,281 ± 526	84.4 ± 10.1	84.6 ± 5.1
Poultry Processing Population, mean ± SD	124	2,612 ± 402	86.1 ± 10.3	3,072 ± 465	82.2 ± 9.8	85.1 ± 5.0
		-26 (-110, 57)	0.3 (-2.5, 3.0)	-64 (-170, 41)	-2.0 (-4.7, 0.7)	1.0 (-0.4, 2.3)
Poultry Processing Activities						
Receiving, hanging, killing, plucking	3	-80 (-217, 58)	-2.2 (-6.5, 2.1)	76 (-275, 428)	0.5 (-10.7, 11.7)	-4.5 (-11.8, 2.9)
Cutting, evisceration	34	-27 (-136, 83)	0.1 (-3.4, 3.7)	-16 (-141, 109)	0.1 (-3.2, 3.4)	-0.5 (-2.2, 1.3)
Wash-up	7	12 (-207, 231)	3.8 (-5.1, 12.7)	-130 (-474, 214)	-4.2 (-13.5, 5.0)	4.6 (-0.3, 9.5)
Trimming	34	-14 (-128, 99)	0.8 (-2.9, 4.4)	-15 (-150, 121)	-0.7 (-4.2, 2.9)	0.0 (-2.2, 2.3)
Deboning	21	-65 (-242, 112)	-3.1 (-8.5, 2.3)	-55 (-286, 175)	-2.7 (-7.9, 2.6)	-0.5 (-2.8, 1.8)
Chilling, packing	37	-76 (-197, 45)	-0.6 (-4.4, 3.2)	-149 (-311, 14)	-4.8 (-8.3, -1.3)	1.7 (-0.3, 3.7)
Sanitation	1	--[e]	--	--	--	--
Other	10	22 (-188, 233)	1.8 (-6.0, 9.7)	-23 (-263, 218)	0.4 (-6.5, 7.4)	1.1 (-1.8, 4.0)
No. Activities Reported						
1	103	-26 (-114, 60)	0.0 (-2.9, 2.8)	-80 (-190, 31)	-2.7 (-5.5, 0.2)	1.3 (-0.1, 2.8)

2-3	21	-24 (-161, 112)	1.7 (-2.6, 6.0)	5 (-146, 157)	0.9 (-3.0, 4.9)	-0.8 (-3.1, 1.5)

[a] Referent category
[b] Differences (with 95% CI) are adjusted for age, age squared, allergy history, height, height squared, smoking status, and other inhalation exposures
[c] Differences (with 95% CI) are adjusted for allergy history, smoking status, and other inhalation exposures
[d] Negative values indicate mean values (in mL) lower than the mean of the comparison population; positive differences indicated mean values higher than the mean of the comparison population. For example, the adjusted mean FEV_1 generated among men who reported receiving, hanging, killing, or plucking is 81 mL lower than that of the comparison population.
[e] Not estimated

1-11. Airway Obstruction Among Latino Poultry Processing Workers in North Carolina

ABSTRACT

This analysis was conducted to evaluate the prevalence of airway obstruction among Latino poultry processing workers. Data were collected from 279 poultry processing workers and 222 other manual laborers via spirometry and interviewer-administered questionnaires. Participants employed in poultry processing reported the activities they perform at work. Participants with forced expiratory volume in one second (FEV_1) or FEV_1/forced expiratory volume (FVC) below the lower limits of normal were categorized as having airway obstruction. Airway obstruction was identified in 13% of poultry processing workers and 12% of the comparison population. Among poultry processing workers, the highest prevalence of airway obstruction (21%) occurred among workers deboning chickens (prevalence ratio: 1.75; 95% confidence interval: 0.97, 3.15). These findings identify variations in the prevalence of airway obstruction across categories of work activities.

INTRODUCTION

Epidemiologic research into the health of workers in the poultry production industry has reported adverse occupational health outcomes in the largely minority and immigrant poultry processing workforce in North Carolina [1-5]. In previous analyses, we reported low prevalences of nasal and respiratory symptoms among Latino men and women working in poultry production [3], suggesting the role of an asthma-specific healthy worker effect [6]. Despite the low prevalence of self-reported symptoms, the lower lung function observed among men employed in poultry processing suggest that poultry processing work may affect lung function [3]. We conducted these additional analyses to investigate the prevalence of a specific lung function outcome, airway obstruction, in the same population of Latino workers.

METHODS

We conducted an epidemiologic analysis using data collected from a cross-sectional study designed to assess the health of Latino men and women employed in poultry processing jobs in North Carolina. The study design and methods are described in detail elsewhere [3]. Poultry processing workers were eligible for inclusion if they were adults who self-identified as Latino or Hispanic and were working in poultry processing ≥35 hours per week at the time of recruitment. Participants in the comparison population were employed for pay in manual jobs, excluding jobs in poultry processing or production. Recruitment was limited to the geographic areas surrounding three poultry processing plants in western North Carolina.

Data were collected via in-person, interviewer-administered questionnaires and data collection clinics held within one month of participants completing the questionnaire. Questionnaires and spirometry testing were completed by 289 poultry processing workers and 229 other manual laborers [3]. We excluded 10 poultry processing workers and 7 other manual laborers whose spirometry testing yielded unusable results. Our final study population for this analysis includes 279 poultry processing workers and 222 members of the comparison population. The Wake Forest University Health Sciences institutional review board approved the study. All participants provided written informed consent.

Each participant in the poultry processing cohort responded to survey questions designed to identify poultry processing activities performed on the job. As in previous analyses [3], and because of the small number of participants reporting several of the individual poultry processing activities, activities were grouped, as shown in Table 2. Participants who reported performing job activities in more than one grouping were included in each group. To evaluate the impact of including participants in more than one category on our final results, we conducted sensitivity analyses using a revised classification system in which participants who reported one activity were categorized according to that activity and participants who reported more than one activity were categorized into a single category of participants performing multiple job activities.

We categorized each participant as having airway obstruction based on the results of spirometry testing. Participants with forced expiratory volume in one second (FEV_1) less than the lower limit of normal (LLN) or the

ratio of FEV_1/forced vital capacity (FVC) less than LLN were categorized as having airway obstruction. For each participant, FEV_1 and FVC values used were the best values obtained from all exhalation maneuvers. Values for LLN were computed using age- and sex-specific reference equations for Mexican-American adults [7].

Each participant reported his/her age, country of birth, history of asthma, and smoking status. We categorized smoking status as lifetime non-smoker, former smoker, or current smoker. Participants who reported smoking cigarettes within the last month were categorized as current smokers; those who reported ever smoking, but not within the last month, were categorized as former smokers; the remaining participants (i.e., those who reported never having smoked cigarettes) were categorized as lifetime non-smokers. Associations between poultry processing activities and airway obstruction were estimated using binomial regression, adjusted for history of asthma and smoking status. Our statistical model accounted for the clustering of participants within housing units and recruitment sites. Associations are presented as prevalence ratios (PRs) with 95% confidence intervals (95% CI). All analyses were conducted using SAS version 9.2 (SAS Institute Inc., Cary, NC).

RESULTS

Table 1 shows demographic characteristics of the populations. In both groups of workers, approximately 3% reported a history of asthma and over 70% were identified as lifetime non-smokers. Based on the results of spirometry testing, 13% of the poultry processing population and nearly 12% of the comparison population were categorized as having airway obstruction.

The prevalences of airway obstruction among workers performing specific poultry processing activities are shown in Table 2. The highest prevalences were found among workers performing deboning (21%) and sanitation (17%). Adjusted for history of asthma and smoking status, and taking into account the clustered recruitment of study participants, the highest prevalence of airway obstruction relative to that of the comparison population was generated for deboning (PR: 1.75; 95% CI: 0.97, 3.15). Overall, performing any poultry processing work was not associated with airway obstruction (PR: 1.10; 95% CI: 0.70, 1.75).

Our sensitivity analyses identified 54 workers who reported performing activities in two or more categories. Repeating our analyses with this revised classification of poultry processing tasks generated PRs similar to those in our main analyses (e.g., deboning: PR: 1.74; 95% CI: 0.92, 3.28). Seven (13%) of the 54 poultry processing workers who reported performing job activities in multiple categories were identified as having airway obstruction (PR: 1.07, 95% CI: 0.38, 2.98).

DISCUSSION

This study did not identify employment in poultry processing as a risk factor for airway obstruction. However, analysis of specific poultry processing job tasks identified variations in the prevalence of airway obstruction across categories of tasks, with most notable elevations among workers who reported deboning and sanitation activities. Such variations suggest that workers in poultry processing facilities may not be adequately protected from potential inhalation hazards on the job. This conclusion is supported by our earlier observation of lower lung function observed among men employed in poultry processing, particularly among men who reported performing sanitation activities [3], and by findings of elevated respiratory symptom prevalences among poultry processing workers exposed to soluable chlorine [8]. Results of the present analysis extend those observations by reporting the prevalence of one specific and important pulmonary outcome, airway obstruction, in a population of Latino workers.

Partial obstruction of the airways may occur in several ways, including blockage due to excessive secretions into the airway; contractions of the smooth muscles of the airways; thickening of the airway walls; and introduction of foreign materials into the airways [9]. In poultry processing facilities, workers may encounter biological and chemical inhalation hazards [10-12] and reactions to respiratory irritants or allergens may trigger inflammation of the airway wall and the production of mucus in the airways [9]. These reactions may plausibly

produce the outcomes categorized in the present study as airway obstruction regardless of whether the participant reports respiratory symptoms or a history of asthma. In fact, in previous analyses, we did not observe an elevated prevalence of asthma in the poultry processing population [3]. These earlier findings, in combination with the prevalence of airway obstruction reported here, support a hypothesis regarding the role of a respiratory-specific healthy worker effect in which workers with acute respiratory responses to the inhalation hazards encountered in poultry processing facilities may no longer be employed in jobs such as these [3]. If poultry processing work and, as a consequence, our study, were affected by such a phenomenon, then the airway obstruction observed in this population may indicate an under-recognized chronic obstructive phenotype of respiratory disease.

Limited epidemiologic data are available with which to contrast our findings. While extensive reviews are available to describe associations of obstructive lung disease with occupational dust exposures [13-16], few studies have been conducted among animal processing workers. Additional information about the inhalation exposures encountered in poultry processing, the use of personal protective equipment, and workers' ability to rotate out of job activities that elicit health symptoms would improve our characterization of poultry-related exposures potentially associated with obstructive airway disease. Improvements in exposure assessment related to inhalation exposures in both the poultry processing and comparison populations and would reduce the extent to which exposure misclassification affects our results. Despite the small number of participants identified with airway obstruction, notable strengths of our study include the large number of participants who completed spirometry testing, objective measurement of lung function, review of each participant's spirograms by study personnel (ABC, MCM), and the low likelihood of misclassification of participants' FEV_1 and FEV_1/FVC values, relative to the age- and sex-specific LLN values.

Poultry processing provides jobs for individuals with minimal education and limited ability to communicate in English, but little information is available about working conditions inside poultry processing plants. If air inside the facilities includes inhalation hazards, then workers may be at risk of developing or exacerbating obstructive airway disease. Task-specific inhalation exposure assessment would improve the interpretation of variation in the prevalence of airway obstruction observed. Access to poultry processing facilities would enable direct observation and measurement of work conditions, including indoor air quality, potential inhalation exposures, and use of personal protective equipment; however, such exposure assessment in occupational health studies of poultry processing continues to be a challenge.

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Table 1. Characteristics of the study population and the prevalence of airway obstruction

	Total Population	Poultry Processing Workers		Comparison Population	
			with Airway Obstruction		with Airway Obstruction
	No.	No.	No. (%)	No.	No. (%)
Total	501	279	37 (13.3)	222	26 (11.7)
Age, years					
Mean ± SD	34.6 ± 10.4	36.4 ± 11.2	34.1 ± 11.5	32.4 ± 8.8	30.1 ± 7.2
Min - Max	18 – 68	18 – 68	19 – 63	18 – 60	18 – 52
Country of Birth					
Guatemala	171	106	17 (16.0)	65	8 (12.3)
Mexico	269	124	11 (8.9)	145	15 (10.3)
Other	61	49	9 (18.4)	12	3 (25.0)
History of asthma					
No	487	272	36 (13.2)	215	22 (10.2)
Yes	14	7	1 (14.3)	7	4 (57.1)
Sex					
Female	224	124	9 (7.3)	100	8 (8.0)
Male	277	155	28 (18.1)	122	18 (14.8)
Smoking status					
Current smoker	67	35	4 (11.4)	32	6 (18.8)
Former smoker	76	47	7 (14.9)	29	2 (6.9)
Lifetime non-smoker	358	197	26 (13.2)	161	18 (11.2)

Table 2. Occupational exposures and airway obstruction in the poultry processing and comparison populations

Poultry Processing Activities[1]	No. (%)	No. (%) with Airway Obstruction	PR (95% CI)[2]
None[3]	222	26 (11.7)	1.00
Receiving, hanging, killing, plucking	34	3 (8.8)	0.70 (0.22, 2.18)
Cutting, evisceration	64	8 (12.5)	1.04 (0.52, 2.09)
Wash-up	11	0 (0.0)	--[4]
Trimming	46	5 (10.9)	0.88 (0.35, 2.18)
Deboning	58	12 (20.7)	1.75 (0.97, 3.15)
Chilling, packing	73	10 (13.7)	1.07 (0.56, 2.05)
Sanitation	35	6 (17.1)	1.59 (0.71, 3.55)
Other activities	23	1 (4.4)	0.41 (0.06, 2.86)

[1] Participants who reported performing job activities in more than one category were included in each group
[2] Adjusted for history of asthma and smoking status, and taking into account the clustered recruitment of study participants
[3] Comparison population
[4] Not estimated

1-12. Musculoskeletal and Neurological Injuries Associated with Work Organization among Immigrant Latino Women Manual Workers in North Carolina

ABSTRACT

Background: This analysis examines the associations of work organization attributes among Latino women in manual occupations with musculoskeletal and neurological injuries.

Methods: Participants included 234 women in western North Carolina. Outcome measures included epicondylitis, rotator cuff syndrome, back pain, and carpal tunnel syndrome. Independent measures included indicators of job demand, job control, and job support, as well as personal characteristics.

Results: Latina workers commonly experienced epicondylitis, rotator cuff syndrome, back pain, and CTS. Awkward posture and decision latitude were associated with epicondylitis. Rotator cuff syndrome was associated with awkward posture and psychological demand. Awkward posture and psychological demand, and decreased skill variety and job control were related to CTS.

Conclusions: Work organization factors are potentially important for musculoskeletal and neurological injury among vulnerable workers. Research is required to understand the associations of work and health outcomes of these women. Policy initiatives need to consider how work organization affects health.

INTRODUCTION

The way in which work is organized affects the health of workers [Sauter et al., 2002]. This is particularly the case for vulnerable workers, who often have few options for alternative employment [Landsbergis et al., 2012; Grzywacz et al., 2013]. Low wage manual work provides less flexibility in how the job is done, and may provide more structural constraints, such as line speed, high hand force work, or more frequent awkward postures [Niedhammer et al., 2008]. Minorities and immigrants are more likely to be over-represented in hazardous manual labor jobs [Chung-Bridges et al., 2008; Forst et al., 2010; Pransky et al., 2002]. Immigrant women constitute one of the most vulnerable worker groups [Arcury et al., 2013]. However, little research has considered the association of work organization with the health of immigrant women. Arcury and colleagues [2013] report in an analysis of full-time employed immigrant Latino women that greater job demands (heavy load, awkward posture, psychological demand) were associated with more musculoskeletal and depressive symptoms, and worse mental health-related quality of life; less decision latitude (lower skill variety, less job control) was associated with more musculoskeletal and depressive symptoms, and greater support (supervisor's power and safety climate) was associated with fewer depressive symptoms and better mental health related quality of life.

A few studies have considered the association of work organization characteristics with clinical health measures. For example, high job strain (defined as high job demands and low job control based on measures from the Job Content Questionnaire [Karasek et al., 1998]) and low social support have been associated with the incidence of carpal tunnel syndrome [Harris-Adamson et al., 2013]. Greater psychosocial job demand, but not social support, has been associated with incidence of CTS [Silverstein et al., 2010]. Suggestive associations of work organization factors, such as structural constraints, decision latitude, and job satisfaction, with rotator cuff syndrome, have been reported [Silverstein et al., 2008]. Although Latino workers have a greater burden of work-related injuries and are less likely to have health insurance than to other workers [Sears et al., 2012], the majority of studies that have investigated the relationship between work organization and musculoskeletal disorders have been conducted among primarily non-Latino white populations.

The job demand-control-support model [Karasek, 1979, 1998; Johnson & Hall, 1998; Snyder et al., 2008] provides a framework for examining the association of work organization with clinical musculoskeletal injuries experienced by immigrant Latina workers. This model argues that greater physical and psychological demands in a job increase the risk of injury and illness. However, the negative health effects of physical and psychological demands can be moderated with greater worker control [Hoven & Siegrist, 2013], such as the

ability to make decisions about work and to use a greater variety of skills, and by greater social support from supervisors, such as a positive work safety climate [Zohar, 2002].

This analysis examines the associations of worker organization attributes among Latino women in manual occupations with clinically assessed musculoskeletal and neurological injuries, including epicondylitis, rotator cuff syndrome, back pain, and carpal tunnel syndrome. The work organization attributes include indicators of job demands (heavy load; awkward posture; psychological demand), job control (skill variety; decision latitude); and supervision (perceived supervisor control; work safety climate). Personal characteristics (age, years lived in US, language, poultry processing worker) are included in multivariate analysis.

METHODS

Data for this analysis are from a study comparing Latino poultry processing workers occupational injuries with those among other Latino manual workers [Arcury et al., 2012a; Cartwright et al., 2012; Pichardo-Geisinger et al., in press; Rosenbaum et al., 2013]. Data were collected from 2009 to 2011. The study was approved by the Wake Forest School of Medicine Institutional Review Board. All participants provided signed informed consent.

Participants

Participants were recruited from a four county area in western North Carolina. The sample design had two components: (1) dwellings in Latino neighborhoods in the four counties were mapped and listed; and (2) the four counties were surveyed to identify dispersed dwellings with Latino residents. A total of 4,376 potential Latino dwellings were listed, with about two-thirds in neighborhoods. The dwelling list was randomized proportionately with two-thirds from neighborhoods and one-third from dispersed dwellings.

Interviewers visited randomly selected dwellings. Residents were screened for inclusion criteria: self-identified as Latino or Hispanic, worked 35 hours or more per week in a manual labor job, and 18 years or older. Manual labor in poultry processing was defined as non-supervisory work in a poultry processing plant with job categories from receiving through sanitation. Other manual labor was defined as employment in non-managerial jobs in industries such as landscaping, construction, restaurant work, hotel work, child care, and manufacturing. Non-poultry workers with previous work in poultry were excluded if they had more than 6 months employment in poultry processing, or had worked in poultry processing in the previous two years. More than one resident per dwelling could be recruited. Of 1,681 dwellings contacted, 965 were screened, for a screening rate of 57%. Of 1,526 individuals screened, 957 were eligible for enrollment, with 742 completing interviews (77.5% participation rate). The participants included 319 women (77.6% participation rate), with 173 employed as poultry processing workers (82.0% participation rate), and 146 employed as other manual workers (73.0% participation rate). Of those, 234 women (128 employed in poultry processing, and 106 employed in other manual work) attended data collection clinics and are included in this analysis.

Data Collection

Data collection included an interviewer-administered survey questionnaire completed in participants' homes and a clinical evaluation completed at a research clinic. The survey questionnaire included items to measure basic personal characteristics information (e.g., age, preferred language), types of work performed for pay, and work organization characteristics. All interviews were conducted in Spanish and took approximately 60 minutes to complete. Participants were given a $10 incentive for completing the survey questionnaire.

Clinics were scheduled on Sundays at seven locations in the four study counties. Participants were scheduled for a clinical evaluation within 30 days of completing the survey questionnaire. Participants completed musculoskeletal and neurological examinations at the clinics. Those who attended the clinic were given an incentive of $30. For the musculoskeletal examination, participants first completed a short interview questionnaire that documented any pain at the elbows, shoulders, or low back on two or more days in the last month. Two board-certified physicians with fellowship training in sports medicine conducted all of the

musculoskeletal examinations of the elbow, shoulder, and back.

For the neurological examination, participants' height and weight were recorded; and they reported if they had numbness, pain, or weakness in their hands for two or more days in the previous month. If they answered affirmatively, they completed the Katz hand diagram (Katz & Stirrat, 1990] to indicate distribution of symptoms. Participants also completed bilateral nerve conduction studies by using a Teca TD10 Electromyograph (Teca Corporation, Pleasantville, NY). The studies were performed by experienced technicians blinded to the participants' occupation and clinical evaluations. Hands were warmed to 32°C, and median and ulnar antidromic sensory studies were performed, stimulating the wrist and recording with ring electrodes 140 mm distally on the second and fifth fingers. The onset and peak latencies were recorded, and those without median sensory potentials underwent orthodromic median motor studies recording from the abductor pollicis brevis muscle.

Measures

Outcome measures included physician diagnosed epicondylitis, rotator cuff syndrome, back pain, and carpal tunnel syndrome [Rosenbaum et al., 2013; Cartwright et al., 2012]. Epicondylitis was defined as self-reported pain at either epicondyle area on 2 or more days in the previous month and one of the following on exam: presence of pain at the lateral epicondyle with resisted active wrist extension, pain at the medial epicondyle with resisted active wrist flexion, or tenderness to palpation over the medial and lateral epicondyle regions physical exam [Werner et al., 2005]. Rotator cuff syndrome was defined as self-reported pain at the shoulder on 2 or more days in the previous month and one of the following on exam: presence of pain with resisted abduction, internal rotation, external rotation, or forward flexion of the shoulder, or tenderness to palpation over the bicipital groove or lateral shoulder. Low back pain was defined as self-reported low back pain on 2 or more days in the previous month and one of the following on exam: presence of pain with active flexion, extension, side-bending to right or left, or twisting to right or left, or tenderness to palpation anywhere.

A combination of symptoms, based on the Katz hand diagram, and nerve conduction abnormalities was used to define carpal tunnel syndrome [Katz & Stirrat, 1990]. Two physicians, blinded to the participant's occupation and nerve conduction results scored the hand diagrams as "unlikely" (0), "possible" (1), "probable" (2), or "classic" (3) for CTS on the basis of the published methods for scoring of the diagram [Katz & Stirrat, 1990]. If the hand diagram was scored a 1, 2, or 3, then the participant was assigned a score of "1" for symptoms; if not, the participant was assigned a "0." Peak median and ulnar sensory latencies were compared. If the median was less than 0.49 ms longer than the ulnar, it was scored a "0"; if it was 0.50 to 0.79 ms longer, it was scored a "1"; and if it was greater than 0.80 ms longer, it was scored a "2" [Violante et al., 2007]. The symptom score and nerve conduction score were then added; and a total score of 0 was defined as "no carpal tunnel syndrome," 1 to 2 as "possible carpal tunnel syndrome," and 3 as "definite carpal tunnel syndrome." This scoring system was applied to each wrist. In addition, individuals were defined as having "no carpal tunnel syndrome" if both wrists were scored as "0," "possible carpal tunnel syndrome" if one or both wrists were scored a "1 or 2," and "definite carpal tunnel syndrome" if either wrist was scored a "3." For this analysis, possible and definite carpal tunnel syndrome were combined into one category.

Measures for work organization included indicators of job demands (heavy load, awkward posture, psychological demand), job control (skill variety, decision latitude), and support (perceived supervisor control; work safety climate) [Arcury et al., 2013]. The scales on which these indicators are based are in the appendix. Heavy load and awkward posture were measured with an established physical workload instrument that has been used in previous research with immigrant Latinos [Bot et al., 2004; Grzywacz et al., 2007]. Response categories ranged from "seldom/never" (1) through "almost always" (4). Heavy load was assessed with the average of 12 items ($\alpha = 0.70$), and awkward posture was assessed with the average of 6 items ($\alpha = 0.80$), coded such that higher values indicate greater exposure. Psychological demand, was assessed with items from the Job Content Questionnaire [Karasek et al., 1998] with response options ranging from "seldom/never" (1) through "almost always" (4). Psychological demand is the mean of four items ($\alpha = 0.74$). Higher values indicate greater levels for the concept.

Skill variety and decision latitude were also assessed using items modified from the Job Content Questionnaire [Karasek et al., 1998] with response options ranging from “seldom/never” (1) through “almost always” (4). Skill variety is the mean of three items (α = 0.70); and decision latitude is the mean of three items (α = 0.81). Higher values indicate greater levels for each concept. Each of these measures has been used previously with immigrant Latino worker populations [Grzywacz et al., 2008, 2012; Arcury et al., 2013].

Perceived supervisor control was assessed with seven items from the social power scale [Hinkin & Schriesheim, 1989]. Participants stated whether their supervisor had control over pay, benefits, promotions, job assignments, and making work difficult. Response options ranged from “strongly disagree” (1) through “strongly agree” (4). Perceived supervisor control is the mean of the seven items (α = 0.74) coded such that higher scores indicate greater perceived control. This measure has been used in previous studies of immigrant Latino workers [Arcury et al., 2013]. Work safety climate was assessed with the Perceived Safety Climate Scale [Gillen et al., 2002]. This measure has been used in previous studies of immigrant Latino workers [Arcury et al., 2012b, 2012c, 2013; Swanberg et al., 2012]. Nine of the items in the scale used a four-point Likert format. The tenth item included three response categories. After an analysis of internal consistency, one of the nine four-point Likert format items was discarded due to lack of fit within the scale. A total Work Safety Climate was calculated by summing the remaining nine items (α = 0.73). Values range from 9 to 39, with higher values indicating better work safety. Measures of perceived supervisor control and work safety climate were not applied to women who were self-employed.

Personal characteristics used in the analysis include age (in years), years lived in US, speaking an indigenous language, and poultry processing worker versus other manual worker. In addition, information on the percent of participants who are currently married and number of co-resident children are included to describe the sample.

Analysis

All statistical analyses were adjusted for the stratified cluster sampling design of the study with sites being strata and dwellings being clusters. Continuous sample characteristics (age, years lived in US, and work organization indicators) were summarized using means and standard errors (SE). Categorical characteristics (language, marital status, number of children, employment, and presence of musculoskeletal injuries) were summarized using frequencies and percentages. Logistic regression models were used to examine the associations between work organization indicators and prevalence of each of the musculoskeletal and neurological injuries. We first fit bivariate models, and unadjusted odds ratios (OR) with 95% confidence intervals (CI) are reported. Next we fit multivariable models for rotator cuff syndromes and CTS; and adjusted ORs are reported. Multivariate models were first fit with the entire sample but excluding the supervisor support measures; some individuals were self-employed and the supervisor support scales were not collected. Multivariable models were then fit with those participants who were not self-employed, but with all of the work organization measures, including the supervisor support indicators. Measures of each work organization measure (heavy load, awkward posture, psychological demands, skill variety, decision latitude, perceived supervisor control, and work safety climate) as well as the personal characteristics age and years lived in the US were entered into logistic regression models as continuous measures, and indigenous versus non-indigenous language and poultry processing versus other manual work were entered into the logistic regression models as categorical measures. All analyses were performed by SAS 9.3 (Cary, NC) and p-values less than 0.05 were considered statistically significant.

RESULTS

The mean age of the participants was 34.9 years (SE = 0.64) (Table I). They had lived in the US an average of 11.3 years (SE = 0.40). A minority (15.8%) lived in households in which an indigenous language was spoken when they were a child. Most (78.3%) were married; they had an average of 1.8 (SE = 0.08) children living with them. About half (54.7) were employed in poultry processing, with the remainder employed in other manual occupations. Thirteen (5.5%) participants had epicondylitis, 16.2% had rotator cuff syndrome, 20.4% had back pain, and 48.9% had carpal tunnel syndrome. The indicators of work organization are reported in

Table II.

Several of the work organization characteristics were associated with epicondylitis, rotator cuff syndrome, and carpal tunnel syndrome (Table III); none of the work organization measures were associated with back pain. Among the demand measures, heavy load was not associated with the presence of any of the musculoskeletal injuries. Awkward posture had a significant, positive association with the presence of rotator cuff syndrome and carpal tunnel syndrome; it had a positive association with the presence of epicondylitis, but at the trend level. Psychological demand had a significant, positive association with rotator cuff syndrome. The job demands measure, skill variety, had an inverse association with the presence of carpal tunnel syndrome. Decision latitude had inverse associations with the presence of epicondylitis and carpal tunnel syndrome. The support measures did not have significant associations with the presence of musculoskeletal injuries; however, perceived supervisor control was associated with the presence of rotator cuff syndrome at the trend level.

None of the work organization measures were associated with back pain. Epicondylitis was not included in the multivariate analysis due to the small number of cases. Awkward posture maintained its positive association with the presence of rotator cuff syndrome (Table IV). Skill variety maintained its inverse association with the presence of carpel tunnel syndrome. Several personal characteristics were also significantly associated with musculoskeletal injuries in the multivariate analysis. Greater age was associated with rotator cuff syndrome and carpal tunnel syndrome. Years lived in the US was inversely associated with carpal tunnel syndrome, while working in poultry processing versus other manual work had a positive association with carpal tunnel syndrome.

DISCUSSION

Latina manual workers in this study commonly experienced epicondylitis, rotator cuff syndrome, back pain, and CTS. The proportion of those diagnosed with these musculoskeletal injuries was similar to the proportion to the total sample of participants in the large study that included men as well as women [Rosenbaum et al., 2013; Cartwright et al., 2012]. The prevalence for epicondylitis and CTS were similar to that reported in the literature for other working populations. Fan and colleagues [2009] reported 5.2% of workers with epicondylitis compared to 5.5% of the participants in this study. The prevalence of possible CTS was 40% and of definite CTS was 8.9% among the participants in this study. This compares with the 6.7% rate reported by Luckhaupt and colleagues [2013], the 7.8% prevalence reported by Dale and colleagues [2013], and the 10.8% prevalence reported by Silverstein and colleagues [2010] using samples largely composed of non-Hispanic white Americans. The level of rotator cuff syndrome is substantially greater for the participants in this study (16.2%) compared to the largely non-Hispanic white sample (7.5%) analyzed by Silverstein and colleagues [2008].

Work organization characteristics were associated with the presence of epicondylitis, rotator cuff syndrome, and CTS among the study participations. Awkward posture and decision latitude were associated with epicondylitis among the women in this study. Similarly, Fan and colleagues [2009] reported epicondylitis being associated with greater physical workload. Rotator cuff syndrome was associated with the job demand factors awkward posture and psychological demand among the study participants. Silverstein and colleagues [2008] reported that the associations of work organization factors, such as structural constraints, decision latitude, and job satisfaction, with rotator cuff are suggestive. Job strain, as indicated by increased awkward posture (bivariate analysis) and psychological demand (multivariate analysis), and decreased skill variety (bivariate and multivariate analyses) and job control (bivariate analysis), were related to CTS among these Latina manual workers. Harris-Adamson and colleagues [2013] reported that high job strain and social support were associated with the incidence of carpal tunnel syndrome.

The results of this research should be interpreted in light of its limitations. The study sample is limited to currently full-time employed women. Some women with musculoskeletal and neurological injuries may have left the work force. Women with part-time employment may experience different rates of injury. This research was conducted in one part of one state, which limits the generalizability of the results to other locales. Because the study had a cross-sectional design, the injuries found among the participant cannot be definitely

associated with their work in general or their current jobs.

This analysis provides important, although limited, evidence that work organization characteristics, particularly job control and job demands, are associated with the presence of clinically diagnosed musculoskeletal and neurological injuries among immigrant Latina workers. The pattern of these results is consistent with research focused on non-immigrant workers in the US [Fan et al., 2009; Harris-Adamson et al., 2013; Luckhaupt et al., 2013; Silverstein et al., 2008, 2010]. Further research examining clinically evaluated health outcomes among immigrant women workers is needed. Such research should use a longitudinal design so that the degree to which injuries and other health outcomes actually result from work can be assessed. This research should also expand measurement of the potential sources of injury (e.g., domestic responsibilities [Borrell et al., 2004; Guendelman et al., 2001; Grzywacz et al., 2009], and the kinds of injuries in terms of location (e.g., lower body) and type (e.g., dermatological, lacerations). Optimally, this research should include a large, heterogeneous sample that is diverse by occupation, sex, immigrant status, and ethnicity. Such research would allow comparisons in the prevalence of health outcomes and allow the delineation of the differential effects of work organization factors. However, as such large scale studies are rare, comparisons of specific populations should be conducted to determine these associations.

This research does support consideration of occupational safety policy, even with its limitations. Work demands, particularly in terms of posture and psychological demand, for the types of manual work held by the participants in this research need to be examined in light of current ergonomic standards. Ergonomic changes can reduce the risk of some musculoskeletal and neurological injuries [Kim & Nussbaum, 2013; Lin et al., 2012]. Increased frequency of breaks can reduce work injuries, sometimes without impeding productivity [Dababneh et al., 2001; Tucker et al., 2003]. Investigations of the psychological demands of workers in these manual industries, such as poultry and meat processing, show that high levels of productivity are demanded of workers [Arcury et al., 2013; Fink, 1998; Horton & Lipscomb, 2011; **Lipscomb** et al., 2007]. For poultry processing, the industry in which half of the study participants are employed, a current policy initiative from the US Department of Agriculture would increase work demands by increasing the rate of production (line speed) (Federal Register Volume 77, Number 228 (Tuesday, November 27, 2012)), even in the face of evidence showing the detrimental health effects of this policy [Musolin et al., 2013].

In conclusion, this analysis indicates the potential importance of work organization factors as causes of occupational musculoskeletal and neurological injury among immigrant Latinas and other vulnerable workers. Further research is required to understand the associations of work and health outcomes of these women. Policy initiatives need to consider how work organization affects occupational health.

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Table I. Personal Characteristics, Employment Characteristics, and Musculoskeletal Injuries of Latina Woman Manual Workers, Western North Carolina, 2010 (n=234).

Personal and Employment Characteristics, and Musculoskeletal Injuries	n	%	Mean	SE
Age (in years)			34.9	0.64
Years Lived in US			11.3	0.40
Indigenous Language	37	15.8		
Currently Married (not used in analysis)	184	78.3		
Number of Co-Resident Children (not used in analysis)			1.8	0.08
Employment				
Poultry processing	128	54.7		
Other manual work	106	45.3		
Musculoskeletal and Neurological Injuries				
Epicondylitis	13	5.5		
Rotator cuff syndrome	38	16.2		
Back pain	48	20.4		
Carpal tunnel syndrome	115	48.9		

Table II. Work Organization Indicators, Latina Woman Manual Workers, Western North Carolina, 2010 (n=234).

Organization of Work	Mean	SE	Range
Job Demands			
Heavy load	1.71	0.03	1.00-3.45
Awkward posture	2.03	0.05	1.00-4.00
Psychological demand	2.43	0.06	1.00-4.00
Job Control			
Skill variety	1.89	0.05	1.00-4.00
Decision latitude	1.84	0.06	1.00-4.00
Support			
Perceived supervisor control (excludes self-employed; n = 202)	2.34	0.03	1.00-3.57
Work safety climate (excludes self-employed; n = 197)	24.66	0.24	13.00-32.00

Table III. Bivariate Associations of Work Organization with Musculoskeletal Injuries, Latina Woman Manual Workers, Western North Carolina, 2010 (n=234).

Work Organization	Epicondylitis	Rotator Cuff Syndrome	Carpal Tunnel Syndrome
Job Demands			
Heavy load			
Odds ratio	1.01	1.25	0.77
95% confidence interval	0.27-3.67	0.62-2.52	0.42-1.38
P-value	0.98	0.53	0.37
Awkward posture			
Odds ratio	1.74	**2.13**	**1.53**
95% confidence interval	0.91-3.37	**1.41-3.20**	**1.12-2.08**
P-value	0.09	**<0.01**	**<0.01**
Psychological demand			
Odds ratio	1.76	**1.49**	1.23
95% confidence interval	0.85-3.60	**1.01-2.20**	0.94-1.59
P-value	0.12	**0.04**	0.12
Job Control			
Skill variety			
Odds ratio	0.83	0.89	**0.55**
95% confidence interval	0.45-1.53	0.55-1.42	**0.39-0.79**
P-value	0.56	0.62	**<0.01**
Decision latitude			
Odds ratio	**0.36**	0.71	**0.72**
95% confidence interval	**0.15-0.85**	0.47-1.07	**0.54-0.96**
P-value	**0.01**	0.10	**0.02**
Support			
Perceived supervisor control			
Odds ratio	0.84	0.53	0.88
95% confidence interval	0.23-2.95	0.26-1.08	0.49-1.58
P-value	0.78	0.07	0.67
Work safety climate			
Odds ratio	0.94	0.93	1.00
95% confidence interval	0.82-1.07	0.85-1.03	0.91-1.08
P-value	0.37	0.19	0.95

Table IV. Multivariate Associations of Work Organization with Musculoskeletal Injuries, Woman Manual Workers, Western North Carolina, 2010 (n=234).

Work Organization	Rotator Cuff Syndrome			Carpal Tunnel Syndrome		
	Odds Ratio	95% CI	P-value	Odds Ratio	95% CI	P-value
Models without Supervision Indicators (n=234)						
Job Demands						
Heavy load	1.19	0.46-3.11	0.71	0.93	0.43-1.98	0.85
Awkward posture	**1.80**	**1.01-3.23**	**0.04**	1.38	0.88-2.13	0.15
Psychological demand	0.80	0.49-1.32	0.39	0.76	0.51-1.12	0.17
Job Control						
Skill variety	1.26	0.66-2.39	0.39	**0.56**	**0.36-0.88**	**0.01**
Decision latitude	0.71	0.39-1.27	0.25	0.93	0.62-1.38	0.71
Personal Characteristics						
Age	**1.06**	**1.02-1.11**	**<0.01**	**1.10**	**1.06-1.14**	**<0.01**
Years lived in US	1.91	9.94-1.08	0.76	**0.93**	**0.87-0.98**	**0.01**
Indigenous versus non-indigenous language	2.65	0.77-9.07	0.11	0.71	0.31-1.58	0.40
Poultry processing versus other manual work	2.75	0.83-9.06	0.09	**2.37**	**1.14-4.92**	**0.02**
Models with Supervision Indicators (n=202)						
Job Demands						
Heavy load	1.27	0.48-3.36	0.61	0.96	0.42-2.13	0.91
Awkward posture	1.68	0.93-3.04	0.08	1.54	0.93-2.53	0.08
Psychological demands	0.91	0.55-1.52	0.74			
Job Control						
Skill variety	1.54	0.78-3.06	0.21	**0.49**	**0.29-0.81**	**<0.01**
Decision latitude	0.84	0.46-1.53	0.57	0.84	0.51-1.39	0.51
Support						
Perceived supervisor control	0.62	0.24-1.60	0.33	1.31	0.58-2.94	0.51
Work safety climate	0.99	0.86-1.14	0.92	1.01	0.92-1.11	0.80
Personal Characteristics						
Age	**1.06**	**1.01-1.11**	**0.01**	**1.09**	**1.04-1.14**	**<0.01**
Years lived in US	1.01	0.94-1.09	0.68	**0.92**	**0.87-0.98**	**0.01**
Indigenous versus non-indigenous language	3.33	0.87-12.65	0.07	0.92	0.37-2.27	0.86
Poultry processing versus other manual work	3.13	0.81-12.66	0.09	**2.57**	**1.12-5.88**	**0.02**

1-13. Personal Protective Equipment and Work Safety Climate among Poultry Processing Workers

ABSTRACT

Background Job-appropriate personal protective equipment (PPE) is important for decreasing the high rates of occupational injury experienced by poultry processing workers. This analysis describes the job-appropriate PPE provided to poultry processing workers by their employers and the PPE used by these workers, and delineates the association of work safety climate with job-appropriate PPE.

Methods Data are from a cross-sectional study of 403 Latino poultry processing workers in western North Carolina.

Results Most poultry processing workers are not provided with or use job-appropriate PPE; however, more workers use job-appropriate PPE than are provided with this PPE. The provision and use of job-appropriate PPE differs among workers by employer. Work safety climate did not differ by job, once employer was considered. Work safety climate was associated with use of job-appropriate PPE.

Conclusions Poultry processing workers need to be provided with job-appropriate PPE. Work safety climate reflects the degree to which workers use job-appropriate PPE. Further research on the association of work safety climate and other work organization characteristics on PPE use and other job safety characteristics is needed.

INTRODUCTION

Poultry processing is a dangerous industry in which workers experience high levels of occupational injury and illness [Lipscomb et al., 2005, 2007a, 2007b, 2008; McPhee & Lipscomb, 2009; Quandt et al., 2006; Grzywacz et al., 2007; Cartwright et al., 2012; Pichardo-Geisinger et al., 2012]. Occupational injury and illness frequently experienced by poultry processing workers include musculoskeletal injures that result falls, lifting, and repetitive motion; lacerations that result from knives, scissors, and powered cutting tools, as well as from getting hands and fingers caught in equipment; and skin infection and inflammation that result from exposure to chicken fluids and chemicals used for cleaning and sanitation. Evidence suggests that work in poultry processing also affects the mental health of workers [Horton & Lipscomb, 2011].

Workers in the poultry processing industry are generally members of minority groups. Most are immigrants from Latin American countries [Griffith, 1990; Striffler, 2005; Stull & Broadway, 2004]. The high proportion of poultry processing workers who are members of minority and immigrant populations, and the high prevalence of occupational injuries raises concerns about the occupational justice and health disparities experienced by these workers [Lipscomb et al., 2006; Grzywacz et al., 2007; Marín et al., 2009]

One mechanism for decreasing occupational injury and illness among poultry processing workers is the use of appropriate personal protective equipment (PPE) [Quandt et al., 2006]. The PPE that is appropriate for poultry processing workers must reflect the specific their specific jobs. These jobs are diverse and represent the process of transforming live chickens to chilled and packaged meat that is distributed to stores and restaurants. They include receiving the live birds from trucks; hanging these live birds; killing and plucking the birds; eviscerating, cutting, trimming, and deboning the birds; washing the bird parts; and then chilling and packing the bird parts [Striffler, 2005]. Additionally, sanitation is an important job in poultry processing plants. The PPE required for each of these jobs varies [Occupational Safety and Health Administration, 2001]. However, little research has documented the provision of job-appropriate PPE to poultry processing workers or the use of PPE by these workers. Recent analyses of PPE for poultry processing workers have been directed at prevention of exposure to avian influenza [Coetzee et al., 2011; McMahon et al., 2008].

Work safety culture is an indicator of the value of occupational safety shared by workers and their supervisors [Zohar, 1980, 2010]. Work safety climate is one component of work safety culture that indicates workers'

perceptions of the value that their supervisors place on occupational safety. The provision of job-appropriate PPE by employers and the use of this PPE by workers should reflect the work safety climate in which they work [Sauter et al., 2002; Zohar, 2000, 2010). Work safety climate is particularly important for immigrant Latino workers [Arcury et al., 2012a, 2012b]. These workers are vulnerable; they have limited formal education and low-incomes, they live in communities with high unemployment, and they are frequently undocumented. Therefore, they are unwilling to complaint when safe working standards, such as the provision of job-appropriate PPE, are not observed. Even when documented, they fear increased discrimination and harassment if they complain about the lack of safety [Marín et al., 2009]. People from Latin American countries have little experience with regulated workplace safety and do not expect employers to minimize hazardous exposures. Finally, men from Latin American countries often feel that they cannot complain about the lack of workplace safety or about uncomfortable conditions [Menszel & Gutierrez, 2010; Quandt et al. 1998; Hunt et al., 1999; Arcury et al., 2012].

This analysis has two objectives. The first is to describe the job-appropriate PPE provided to poultry processing workers by their employer, and the job-appropriate PPE used by workers. The second objective is to delineate the association of work safety climate with receiving and using job-appropriate PPE among poultry processing workers.

METHODS

Data are from a cross-sectional study of Latino poultry processing workers employed in four western North Carolina counties. Three different companies operate poultry processing plants in these counties.

Sample

A community-based approach was used to recruit a representative sample [Arcury & Quandt, 1999]. A sample frame was developed of dwellings where Latinos lived in the study counties. Working with a community-based organization, the study team mapped the neighborhoods in each county with high proportions of Latino residents. The research team also surveyed other areas of the counties to identify other dispersed dwellings that were likely inhabited by Latino residents; surveyors looked for cultural or behavioral indicators known to characterize Latino residents (e.g., car decals, bicycles, particular satellite dishes) to identify such dwellings. The lists of neighborhood and dispersed dwellings contained 4,376 possible Latino dwellings, with about two-thirds in neighborhoods. The lists were randomized and stratified to ensure that two-thirds of potential dwellings were located in neighborhoods and one-third of potential dwellings were dispersed.

Two to four members of the local Latino communities were hired as recruiters in each of the four counties. Recruiters approached randomly selected dwellings in order. If no one was home, recruiters returned at different times and on different days. Residents were screened for inclusion criteria: self-identified as being Latino or Hispanic, worked 35 hours or more per week in a manual labor job, and were 18 yrs or older. Manual labor jobs were defined as employment in non-managerial jobs in industries such as poultry processing, landscaping, construction, restaurant work, hotel work, child care, or manufacturing. Non-poultry manual workers with previous work in poultry only qualified if lifetime employment in poultry production or processing was 6 months or less, and not within the past 2 years. Work in poultry processing was defined as any type of non-supervisory work in a poultry processing plant with job categories from receiving through sanitation. Employees of poultry production farms were excluded. More than one resident per dwelling could be recruited, if eligible. Of 1,681 dwellings selected, 965 were screened, for a screening rate of 57%. A total of 1,526 residents were screened. Of those eligible, 78% were interviewed. Of the 742 interviewed participants, 403 were poultry processing workers who were included in this analysis.

Data Collection

Interviewers completed a 1-day training session that addressed interview techniques, questionnaires contents, human subject protection, and ethics. Each interviewer was required to conduct a practice interview prior to beginning data collection. Participants completed face-to-face interviews in their homes. All interviews were

conducted in Spanish. Interviews took approximately 60 minutes to complete and included information on work history, work environment, symptoms and disability, and psychosocial characteristics. Participants received a $10 incentive at the completion of the interview. All procedures were approved by the Wake Forest School of Medicine Institutional Review Board. All participants provided written informed consent.

Measures

Two sets of measures of job-appropriate PPE are included in the analysis: whether the PPE is provided by the employer and whether the PPE is used by the employee. The job-appropriate PPE for each job was determined by first reviewing the Occupational Safety and Health Administration's "Poultry processing industry e-tool" [2001]. The resulting list was reviewed by a representative of the UFCW (United Food and Commercial Workers) familiar with occupational safety in the poultry processing industry (Jackie Nowell, personal communication, March 22, 2012). The minimal set of appropriate PPE was determined for each job (Table I). Participants were asked if they were provided with every type of PPE in the list, and they were asked if they used every type of PPE in the list. For each type of PPE that was appropriate to their jobs, participants were categorized as it being provided by their employer and as it being used. Participants were also categorized as to whether or not their employer provided all of the job-appropriate PPE, and as to whether or not they used all of the job-appropriate PPE. The number of job-appropriate PPE items provided by the employer and the number of job-appropriate items used by the worker were also calculated.

Participants evaluated their supervisors with the 10-item Perceived Safety Climate Scale [Gillen et al., 2002]. Nine of the items in this scale used a four-point Likert format (strongly agree, agree, disagree, strongly disagree). The tenth item included three response categories. After a Cronbach's Alpha analysis was performed, one of the nine four-point Likert format items was discarded due to lack of fit within the scale. This item had a correlation with the total scale that was close to 0, indicating that it was not measuring the same construct as the remaining scale items. A total Work Safety Climate was calculated by summing the remaining nine items. Values for the scale ranged from 9 to 35, with higher values indicating better work safety climate. The mean score in this study was 24.8, with a standard deviation of 3.2 ($\alpha = 0.73$).

Personal and work characteristics considered in the analysis are gender, language, age, years working in poultry, employer, and job. Language has the values of Spanish and indigenous indicating the language spoken in their home when they were children. Age and years working in poultry processing are continuous measures. Employer is a 3-level categorical variable. Thirteen jobs were identified among the participants: receiving, hanging, killing and plucking, evisceration, cutting, trimming, deboning, evisceration-cutting-trimming-deboning (ECTD), wash-up, chilling, packing, sanitation, and other.

Analysis

Data were summarized using means and standard deviations (SDs) for continuous variables, and frequencies and percents for categorical variables. All analyses accounted for the sampling structure of the data, clustering on county of residence and dwelling unit. Associations between employer and PPE use and provision were explored using Rao-Scott Chi-square tests.

Associations between the work safety climate total score and job were explored with ANOVA tests. Subsequently, these ANOVA tests were also adjusted for employer. Job categories with fewer than 10 participants were not included in the association analyses. Associations between the work safety climate total score and job-appropriate PPE use and provision (both the number of PPE and whether or not all appropriate PPE were used and provided) were also explored with ANOVA tests, adjusting for employer. All analyses were completed using SAS version 9.2 (SAS Institute, Inc, Cary, NC). A p-value of 0.05 or less was considered statistically significant.

RESULTS

Participant Characteristics

A majority of the participants were male (Table II). The primary language for most was Spanish, although one-quarter spoke an indigenous language. Their mean age was 35 years, and the mean number of years worked in poultry processing was 4.9. About one-third worked for each of the three employers. The jobs held by the participants included all aspects of poultry processing. Several of the jobs were not frequent; these included receiving, killing and plucking, evisceration, wash-up, and chilling. A substantial number of participants had the jobs hanging, cutting, trimming, deboning, evisceration-cutting-trimming-deboning (ECTD), packing, and sanitation. Twenty-five had other jobs that fall outside this analysis

The distribution of jobs reported by the participants differed among the employers (Table III). Most of those with the job of hanging, trimming, packing and other worked for Employer 1. Most of those with the job deboning worked for Employer 2. Most of those with the job cutting and ECTD worked for Employer 3.

Personal Protective Equipment

Eye protection was generally provided and used by sanitation workers (Table IV). Hearing protection was also generally provided and used. Special foot wear was less often provided, especially for those with the jobs of trimming and deboning, as well as packing. However, special footwear was generally used. Specialized hand tools were not frequently provided by employers. A greater number of workers actually used these specialized hand tools. Specialized material handling tools were seldom provided by employers, and seldom used by workers. Head protection was provided to and used by about three-in-five workers. Protective clothing was generally provided and used by those having the jobs hanging and sanitation. All appropriate PPE being provided by employers differed widely by job. Most of those with the job of hanging received all of the appropriate PPE, as did those with sanitation jobs. Fewer than half of those with the jobs of cutting and ECDT were provided with all of the appropriate PPE. About one-in-ten workers with the job trimming were provided with all the appropriate PPE, while fewer than 10% of those with the jobs deboning and packing are provided with all of the appropriate PPE. Generally a greater number of workers used all appropriate PPE than were provided this PPE by their employers.

The provision and use of all job-appropriate PPE differed significantly by employer. The provision of all job-appropriate PPE was reported by 22 (18.2%) Employer 1 workers and 24 (21.2%) Employer 2 workers, but by 66 (50.0%) Employer 3 workers ($p<0.01$). The use of all job-appropriate PPE was reported by 22 (18.2%) Employer 1 workers and 34 (28.6%) Employer 2 workers, but by 85 (64.0%) Employer 3 workers ($p<0.01$) .

Work Safety Climate

The elements of Work Safety Climate differed among workers with different jobs (Table V). Most (75% or more) participants in each job agreed with the statements that “workers’ safety practices are very important to management,” “workers are regularly made aware of dangerous work practices or conditions,” “workers receive instructions on safety when hired,” “proper safety equipment is always available,” and “workers have almost total control over personal safety.” Fewer workers agreed with the statement that “workers are regularly praised for safe conduct,” with as few as 34.0% of those working in packing and 37.5% of those working in hanging agreeing with this statement. However, 88.5% of those working in deboning agreed with this statement. Similarly, fewer workers agreed with the statement that “taking risks is not a part of my job,” with as few as 10.2%of those working in ECTD, 10.8% of those working in cutting, and 16.7% of those working packing agreeing with the statement. However, 50.8% of those working in deboning agreed with this statement. In responding to the statement that “supervisors are only interested in doing the job fast and cheap,’ two-thirds or more of those working in hanging, cutting and ECTD agreed with the statement and about half or more of those employed in trimming, packing and sanitation agreed with the statement, but only 4.9% of those working in deboning agreed with the statement.

Total Work Safety Climate score differed significantly by job ($p < 0.01$) in an unadjusted analysis. However, these differences were no long significant ($p = 0.09$) when the analysis adjusted for employer.

Total Work Safety Climate score did not differ significantly ($p = 0.51$) when participants were compared as to whether or not their employer provided all the job-appropriate PPE for their job (mean scores for both all provided and not all provided was 24.9). This association remained non-significant when the analysis considered Work Safety Climate by number of job-appropriate PPE provided (Spearman correlation = 0.02, $p = 0.73$). However, total Work Safety Climate score was significantly greater ($p < 0.02$) for those who used all job-appropriate PPE (mean score of 25.2) compared to those who did not use all job-appropriate PPE (mean score of 24.7). The significant association of Work Safety Climate with use of job-appropriate PPE remained when the analysis compared Work Safety Climate by number of job-appropriated PPE used (Spearman correlation = 0.17, $p < 0.01$).

DISCUSSION

Most Latino workers in western North Carolina poultry processing plants are not provided with a minimum set of job-appropriate PPE, and most of these workers do not use a minimum set of job-appropriate PPE. However, a greater percentage of workers use job-appropriate PPE than are provided with this PPE. The provision and use of job-appropriate PPE differs among these Latino poultry processing workers by employer. Work safety climate did not differ by job, once employer was considered. However, work safety climate was associated with whether job-appropriate PPE was used.

The use of appropriate PPE is important for protecting workers from occupational injuries [Occupational Safety and Health Administration, 2001]. Appropriate PPE should be provided to workers at no cost, "except for certain safety-toe shoes and boots, prescription safety eyewear, and logging boots" [Occupational Safety and Health Administration, 2007]. Job-appropriate PPE provided to poultry processing workers and their use of this PPE has not been document in previous research. This analysis shows that few poultry processing workers are provided with the minimum PPE that is appropriate for their job. The job-appropriate PPE that is generally provided is that PPE which is in-expensive; eye protection and hand protection. More expensive PPE, such as special footwear and specialized hand tools, is provided to far fewer workers. That more workers use job-appropriate PPE than is provided by their employers indicates that these workers value the protection afforded to them by the PPE.

Although the use of PPE improves occupational safety and reduces occupational injury and illness [Occupational Safety and Health Administration, 2001], employers are not providing Latino poultry processing workers with the minimum PPE that is required for their jobs and workers are not using the minimum job-appropriate PPE. The lack of job-appropriate PPE occurs in the face of high rates of occupational injury and illness experienced by workers in the poultry processing industry [Lipscomb et al., 2007a, 2008; McPhee & Lipscomb, 2009; Cartwright et al., 2012; Pichardo-Geisinger et al., 2012]. It is essential that processes and structures be implemented to ensure that employers provide all job-appropriate PPE to workers in the poultry processing industry. It is also essential that these processes and structures be implemented to ensure that workers use all job-appropriate PPE. Information about job-appropriate PPE has been provided successfully to poultry processing workers in community interventions outside of the workplace [Grzywacz et al., 2009].

A component of work organization [Sauter et al., 2002], work safety climate is a measure of how workers perceive the value their supervisors place on safety over production [Zohar, 1980]. Little research has examined work safety climate in manufacturing. Among Latino manufacturing workers who participated in this study, work safety climate did not differ by job when employer is considered in the analysis. Therefore, although work safety climate may be affected by job among Latino poultry processing workers, it is driven by the employer. This reflects Zohar's [2000] conclusion that those working for a specific employer were homogenous in their perceptions of work safety climate. However, this differs from Latino construction workers in which work safety climate did differ by job (roofers perceived work safety climate to be worse than framers and general construction workers) [Arcury et al., 2012b]. This difference reflects how work safety climate may differ in terms of other work organization characteristics. Manufacturing plants, as the poultry processing companies considered in this analysis, often have a large number of employees. These employees work under one set of safety guidelines which reflects a common safety culture, even when they have different jobs. Even contract workers in a manufacturing plant must abide by the company's safety policies. Construction

workers often work in small groups with different employers, even if on the same job site.

Work safety climate is important for Latino immigrant workers. These workers are financially and politically vulnerable [Lipscomb et al., 2006]. They generally will not complain if they are faced with a poor work safety [Arcury et al., 2012a, 2012b]. They will continue to work in unsafe environments because they need the jobs and they fear harassment from authorities if they complain [Marín et al., 2009]. However, occupational health research is just beginning to examine work safety climate among Latino immigrant workers. Menzel and Gutierrez [2010] and Arcury and colleagues [2012b] report that work safety climate was associated with the use of PPE among Latino immigrant construction workers. Quandt and colleagues [2006] report measures of work safety climate and employer paying for specific PPE among Latino poultry processing workers, but they do not consider the association of safety climate and employer provided PPE. Grzywacz and colleagues [2007] found that safety commitment among supervisors was associated with the prevalence of musculoskeletal problems, respiratory problems, and injury in bivariate analysis of Latino poultry processing workers. Investigations of work safety climate among immigrant Latino farmworkers indicates that work safety climate is related to employer safety practices [Whalley et al., 2009] and to occupational injuries [Arcury et al., 2012a]. The diversity of industries and jobs in which Latino immigrants work requires further investigations before greater generalizations can be provided about work safety climate among these workers, and about the associations between work safety climate, occupational safety behaviors, and health outcomes.

These results should be considered within the study's limitations. Participants were recruited from one area of North Carolina and all were Latino, limiting generalizability to other areas and workers from other ethnic groups. The study had a cross-sectional design which does not allow for determination of causation between provision and use of PPE, employer, and work safety climate. The provision and use of PPE is based on self-report. However, the study's strengths are also important. The sample was large and participants worked for three different poultry processing companies. The sample design attempted to recruit participants randomly. The study used a standard measure of work safety climate [Gillen et al., 2002], which has been used in other analyses of immigrant Latino workers [Arcury et al., 2012a, 2012b; Grzywacz et al., 2007; Quandt et al., 2006].

Greater effort is needed to ensure that all poultry processing workers are provided with and use job-appropriate PPE. Work safety climate reflects the degree to which workers used job-appropriate PPE. Further research on the influence of work safety climate and other work organizations characteristics on the use of PPE and other job safety characteristics is needed.

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Table I. Type of Appropriate Personal Protective Equipment Provided for Each Job, Poultry Processing Workers, Western North Carolina, 2010 (n=403).

Personal Protective Equipment	Jobs											
	Receiving	Hanging	Killing & Plucking	Evisceration	Cutting	Trimming	Deboning	ECTD*	Wash-up	Chilling	Packing	Sanitation
Eye protection			X									X
Hearing protection	X	X	X	X	X	X	X	X	X	X	X	X
Dust masks	X											
Hand protection	X	X	X	X	X	X	X	X	X	X	X	X
Special footwear	X		X	X	X	X	X		X	X	X	
Specialized hand tools			X	X	X	X	X	X				
Specialized material handling tools										X	X	
Head protection											X	
Protective clothing		X	X							X		X

*Includes jobs in which workers perform two or more of the jobs of evisceration, cutting, trimming, and deboning.

Table II. Personal Characteristic, Employer and Jobs of Poultry Processing Workers, Western North Carolina, 2010 (n=403).

Personal Characteristics, Employers and Jobs	n	%	Mean	SD
Gender				
Female	173	42.9		
Male	230	57.1		
Language				
Spanish	293	73.4		
Indigenous	106	26.6		
Age			35.0	10.8
Years Working in Poultry Processing			4.9	4.2
Employer				
Employer 1	139	35.1		
Employer 2	121	30.6		
Employer 3	136	34.3		
Jobs				
Receiving*	6	1.5		
Hanging	24	6.0		
Killing & Plucking*	5	1.2		
Evisceration*	5	1.2		
Cutting	41	10.2		
Trimming	36	8.9		
Deboning	61	15.1		
ECTD**	49	12.2		
Wash-up*	7	1.7		
Chilling*	2	0.5		
Packing	98	24.3		
Sanitation	44	10.9		
Other***	25	6.2		

*Removed from remaining analyses due to small numbers.
**Includes jobs in which workers perform two or more of the jobs of evisceration, cutting, trimming, and deboning.
***Removed from remaining analyses due to inability to determine proper PPE.

Table III. Distribution of Jobs by Employer, Poultry Processing Workers, Western North Carolina, 2010 (n=403).

Jobs	Employer 1		Employer 2		Employer 3	
	N	%	N	%	N	%
Receiving	4	66.7	1	16.7	1	16.7
Hanging	12	52.2	2	8.7	9	39.1
Killing & Plucking	1	25.0	0	--	3	75.0
Evisceration	5	100.0	0	--	0	--
Cutting	4	9.8	7	17.1	30	73.2
Trimming	26	72.2	8	22.2	2	5.6
Deboning	0	--	59	96.7	2	3.3
ECTD*	1	2.0	7	14.3	41	83.7
Wash-up	1	14.3	5	71.4	1	14.3
Chilling	0	--	1	100.0	0	--
Packing	53	55.8	10	10.5	32	33.7
Sanitation	14	31.8	19	43.2	11	25.0
Other	18	75.0	2	8.3	4	16.7

*Includes jobs in which workers perform two or more of the jobs of evisceration, cutting, trimming, and deboning.

Table IV. Appropriate Personal Protective Equipment That is Employer Provided and That is Used by Poultry Processing Workers for Each Job, Western North Carolina, 2010.

Personal Protective Equipment	Hanging	Cutting	Trimming	Deboning	ECTD*	Packing	Sanitation
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Total Number of Appropriate Personal Protective Equipment Items	3	4	4	4	4	5	4
Employer Provided							
Eye protection	--	--	--	--	--	--	41 (93.2)
Hearing protection	23 (95.8)	40 (100.0)	36 (100.0)	61 (100.0)	48 (98.0)	96 (98.0)	44 (100.0)
Hand protection	23 (95.8)	36 (90.0)	34 (94.4)	31 (50.8)	47 (95.9)	74 (75.5)	42 (95.5)
Special footwear	--	27 (67.5)	12 (33.3)	3 (4.9)	44 (95.9)	48 (49.0)	--
Specialized hand tools	--	24 (60.0)	17 (47.2)	12 (19.7)	27 (55.1)	--	--
Specialized material handling tools	--	--	--	--	--	22 (22.5)	--
Head protection	--	--	--	--	--	58 (59.2)	--
Protective clothing	23 (95.8)	--	--	--	--		42 (95.5)
All Appropriate Personal Protective Equipment Provided	21 (87.5)	17 (41.5)	4 (11.1)	3 (4.9)	23(46.9)	7 (7.1)	37 (84.1)
Used							
Eye protection	--	--	--	--	--	--	41 (93.2)
Hearing protection	23 (95.8)	41 (100.0)	36 (100.0)	61 (100.0)	47 (95.9)	98 (100.0)	44 (100.0)
Hand protection	20 (83.3)	40 (97.6)	36 (100.0)	61 (100.0)	49 (100.0)	72 (74.2)	40 (90.9)
Special footwear	--	34 (82.9)	17 (47.2)	59 (96.7)	45 (91.8)	56 (57.7)	--
Specialized hand tools	--	29 (76.3)	21 (58.3)	12 (19.7)	31 (63.3)	--	--
Specialized material handling tools	--	--	--	--	--	27 (27.8)	--
Head protection	--	--	--	--	--	59 (60.8)	--
Protective clothing	23 (95.8)	--	--	--	--		43 (97.7)
All Appropriate Personal Protective Equipment Used	19 (79.2)	25 (61.0)	6 (16.7)	10 (16.4)	28 (57.1)	12 (12.2)	37 (84.1)

*Includes jobs in which workers perform two or more of the jobs of evisceration, cutting, trimming, and deboning.

Table V. Work Safety Climate by Job for Poultry Processing Workers, Western North Carolina, 2010.

	Total Sample	Jobs						
		Hanging	Cutting	Trimming	Deboning	ECTD	Packing	Sanitation
Number of participants	403	24	41	36	61	49	98	44
Work Safety Climate Items	Percent Agree or Strongly Agree							
Workers' safety practices are very important to management.	89.1	87.0	91.9	100.0	100.0	79.2	88.5	84.1
Workers are regularly made aware of dangerous work practices or conditions.	90.6	87.5	95.1	91.7	98.4	81.6	88.7	95.5
Workers are regularly praised for safe conduct.	50.1	37.5	60.0	36.1	88.5	57.1	34.0	54.6
Workers receive instructions on safety when hired.	87.5	83.3	90.2	88.6	98.4	75.5	87.8	93.0
Workers attend regular safety meetings.	82.7	75.0	90.0	82.9	98.4	77.6	76.0	88.6
Proper safety equipment is always available.	89.6	91.7	97.3	91.4	100.0	91.8	86.3	84.1
Workers have almost total control over personal safety.	84.9	91.7	79.0	77.1	100.0	81.6	83.3	88.6
Taking risks is not a part of my job	64.7	41.7	62.2	75.0	95.1	25.0	63.5	70.5
Overall safety climate assessment:								
Supervisors do as much as possible to make my job safe.	24.2	26.1	10.8	21.2	50.8	10.2	16.7	32.6
Supervisors could do more to make my job safe.	26.0	8.7	21.6	21.2	44.3	18.4	30.2	20.9
Supervisors are only interested in doing the job fast and cheap.	49.7	65.2	67.6	57.6	4.9	71.4	53.1	46.5
Total Score: mean (SD)	24.8 (3.2)	24.7 (3.1)	25.3 (3.1)	24.8 (2.5)	26.6 (1.6)	23.7 (4.0)	24.3 (2.9)	25.7 (3.5)

1-14. Employer, Use of Personal Protective Equipment, and Work Safety Climate: Latino Poultry Processing Workers

ABSTRACT

Background This analysis describes the work safety climate of Latino poultry processing workers and notes differences by worker personal characteristics and employer; describes the use of common personal protective equipment (PPE) among workers; and examines the associations of work safety climate and use of common PPE.

Methods Data are from a cross-sectional study of 403 Latino poultry processing workers in western North Carolina.

Results Work safety climate differed little by personal characteristics, but it did differ consistently by employer. Provision of PPE varied by type of equipment; e.g., 27.2% of participants were provide with eye protection at no cost, 57.0% were provided with hand protection at no cost, and 84.7% were provided with protective clothing at no cost. PPE use varied by type. Provision of PPE at no cost was associated with lower work safety climate, while consistent use of PPE was associated with higher work safety climate.

Conclusions Work safety climate is important for improving workplace safety for immigrant workers. Research among immigrant workers should document work safety climate for different employers and industries, and delineate how work safety climate affects safe behavior and injuries.

INTRODUCTION

Poultry farming and processing have expanded in the southeastern US over the past several decades [Striffler, 2005]. This expansion has been most significant in rural communities as poultry processers have moved closer to the source of their raw materials [Griffith, 1990; Grey, 1999]. Poultry processing results in substantial occupational injury [Lipscomb et al., 2005, 2007a, 2008; McPhee & Lipscomb, 2009; Quandt et al., 2006; Cartwright et al. in press]. Safety in poultry processing plants is often questioned [Lipscomb et al., 2007b; Marín et al., 2009].

Few rural communities have sufficient labor needed by the poultry processing industry [Fink 1998; Griffith et al., 1995; Striffler, 2005; Stull, 1994; Stull & Broadway, 2004]. As in other meat processing industries, the demand for this labor has been satisfied by immigrant Latino labor [Grey, 1999; Quandt et al., 2006]. Latino workers employed in poultry processing are vulnerable and marginal. Many more have migrated to the rural communities than there are jobs. These immigrant workers experience high rates of underemployment and unemployment. Many of these workers are not documented, and they are working on purchased documents. They are fearful of discovery and loss of employment, and potential deportation. Although demanding and dangerous, poultry processing jobs are considered to be “good jobs” as they provide reliable and long-term income [Grzywacz et al., 2007a]. For Latino men, culturally, it is unseemly for them to complain about the lack of safety or uncomfortable conditions [Menszel & Gutierrez, 2010; Quandt et al. 1998; Hunt et al., 1999; Arcury et al., in press]. Therefore, Latino poultry processing workers are not likely to complain about the work environment or work safety.

Recognition of the importance of the organization of work for occupational health and safety is increasing, including for the poultry processing industry [Sauter et al., 2002; Grzywacz et al. 2007b]. Work safety climate is one component of the organization of work [Zohar, 1980, 2010]. Work safety climate is workers’ perception of their supervisors’ value of safety over production. Work safety climate is often associated with occupational safety performance and reduced occupational injuries [Neal & Griffin, 2002; Zohar, 2010]. Given the vulnerability and marginality of Latino workers in poultry processing, their perception of the safety climate where they work is particularly important for the occupational safety [Grzywacz et al., 20076; Quandt et al., 2006].

Little documentation of work safety climate among Latino workers in the poultry processing industry is available. Quandt and colleagues [2006] found among 200 poultry processing worker that measures of work safety climate and the provision of personal protective equipment differed by employer. However, no further

research has confirmed these findings. Using data from a large study of poultry processing workers in western North Carolina, this analysis has three aims. First, it describes the work safety climate of Latino poultry processing workers and notes differences in work safety climate by worker personal characteristics (gender, language, age, years worked in poultry processing) and employer. Second, it describes the use of common personal protective equipment (PPE) among Latino poultry processing workers. Finally, it examines the associations of work safety climate and use of common PPE among Latino poultry processing workers.

METHODS

Data are from a cross-sectional study of Latino poultry processing workers residing in Burke, Surry, Wilkes, and Yadkin Counties in western North Carolina. These are rural counties with new settlement Latino communities [Kochhar et al., 2005]. The 2010 Latino population of the four counties was 19,310, 7.1% of their total population [US Bureau of the Census]. Three different poultry processing companies operate plants in the counties.

Sample Design

The research team did not have access to workplaces of the participants. No list of Latinos in the counties exists. Therefore, a community-based approach to sampling was used to assure that a representative sample would be selected (Arcury & Quandt, 1999). A sample frame was developed of dwellings where Latinos lived in the study area. The study team and a community-based organization partnered to map areas mostly populated by Latino residents (enclaves). The research team also surveyed other areas of the counties to identify other dispersed dwellings that were likely inhabited by Latino residents. To identify such dwellings, surveyors looked for cultural or behavioral indicators known to characterize Latino residents (e.g., car decals, bicycles, particular satellite dishes). The lists of enclave and dispersed dwellings contained 4,376 possible Latino dwellings, with about two-thirds in residential enclaves. The lists were randomized, and assigned proportionately to recruit two-thirds from enclaves and one-third from dispersed dwellings.

Recruitment

Well known members of the local Latino communities were hired as recruiters, with two to four recruiters for each county. Recruiters visited randomly selected dwellings in order. If no one was home, recruiters returned at different times and on different days. Residents were screened for inclusion criteria: self-identified as being Latino or Hispanic, worked 35 hours or more per week in a manual labor job, and were 18 yrs or older. Manual labor jobs were defined as employment in non-managerial jobs in industries such as poultry processing, landscaping, construction, restaurant work, hotel work, child care, or manufacturing. Non-poultry manual workers with previous work in poultry only qualified if lifetime employment in poultry production or processing was 6 months or less, and not within the past 2 years. Work in poultry processing was defined as any type of non-supervisory work in a poultry processing plant with job categories from receiving through sanitation. Employees of poultry production farms were excluded. More than one resident per dwelling could be recruited, if eligible. Of 1,681 dwellings selected, 965 were screened, for a screening rate of 57%. A total of 1,526 residents were screened. Of those eligible, 78% were interviewed. Of the 742 interviewed participants, 403 were poultry processing workers who were included in this analysis.

Data Collection

Interviewers completed a 1-day training session that addressed interview techniques, questionnaires contents, human subject protection, and ethics. Each interviewer was required to conduct a practice interview prior to beginning data collection. Participants completed face-to-face interviews in their homes. All interviews were conducted in Spanish. Interviews took approximately 60 minutes to complete and included information on work history, work environment, symptoms and disability, and psychosocial characteristics. The interviewers explained the purpose, procedures, risks and benefits of the study; answered questions; and obtained written informed consent. The respondent was given a $10 incentive as an appreciation for their participation. All procedures were approved by the Wake Forest University Health Sciences Institutional Review Board. Study supervisors met with each interviewer at least weekly to collect and review completed questionnaires to ensure data quality,

Measures

Work safety climate was the primary measure for this analysis. Participants were asked to evaluate their current employers with the 10-item Perceived Safety Climate Scale [Gillen et al., 2002]. Nine of the items in this scale used a four-point Likert format (strongly agree, agree, disagree, strongly disagree). The tenth item included three response categories. After a Cronbach's Alpha analysis was performed, one of the nine four-point Likert format items was discarded due to lack of fit within the scale. This item had a correlation with the total scale that was close to 0, indicating that it was not measuring the same construct as the remaining scale items. A total Work Safety Climate was calculated by summing the remaining nine items. Values for the scale ranged from 9 to 35, with higher values indicating better work safety climate. The mean score in this study was 24.8, with a standard deviation of 3.2, and a Cronbach's alpha of .73.

Personal protective equipment (PPE) that should be used by poultry processing workers depends on the tasks that they are performing. Participants asked about 10 specific types of PPE. Four of these were included in the analysis by Quandt and colleagues [2006]: eye protection (e.g., safety goggles, glasses), hand protection, special footwear (e.g., non-slip, steel toed), and protective clothing (e.g., overalls, jackets). These are general types of PPE that should be used in poultry processing plants. The other six types of PPE included: hearing protection (e.g., ear plugs, ear muffs), dust masks, shoe insoles, specialized hand tools, special material handling tools, and head protection (e.g., hard hat, plastic helmets). Finally, participants reported if they used any other PPE. Measures for each type of PPE included: (1) whether it was provided; (2) whether it was provided at no cost; and (3) if it was used, with the values less than all of the time versus all of the time. Descriptive results are reported for each type of PPE, but associations with work safety climate are limited to the four general types (eye protection, hand protection, special footwear, and protective clothing).

Personal and work characteristics considered in the analysis are gender, age, years working in poultry, employer, and language. Language has the values of Spanish and indigenous indicating the language spoken in their home when they were children. Employer is a 3-level categorical variable. Age and years working in poultry processing are continuous measures.

Statistical Analysis

Data were summarized using means and standard deviations (SDs) for continuous variables, and frequencies and percents for categorical variables. All analyses accounted for the sampling structure of the data, clustering on county of residence and dwelling unit. Associations of work safety climate components with gender, language, and employer were explored using Rao-Scott Chi-square tests, and the associations of the work safety climate total score with gender, language, and employer were assessed with ANOVA tests. The relationships of age and years working in poultry processing with work safety climate components were examined using simple linear regression. Associations between the work safety climate total score and PPE provision and use were explored with ANOVA tests. All analyses were completed using SAS version 9.2 (SAS Institute, Inc, Cary, NC). A p-value of 0.05 or less was considered statistically significant.

Results

Personal and Work Characteristics

Most (57.1%) of the participants were male (Table I). Spanish was spoken in the homes of 73.4% of the participants when they were children, while 26.6% reported that an indigenous language was spoken in their childhood homes. The mean age of participants was 35.0years (SD 10.8 years). Participants had an average of 4.9 years working in poultry processing (SD 4.2). About one-third of participants worked for each of the three employers.

Work Safety Climate

The majority of the participants agreed with each of the first nine work safety climate items, indicating that they felt that work safety was important where they worked (Table II). About 90% of the participants included that

workers' safety was important to management, workers were regularly made aware of dangerous practices or conditions, worker receive instructions on safety when hired, and that proper safety equipment is always available. Most also agreed that workers attend regular safety meetings (82.7%), and that workers have control over personal safety (84.9%). Half of the participants stated that workers are regularly praised for safe conduct, and almost two-thirds state that taking risks was not part of their jobs. However, half also stated that were only interested in doing the job fast and cheap, as opposed to one-quarter indicated that supervisors do as much as possible to make the job safe, and another quarter who indicated that supervisors could do more to make the job safe. The mean total work safety climate score was 24.8 of a possible 35 (SD 3.2).

Few differences in the work safety climate items or score were apparent by worker gender, language, age, or years working in poultry process. For gender, more males (55.5%) than females (43.0%) reported that workers were regularly praised for safe conduct ($p = 0.01$). For language, more Spanish (87.6%) than indigenous speakers (77.5) ($p = 0.01$) reported that workers had almost total control over personal safety, and that taking risks was not part of the job (72.2% versus 41.6%; $p < 0.01$). A greater percent of indigenous (66.0%) versus Spanish speakers (43.7%) reported that supervisors were only interested in doing the job fast and cheap ($p < 0.01$). Workers who agreed or strongly agreed that taking risks was not part of the job were older (36.8 versus 31.7 years; $p < 0.01$) and had worked in poultry processing longer (5.6 versus 3.6 years; $p<.01$) than those who disagreed or strongly disagreed.

Differences for each of the work safety climate items and the total score were significant by employer (Table II). A greater percentage of participants working for Employer 2 gave positive responses to the items than did participants working for Employer 1 or Employer 3. For example, 99.2% of participants working for Employer 2 agreed that "workers safety practices are important to management," while 90.6% of participants working for Employer 1 and 78.1% of those working for Employer 3 agreed with this statement. Among Employer 2 participants, 70.3% agreed that "workers are regularly praised for safe conduct," while 23.2% of participants working for Employer 1 and 59.3% of those working for Employer 2 agreed with this statement. Among Employer 2 participants, 93.4% agreed that "taking risks is not a part of my job," while 70.8% of participants working for Employer 1 and 31.3% of those working for Employer 2 agreed with this statement. Finally, 14.0% of participants working for Employer 2 felt that "supervisors are only interested in doing the job fast and cheap," while 58.6% of participants working for Employer 1 and 74.8% of those working for Employer 2 felt that this statement most accurately reflected the overall safety climate.

Personal Protective Equipment

Provision and use of PPE varied by type of equipment (Table III). About one-third (32.7%) of participants reported that they were provided with eye protection, with 27.2% reporting they received it at no cost. Only 16.0% reported using eye protection all of the time. Most (80.4%) of participants reported receiving hand protection, with 57.0% reporting they received it at no cost. Most (83.0%) reported using hand protection all of the time. About half of the participants reported being provided with special footwear, with 24.6% reported receiving this footwear at no cost. Almost three-quarters (72.8) of the participants reported wearing special footwear all of the time. Most (94.8%) participants reported receiving protective clothing, and most (84.7%) reported being provided protective clothing at no cost, and most (92.0%) reported wearing protective clothing all of the time. Most participants reported being provided hearing protection (98.8) and using it all of the time (96.5%), but 22.4% reported not receiving it at no cost. Dust masks were seldom provided by employers (18.2%) or used (11.1%). Shoe insoles were seldom provided by employers (10.0%) or used (35.3%). About one-third (35.4%) of participants reported being provided with specialized hand tools, and they were generally provided these at no cost (32.9%) and used them (23.4%). About one-quarter (22.3) of the participants reported being provided with specialized material handling tools, and they were generally provided these at no cost (20.3%), but they were not used all of the time (4.8%). Finally, most (74.4%) participants reported being provided with head protection, and it was generally provided at no cost (67.2%) and used all the time (65.9%).

Work Safety Climate and Personal Protective Equipment

Work safety climate was associated with various aspects of PPE provision and use (Table IV). Those who were provided with eye protection at no cost had a lower mean work safety climate score than those who had

to pay for eye protection (24.8 versus 27.0; $p < 0.01$). Work safety climate was not associated with the use of eye protection. Those who were provided with hand protection at no cost had lower mean work safety climate scores than those who were provided hand protection at a cost (24.2 versus 26.1; $p < 0.01$). Those who used hand protection all of the time trended toward having greater work safety climate than those who did not (25.0 versus 24.2; $p = 0.06$). Those who were provided special footwear trended to having a lower mean work safety climate than those were not provided with special footwear (24.5 versus 25.2; $p = 0.05$). Those who were provided with special footwear at no cost had a lower mean work safety climate scores than those who were provided hand protection at a cost (23.9 versus 25.; $p = 0.02$). Those who used special footwear all of the time had greater work safety climate than those who did not (25.1 versus 24.0; $p < 0.01$).

Workers who were provided with hearing protection at no cost had lower mean work safety climate scores than those who were provided hearing protection at a cost (24.5 versus 25.8; $p < 0.01$). Those who used shoe insoles all of the time had higher mean work safety climate scores than those who did not (25.9 versus. 24.3; $p < 0.01$). Those who used specialized material handling tools trended toward higher mean work safety climate scores than those who did not (25.9 versus. 24.83; $p = 0.08$). Work safety climate was not associated with the provision or use of several types of PPE, including protective clothing, dusk masks, specialized hand tools, or head protection.

DISCUSSION

Work safety climate varied by employer among these Latino poultry processing workers. Reflecting the results reported by Zohar [2000] that employees within units were homogenous in their perceptions of work safety climate, participants in this study working for Employer 1 and Employer 3 had the significantly lower total work safety climate scores than those working for Employer 2. The percentages of workers agreeing with the individual work safety climate items were significantly different for the three employers included in the work safety climate scale. More Employer 2 workers than Employer 1 and 3 workers agreed with each of the items, and they had the most positive evaluation of work safety climate. Employer 3 workers had the least agreement with each of the work safety items, and they had the worse evaluation of work safety climate. Work safety climate differed little by worker characteristics, including gender, language, age, and years worked in poultry processing.

The use of provision of some types of PPE, such as hand protection, protective clothing, and hearing protection, to these Latino poultry processing was almost universal. The provision of other types of other types of PPE, such as eye protection, dust masks, shoe insoles, and specialized hand tools, was far less frequent. PPE should be provided at no cost to workers, but many of these workers reported that they paid for PPE. The use of PPE among these poultry processing workers reflected whether it was provided, and whether it was provided at no cost. For example, hearing protection and protective clothing was generally provided at no cost, and they were used by almost all of the workers all of the time. Other types of PPE, such as eye protection and dust masks were seldom provided, and they were used all of the time by few workers.
Work safety climate was associated with the provision and use of some PPE. However, this association raises questions. The only significant associations of work safety climate and the provision of PPE at no cost were inverse; those who were provided eye protection, hand protection, special footwear, and heating protection at no cost had lower work safety climate scores than those had a cost associated with the provision of the PPE. This is counter intuitive. At the same time, those who used hand protection, special footwear, shoe insoles, and specialized materials handling tools all of the time have greater work safety climate than those who do not use this PPE all of the time. One explanation for this pattern is that those for whom PPE is provided at no cost understand that they have dangerous jobs, while those who use PPE all of the time feel that have greater safety.

Little research has examined work safety climate among manufacturing workers. Similar to the results of this study, other research has shown an association of work safety climate with unsafe behavior, but not with the occurrence of injury [Clark, 2006; Cooper & Phillips, 2004]. These studies do not compare the work safety climate reported for employers in the same industry, such as poultry processing. Smith and colleagues [2006] compare work safety climate and injury rate across employers in multiple industries and find that work safety

climate is associated with injury claims. However, employers in the same industry are not compared. This research documents that work safety climate for manufacturing workers can vary by employers in the same industry, even when those employers are in the same area. This indicates that work safety climate can be modified when an employer works to promote safety, even in a hazardous industry such as poultry processing.

Few studies have considered work safety climate among Latino immigrant workers. Menzel and Gutierrez [2010] identified perceived risks among Latino construction workers in southern Nevada using qualitative methods. Arcury et al. [under review] found that level of work safety climate was directly associated with the use of personal protective equipment among immigrant Latino construction workers. Work safety climate was different to that reported for immigrant agricultural workers and immigrant construction workers [Arcury et al., 2012, under review]. Using the same work safety climate scale [Gillen et al., 2002], among immigrant agricultural workers, the mean work safety climate score was 26.6, while among immigrant construction workers it was 23.2, compared to the 24.8 among participants in this study. Among immigrant agricultural workers, work safety climate was lower among those reporting musculoskeletal pain and working when injured. Among immigrant construction workers, level of work safety climate was directly associated with the use of personal protective equipment among immigrant Latino construction workers. These differences by industry indicate that work safety climate is not a constant among immigrant workers; rather it is influenced by the environment in which they are working [Zohar, 2010].

These results should be considered within the study's limitations. Participants were recruited from one area of North Carolina, limiting generalizability to other areas. The study had a cross-sectional design which does not allow for determination of causation between provision and use of PPE and work safety climate. The provision and use of PPE is based on self-report, and participants may have wanted to provide socially acceptable responses. However, the strengths of the study are also important. The sample was large and participants worked for three different poultry processing companies. The sample design attempted to recruit participants randomly. The study used a standard measure of work safety climate [Gillen et al., 2002], which has been used in other analyses of immigrant Latino workers [Arcury et al., 2012; Grzywacz et al., 2007b; Quandt et al., 2006].

Latino poultry processing workers are a vulnerable population. This analysis shows that work safety climate varies greatly by employer. Personal protective equipment is not always available to these workers. The association of work safety climate to provision and use of PPE is not clear, in that work safety climate is lower for those to whom PPE is provided at no cost, but it is higher for those who use PPE all of the time. Understanding work safety climate for immigrant workers has the potential for directing policy for improving workplace health and safety. Further research on work safety climate among immigrant workers is needed to document the levels of work safety for different employers and different industries, and to delineate how works safety climate is reflected in safe behavior and levels of injuries.

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Table I: Personal Characteristics and Employers of Poultry Processing Workers, Western North Carolina, 2010 (n=403).

Personal Characteristics and Employers	n	%	Mean	SD
Gender				
Female	173	42.9		
Male	230	57.1		
Language				
Spanish	293	73.4		
Indigenous	106	26.6		
Age			35.0	10.8
Years Working in Poultry Processing			4.9	4.2
Employer				
Employer 1	139	35.1		
Employer 2	121	30.6		
Employer 3	136	34.3		

Table II: Differences by Employer in Work Safety Climate and Total Score, Poultry Processing Workers, Western North Carolina, 2010 (n=403).

Agree or Strongly Agree with Work Safety Climate Item	Total Sample		Employer 1		2		3		
	n	%	n	%	n	%	n	%	p**
Workers' safety practices are very important to management.	356	89.1	125	90.6	120	99.2	100	78.1	<.01
Workers are regularly made aware of dangerous work practices or conditions.	364	90.6	125	90.6	117	96.7	115	84.6	<.01
Workers are regularly praised for safe conduct.	201	50.1	32	23.2	85	70.3	80	59.3	<.01
Workers receive instructions on safety when hired.	351	87.5	121	88.3	115	95.0	108	79.4	<.01
Workers attend regular safety meetings.	329	82.7	96	71.1	116	95.9	110	81.5	<.01
Proper safety equipment is always available.	345	89.6	119	87.5	116	95.9	112	85.5	0.02
Workers have almost total control over personal safety.	337	84.9	114	83.2	119	98.4	98	74.2	<.01
Taking risks is not a part of my job.	256	64.7	97	70.8	113	93.4	41	31.3	<.01
Overall safety climate assessment:									<.01
Supervisors do as much as possible to make my job safe.	95	24.2	30	22.6	53	43.8	8	6.1	
Supervisors could do more to make my job safe.	102	26.0	25	18.8	51	42.2	25	19.1	
Supervisors are only interested in doing the job fast and cheap.	195	49.7	78	58.6	17	14.0	98	74.8	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p***
Total score*	24.8	3.2	24.2	2.4	26.2	2.3	24.2	4.2	<.01

*Cronbach's alpha = 0.73
**Chi Square
***ANOVA

Table III: Use of Personal Protective Equipment by Poultry Processing Workers, Western North Carolina, 2010 (n=403).

Personal Protective Equipment	Provided		Provided at No Cost			Used			
						Less than all of the Time		All of the Time	
	n	%	n	% of Total	% of Provided	n	%	n	%
Eye protection	131	32.7	109	27.2	83.9	335	83.9	64	16.0
Hand protection	323	80.4	228	57.0	71.3	68	17.0	332	83.0
Special footwear	204	50.8	99	24.6	48.5	109	27.2	292	72.8
Protective clothing	382	94.8	337	84.7	89.4	32	7.9	369	92.0
Hearing protection	397	98.8	312	77.8	79.0	14	3.4	389	96.5
Dust masks	72	18.2	62	15.9	87.3	352	88.9	44	11.1
Shoe insoles	39	10.0	31	7.8	81.6	249	64.7	136	35.3
Specialized hand tools	142	35.4	132	32.8	93.0	302	76.7	92	23.4
Specialized material handling tools	89	22.3	81	20.2	93.1	377	95.2	19	4.8
Head protection	300	74.4	271	67.4	90.6	137	34.1	265	65.9
Other	30	7.5	8	2.0	27.6	3	9.7	28	90.3

Table IV: Safety Climate Scores by Personal Protection Equipment Provided, Provided at No Cost, and Used for Total Sample and by Employer, Poultry Processing Workers, Western North Carolina, 2010.

Personal Protective Equipment	Mean Work Safety Climate Score					
	Provided by Employer		Provided by Employed at No Cost*		Used	
	No	Yes	No	Yes	Less than all of the Time	All of the Time
Eye protection						
Mean	24.7	25.1	27.0	24.8	24.9	24.6
n	269	128	21	106	334	60
p-value		0.19		<0.01		0.49
Hand protection						
Mean	25.0	24.8	26.1	24.2	24.2	25.0
n	79	319	92	224	67	328
p-value		0.41		<0.01		0.06
Special footwear						
Mean	25.2	24.5	25.1	23.9	24.0	25.1
n	197	201	105	96	108	288
p-value		0.05		0.03		<0.01
Protective Clothing						
Mean	25.8	24.8	25.1	24.7	24.0	24.9
n	21	377	39	332	32	364
p-value		0.23		0.49		0.20
Hearing protection						
Mean	25.2	24.8	25.8	24.5	25.8	24.8
n	5	393	88	308	14	384
p-value		0.42		<0.01		0.24
Dust masks						
Mean	24.8	24.8	24.8	24.8	24.8	24.8
n	323	69	332	60	351	40
p-value		0.98		0.96		0.98
Shoe insoles						
Mean	24.9	24.8	24.8	24.8	24.3	25.9
n	349	39	363	31	248	136
p-value		0.82		0.99		<0.01
Specialized hand tools						
Mean	24.8	25.0	24.8	24.9	24.8	25.1
n	259	138	270	128	302	89
p-value		0.51		0.82		0.36
Specialized material handling tools						
Mean	24.8	24.9	24.8	24.7	24.8	25.9
n	310	87	316	79	374	19
p-value		0.74		0.82		0.08
Head protection						
Mean	25.0	24.8	25.1	24.7	24.7	24.9
n	103	295	131	266	137	260
p-value		0.49		0.30		0.54

*Based on the subset for whom the PPE is provided by the employer

1-15. Work Organization and Health among Immigrant Women: Latina Manual Workers in North Carolina

ABSTRACT

Objectives. To describe work organization attributes for employed immigrant Latinas, and determine associations of work organization with physical health, mental health, and health related quality-of-life.

Methods. We conducted a cross-sectional survey with 319 employed Latinas in western North Carolina (2009-2011). Measures included job demands (heavy load, awkward posture, psychological demand), decision latitude (skill variety, job control), support (supervisor control, safety climate), musculoskeletal symptoms, mental health (depressive symptoms), and mental (MCS) and physical (PCS) health related quality-of-life.

Results. Three-fifths of women reported musculoskeletal symptoms. Mean scores for depression, MCS, and PCS were 6.2 (SE=0.2), 38.3 (SE=0.5), and 42.8(SE=0.3), respectively. Greater job demands (heavy load, awkward posture, greater psychological demand) were associated with more musculoskeletal and depressive symptoms, and worse MCS. Less decision latitude (lower skill variety, job control) was associated with more musculoskeletal and depressive symptoms. Greater support (supervisor's power and safety climate) was associated with fewer depressive symptoms and better MCS.

Conclusions. Work organization should be considered to improve occupational health of vulnerable women workers. Additional research should delineate the links between work organization and health among vulnerable workers.

INTRODUCTION

Immigrant and low-income workers constitute a vulnerable population that is at significant risk for occupational injury and illness. These workers often have the most demanding jobs in the most dangerous industry sectors (e.g., agriculture, construction).[1-5] When they work in less hazardous sectors, such as manufacturing, they generally work in industries, such as poultry and meat processing, that have substantial hazards and few protections.[6-7] These manufacturing hazards include exposure to toxicants (e.g., cleaners, solvents), exposure to biological materials (e.g., feces, dander), repetitive motion injuries, slips and falls, and lacerations and amputation from sharp tools and machinery.

Although addressing conventional risk factors (e.g., chemical and mechanical exposures) remains important for improving the health of immigrant and low-income workers, greater attention is being given to how work organization affects their health and safety.[5,8] NIOSH[9] defines work organization as the processes and organizational practices that influence job design. Work organization domains include the timing of when work is performed, such as shifts and hours worked, seasonality, and flexibility; the physical and psychological demand of work; the control or decision latitude workers have, including variation in effort and choice in performing work; and style of supervision and support, including supervisor support and control and work safety climate.[10,11]

Work organization has most often been considered in its effects on job satisfaction and health of white-collar workers. Although believed to be particularly influential in the health and safety of vulnerable workers, little research has examined work organization and health outcomes for vulnerable populations such as immigrant workers.[5,8,12] Even less research has focused on work organization among immigrant women. For example, recent analyses of work organization and health among US immigrant workers in agriculture[13-15] and construction[16-18] have shown that, among agricultural workers, job demands are associated with poorer physical health;[13] high worker control is associated with better mental health;[14] and poor safety climate is associated with greater musculoskeletal discomfort.[15] Among construction workers, poor work safety climate is associated with poor work safety behavior.[16] However, participants in these studies are almost exclusively male.

Recent analyses of work organization and health among immigrant poultry processing workers have included a

substantial number of women.[19-22] These analyses show that management practices, such as poor safety commitment, and job design, such as authority, variety, psychological workload, frequent awkward posture, and repetitive movement, are associated with risk of recent musculoskeletal problems, respiratory problems, and self-reported injury/illness.[19-21] Similarly, organizational hazards, including low job control and high psychological demand, are associated with increased risk for epicondylitis, rotator cuff syndrome, and back pain.[22] However, these analyses have not focused on women or on gender differences. A qualitative analysis of female immigrant household domestic workers in Spain reports that such work organization factors as job control affect health.[23,24]

The job demand-control-support model[10,11] provides a framework for examining the association of work organization and health among women immigrant manual workers. This model posits that jobs with greater physical and psychological demand or stressors will result in poorer health. However, jobs with greater control or decision latitude can result in better health, and can offset the effects of demand leading to poor health. Finally, support of peers and supervisors, including perceived safety climate[25] (how workers perceive supervisors' valuing safety over production) reduces occupational injury and buffers the effects of job demands.

The place of work organization in the health of immigrant women is particularly important. These women have major family, child care, and domestic responsibilities that they need to integrate into their work responsibilities.[12,26] Immigrant women are also extremely vulnerable to workplace physical and sexual harassment, as they often do not speak English, do not know their rights, and may lack proper work documents.[27-29]

This analysis has two goals. The first is to delineate work organization attributes of full-time employed immigrant Latinas with manual occupations. The work organization attributes include indicators of job demands, decision latitude, and support. The second goal is to determine the associations of work organization attributes with health characteristics of these women, including physical health, mental health, and health related quality-of-life. Three hypotheses are tested: (1) greater job demands will be associated with poorer physical health, mental health, and health related quality-of-life; (2) greater decision latitude will be associated with better physical health, mental health, and health related quality-of-life; and (3) greater job support (higher perceived supervisor control; better job safety climate) will be associated with better physical health, mental health, and health related quality-of-life.

METHODS

Data are from a cross-sectional study of Latino manual workers residing in four western North Carolina counties conducted from 2009 to 2011. A focus of the research was the association of manual work in the poultry processing industry with occupational health; therefore, about one-half of the study participants were employed in one of the poultry processing plants in the counties. This analysis was limited to the women who participated in the study. Participants employed in poultry processing and other manual work were included in this analysis, as all are manual workers with similar occupational exposures; and inclusion of all participants increased the overall size of the sample.

Sample

The sample design included two components. First, the study team mapped neighborhoods composed largely of Latino residents. Second, the study team surveyed other areas to identify dispersed dwellings that were likely inhabited by Latino residents. The lists of neighborhood and dispersed dwellings contained 4,376 possible Latino dwellings, with about two-thirds in neighborhoods. The lists were randomized proportionately with two-thirds from neighborhoods and one-third from dispersed dwellings.

Recruiters visited randomly selected dwellings. Residents were screened for inclusion criteria: self-identified as Latino or Hispanic, worked 35 hours or more per week in a manual labor job, and 18 years or older. Manual labor in poultry processing was defined as non-supervisory work in a poultry processing plant with job categories from receiving through sanitation. Employees of poultry farms were excluded. Other manual labor

was defined as employment in non-managerial jobs in industries such as landscaping, construction, restaurant work, hotel work, child care, and manufacturing. Non-poultry workers with previous work in poultry only qualified if lifetime employment in poultry processing was 6 months or less, and not within the past two years. More than one resident per dwelling could be recruited. Of 1,681 dwellings selected, 965 were screened, for a screening rate of 57%. Of 1,526 individuals screened, 957 were eligible for enrollment, with 742 completing interviews (77.5% participation rate). The participants included 319 women (77.6% participation rate), with 173 employed as poultry processing workers (82.0% participation rate), and 146 employed as other manual workers (73.0% participation rate).

Data collection

Participants completed face-to-face interviews in their homes. All interviews were conducted in Spanish. Interviews took approximately 60 minutes to complete and included information on work history, work environment, symptoms and disability, and psychosocial characteristics. The respondent was given a $10 incentive for participation. All procedures were approved by the Wake Forest Health Sciences Institutional Review Board. All participants provided written informed consent.

Measures

Measures from the three work organization domains are considered: job demands, decision latitude, and support. Two of the three job demands measures, heavy load and awkward posture, were measured with an established physical workload instrument[30] that has been used in previous research with immigrant Latinos (scale items in English and Spanish are appended).[19] Response options ranged from "seldom/never" (1) through "almost always" (4). Heavy load was assessed with the average of 12 items ($\alpha = 0.70$), and awkward posture was assessed by with the average of 6 items ($\alpha = 0.80$), coded such that higher values indicate greater exposure.

One job demand, psychological demand, and the two decision latitude measures, skill variety and job control, were assessed using items modified from the Job Content Questionnaire[31] with response options ranging from "seldom/never" (1) through "almost always" (4). Psychological demand is the mean of four items ($\alpha = 0.74$). Skill variety is the mean of three items ($\alpha = 0.70$); and job control is the mean of three items ($\alpha = 0.81$). Higher values indicate greater levels for each concept. Each of these measures has been used with immigrant Latino worker populations.[14,20]

The first support measure, perceived supervisor control, was assessed with seven items from an established instrument.[32] The selected items asked the participant to judge whether their supervisor had control over pay, benefits, promotions, job assignments, and making work difficult. The perceived potential of a supervisor to affect these conditions is a perception of supervisor control. Response options ranged from "strongly disagree" (1) through "strongly agree" (4). Perceived supervisor control is the mean of the seven items ($\alpha = 0.74$) coded such that higher scores indicate greater perceived control. This measure has been used with immigrant Latino worker populations.[19] The second support measure, work safety climate, was assessed with the Perceived Safety Climate Scale.[33] This measure has been used in several studies of immigrant Latino workers.[13,15,22] Nine of the items in the scale used a four-point Likert format. The tenth item included three response categories. After an analysis of internal consistency, one of the nine four-point Likert format items was discarded due to lack of fit within the scale. A total Work Safety Climate was calculated by summing the remaining nine items ($\alpha = 0.73$). Values for the scale ranged from 9 to 39, with higher values indicating better work safety climate.[21,22] Measures of perceived supervisor control and work safety climate were not applied to women who reported being self-employed.

Three sets of health measures (physical health, mental health, and health related quality-of-life) are examined. Physical health was assessed by the location and number of upper body musculoskeletal symptoms in six sites: (1) neck, (2) upper or lower back, (3) forearms, (4) wrist/hands, (5) shoulders, and (6) elbows.[34] Participants reporting a symptom for a particular body site were asked whether they experienced discomfort at that site that lasted longer than one day in the last 12 months. The extent of a worker's upper body musculoskeletal symptoms is the sum of the number of sites for which she reported symptoms lasting longer

than one day. The resulting count variable was categorized into three levels (no upper body sites with symptoms, 1-3 upper body sites with symptoms, 4-6 upper body sites with symptoms). Mental health was assessed with the Spanish validated short version of the Center for Epidemiological studies Depression scale (CES-D).[35] This 10-item version of the scale delineates the frequency and severity of current depressive symptoms.[36] Items were scored in a 4-point scale and summed. Possible scores range from 0 to 30 (α=0.72); greater scores reflect higher levels of depressive symptoms.[37] Health related quality-of-life was assessed with the Spanish version of the SF-12 (α=0.60).[38] Proprietary scoring procedures were used to create mental (MCS-12) and physical (PCS-12) component summary scores that range from 0 to 100, had a mean score of 50 and a standard deviation of 10. Higher scores reflect better perceived health.

Personal characteristics include age and years lived in the US. Language has the values of Spanish and indigenous, based on the language spoken at home when the participant was a child.

Analysis

All statistical analyses were adjusted for the stratified sampling design of the study. The overall sample was summarized using means and standard errors (SE) for the continuous characteristics and frequencies and percentages for the categorical characteristics. Personal, health, and work organization characteristics were compared between poultry processing and other manual workers using linear regression models for the continuous variables and Rao-Scott chi-square tests for the categorical variables. Associations between the work organization indicators and the health outcomes were examined using both bivariate and multivariate models. In particular, relative risk regression models were used for the binary health outcome musculoskeletal symptoms. Generalized estimating equation approach was used to estimate the prevalence ratio (PR). In situations where models fit using a log link with a binomial distribution failed to converge, a normal distribution was used instead. The number of musculoskeletal symptoms was modeled using nominal logistic regression to allow the association between predictors and outcome to differ across outcome levels. Maximum likelihood estimates of odds ratios were presented, and Wald chi-square tests were used in aforementioned analyses. Linear regression models were used to analyze CES-D scores and health related quality-of-life. Least square estimates for regression coefficients were presented, and F tests were used for statistical inferences. We note that the continuous variables (including all work organization indicators) were not standardized in the analyses. Therefore, all association is interpreted as the effect on an outcome with one unit increase of a predictor. All analyses were performed using SAS 9.3 (Cary, NC) and p-values less than 0.05 were considered statistically significant.

RESULTS

Participant personal and health characteristics are presented in Table 1. Work organization measures are presented in Table 2.

The job demands indicators of work organization were consistently associated with the health indicators (Table 3). Heavy load was positively associated with having musculoskeletal symptoms and CES-D score; awkward posture was positively associated with having musculoskeletal symptoms and CES-D score, and inversely associated with the SF-12 MCS; and psychological demand was positively associated with musculoskeletal symptoms and CES-D score, and inversely associated with the SF-12 MCS. The decision latitude indicators were also consistently associated with the health indicators. Increased skill variety decreased the odds for having musculoskeletal symptoms and was inversely associated with CES-D score. Increased job control decreased the odds of having musculoskeletal symptoms and had a significant positive association with the SF-12 MCS. The support indicators had limited association with the health indicators.

Multivariate models predicting health were run with and without the support indicators (Table 4). The associations of number of musculoskeletal symptoms with each of the work organization measures were the same whether or not the supervision indicators were included in the models. Heavy load had no association with number of musculoskeletal symptoms. Awkward posture and psychological demand were directly associated with the number of musculoskeletal symptoms when 1 to 3 symptoms or 4 to 6 symptoms were compared to no symptoms. Among the decision latitude indicators, job control had no association with number

of musculoskeletal symptoms. Skill variety was inversely associated with the number of musculoskeletal symptoms, when 1 to 3 symptoms was compared to no symptoms.

The associations of depressive symptoms with each of the work organization measures were also the same whether or not the support indicators were included in the models. Awkward posture was directly associated with the CES-D score. Skill variety was inversely associated with the CES-D score, and psychological demand was positively with the CES-D score. Surprisingly, job control was positively associated with the CES-D score. In the model that included the supervision indicators, work safety climate was inversely associated with CES-D score at the trend level. The association of mental health related quality-of-life with the work organization measures differed little when the support indicators were included. Of the job demands indicators, psychological demand was inversely associated with the SF-12 MCS.

DISCUSSION

Similar to other low-income workers, these immigrant women manual workers experience relatively high levels of musculoskeletal and depressive symptoms, and relatively low health related quality-of-life.[5] The manner in which their work is organized includes high physical and psychological work demands, and limited decision latitude, indicting "passive jobs."[10] These women perceive their supervisors to have a high level of control, and report work safety climates similar to other Latino manual workers.[13,15] Work organization characteristics are consistently associated with multiple health outcomes among these immigrant women employed in manual occupations. Greater physical (awkward posture) and psychological job demands among these Latina manual workers are associated with poorer health as indicated by greater musculoskeletal symptoms, more depressive symptoms, and less mental health related quality-of-life; and these associations remain in models in which decision latitude, support, and personal characteristics are included. Similarly, lower decision latitude (skill variety and job control) for these workers is associated with greater musculoskeletal symptoms and more depressive symptoms; it has little association with health related quality-of-life. However, support measures, perceived supervisor control and work safety climate, have little association with worker health.

Research on the associations of work organization and health among immigrant manual workers remains limited.[14,15,19-22] This analysis builds upon this research and supports the importance of the demands-control-support model[10-11] for understanding and improving the occupational health of vulnerable workers. This is among the first attempts to include measures from each component of the demands-control-support model in one analysis.

Like other analyses, these results document the association of demands and decision latitude (control) with the occupational health of vulnerable workers. For example, a recent analysis by Swanberg and colleagues[15] reports on both work organization and health outcomes for male immigrant crop and livestock farmworkers, indicating that they have high physical demands and low job control, while experiencing high levels of musculoskeletal and respiratory symptoms. High physical demands and little decision latitude are hallmarks of the jobs held by vulnerable workers. The associations of heavy load and awkward posture with musculoskeletal and depressive symptoms found in this analysis reflect other studies of immigrant female and male poultry processing workers.[19,20] Although the strong associations of psychological demand with musculoskeletal symptoms, depressive symptoms, and health related quality-of-life found in this analysis differs from analyses of immigrant male farmworkers,[14,39] it is similar to results for analyses of female and male Latino poultry processing workers and male Latino construction workers,[17,18,40] which found that skill variety and psychological demands were associated with musculoskeletal problems, respiratory problems, and self-reported injury/illness.

The important associations of job demands and decision latitude with health found in this analysis are in direct contrast to Grzywacz and colleagues[14] who found relatively little support for the job demands-control-support model in analyses of job demands and control in immigrant farmworker health. However, like Grzywacz and colleagues, given the limitations of this study, it is important to avoid over-interpreting the pattern of results.

The limited association of supervisor support for health outcomes among these vulnerable workers is surprising. Arcury and colleagues[21,22] report on one aspect of support, work safety climate, among female and

male immigrant poultry processing workers, relating work safety climate and the use of personal protective equipment; however, those analyses do not examine how work safety climate is related to health. This is also in contrast to Grzywacz and colleagues[17,18] who report abusive supervision and poor safety commitment to be associated with risk of recent musculoskeletal problems, respiratory problems, and self-reported injury/illness among female and male Latino poultry processing workers. Similarly, immigrant male farmworkers who perceived work safety climate to be poor reported greater musculoskeletal discomfort and elevated depressive symptoms, and were more likely to work when injured or ill.[13] These differences could reflect the difference in gender composition of this study (all women) and the previous studies (mixed men and women). They could also indicate that supervisor support may not be as important as demands and decision latitude in the health of immigrant and other vulnerable workers.

The positive association of perceived supervisor control on mental health related quality-of-life reflects other research. Swanberg and colleagues[15] suggest that perceived supervisor attitudes toward safety may increase safety climate among immigrant farmworkers. Similarly, Hoppe and colleagues[41] found that supervisor support was related to well-being among Latino warehouse workers. These studies suggest that research should focus on how Latino manual workers' perceptions of their supervisors may influence occupational safety and well-being.

These results should be interpreted in light of study limitations. The data come from one region of one state in one year. Generalizations of results to other regions should be made with caution. This study uses a cross-sectional design; therefore, the causal relationships can only be inferred. However, the study has a number of strengths, including strong sample design, a large sample size and high participation rate, extensive collection of information, and use of existing work organization measures.

Occupational safety policy must consider work organization. Efforts must continue to control such conventional risk factors as chemical, mechanical, and noise exposures among all workers, particularly vulnerable workers.[42] Ergonomic changes can reduce the risk of some musculoskeletal injuries.[43,44] However, the psychological demand of work and value placed on safety by supervisors require that new approaches be used in the design of jobs. For example, Landsbergis and colleagues,[5] suggest micro- and macro-level interventions for improving the psychosocial working conditions of immigrant, women, and minority workers, including increased job autonomy, social support, and management training (micro-level), and job skills training programs and wage premiums for hazardous jobs (macro-level). Future research should expand the work organization characteristics that are examined in two directions, incorporating (1) additional measures of supervisor and co-worker support (e.g., abuse, harassment), and (2) additional job characteristics (e.g., contingent work, work schedule). Future research should examine clinically assessed measures of health. Finally, longitudinal research is needed to determine the specific causal associations of work organization with injury among immigrant women workers.

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Table 1: Personal and Health Characteristics of Latina Woman Manual Workers, Western North Carolina, 2010 (n=319).

Personal and Employment Characteristics	All Women Manual Workers (n=319)				Poultry Processing Workers (n=173)				Other Manual Workers (n=146)				p
	n	%	Mean	SE	n	%	Mean	SE	n	%	Mean	SE	
Age			34.3	0.5			35.2	0.7			33.3	0.8	.08
Years Lived in US			11.1	0.3			12.0	0.4			10.1	0.5	.01
Language													
Spanish	258	81.4			138	80.1			120	82.2			.72
Indigenous	59	18.6			33	19.9			26	17.8			
Musculoskeletal Symptoms - Location													
Neck	54	16.9			32	18.5			22	15.1			.39
Upper or lower back	108	33.9			61	35.3			47	32.2			.58
Forearms	88	27.6			52	30.1			36	24.7			.28
Wrists/Hands	111	34.8			69	39.9			42	28.8			.04
Shoulders	98	30.7			58	33.5			40	27.4			.25
Elbows	22	6.9			20	11.6			2	1.4			<.01
Musculoskeletal Symptoms – Number													.10
None	132	41.4			62	35.8			70	48.0			
1 to 3	135	42.3			79	45.7			56	38.4			
4 to 6	53	16.3			32	18.5			20	13.7			
Depression (CES-D)			6.2	0.2			6.5	0.3			5.8	0.4	.22
Health-Related Quality of Life (SF-12)													
Physical			42.8	0.3			42.9	00.4			42.7	0.5	.84
Mental			38.3	0.5			38.5	.6			38.1	0.8	.74

Table 2: Work Organization Indicators, Latina Woman Manual Workers, Western North Carolina, 2010 (n=319).

Organization of Work	Total Sample			Poultry Processing Workers		Other Manual Workers		p
	Mean	SE	Range	Mean	SE	Mean	SE	
Job Demands								
Heavy Load	1.76	0.43	1.0-3.5	1.75	0.03	1.77	0.04	.64
Awkward Posture	2.00	0.79	1.0-4.0	2.30	0.06	1.64	0.06	<.01
Psychological Demand	2.42	0.92	1.0-4.0	2.78	0.07	1.99	0.06	<.01
Decision Latitude								
Skill Variety	1.85	0.76	1.0-4.0	1.68	0.05	2.06	0.07	<.01
Job Control	1.85	0.95	1.0-4.0	1.56	0.05	2.21	0.09	<.01
Support								
Perceived Supervisor Control (excludes self-employed; n = 273)	2.31	0.51	1.0-3.8	2.24	0.04	2.44	0.05	<.01
Work Safety Climate (excludes self-employed; n = 269)	24.63	3.61	13.0-37.7	24.65	0.25	24.61	0.43	0.93

Table 3. Bivariate Associations of Work Organization with Health Indicators, Latina Woman Manual Workers, Western North Carolina, 2010 (n=319).

Health Indicators		Organization of Work Indicators[a]						
		Job Demands			Decision Latitude		Support[b]	
		Heavy Load	Awkward Posture	Psychological Demand	Skill Variety	Job Control	Perceived Supervisor Control	Work Safety Climate
Musculoskeletal Symptoms – Location[c]								
Neck	Prevalence ratio	1.43	**1.49**	**1.30**	0.93	0.87	1.06	0.96
	95% CI	0.86, 2.38	**1.10, 2.01**	**1.00, 1.69**	0.65, 1.32	0.65, 1.16	0.64, 1.74	0.89, 1.04
Upper or lower back	Prevalence ratio	**1.54**	**1.21**	**1.37**	0.88	**0.76**	1.19	1.01
	95% CI	**1.14, 2.07**	**1.00, 1.45**	**1.16, 1.61**	0.71, 1.08	**0.61, 0.95**	0.8, 1.65	0.96, 1.06
Forearms	Prevalence ratio	**1.53**	**1.29**	**1.44**	**0.74**	0.82	1.26	1.02
	95% CI	**1.11, 2.10**	**1.06, 1.58**	**1.20, 1.73**	**0.57, 0.96**	0.67, 1.01	0.87, 1.81	0.96, 1.08
Wrists/Hands	Prevalence ratio	1.31	**1.49**	**1.44**	0.86	**0.76**	1.12	0.98
	95% CI	0.95, 1.81	**1.28, 1.73**	**1.24, 1.67**	0.69, 1.06	**0.62, 0.93**	0.82, 1.53	0.94, 1.03
Shoulders	Prevalence ratio	1.34	**1.32**	**1.32**	0.86	0.96	1.23	1.03
	95% CI	0.99, 1.80	**1.09, 1.58**	**1.13, 1.55**	0.70, 1.06	0.80, 1.15	0.86, 1.76	0.98, 1.09
Elbows	Prevalence ratio	0.92	**2.16**	**1.93**	0.72	**0.42**	0.68	0.94
	95% CI	0.34, 2.48	**1.38, 3.38**	**1.13, 3.29**	0.41, 1.27	**0.24, 0.74**	0.31, 1.51	0.85, 1.05
Musculoskeletal Symptoms – Number[d]								
1 to 3 versus none	Odds ratio	**2.50**	**1.98**	**1.84**	**0.61**	**0.74**	0.99	0.93
	95% CI	**1.32, 4.72**	**1.43, 2.75**	**1.39, 2.44**	**0.44, 0.84**	**0.58, 0.96**	0.60, 1.64	0.97, 1.00
4 to 6 versus none	Odds ratio	**2.72**	**2.38**	**2.37**	0.71	**0.64**	1.55	0.99
	95% CI	**1.24. 5.93**	**1.57, 3.59**	**1.59, 3.55**	0.46, 1.08	**0.41, 0.98**	0.73, 3.29	0.90, 1.11
Overall p-value		**<0.01**	**<0.01**	**<0.01**	**0.01**	**0.02**	0.45	0.20
Depression (CES-D)[c]	Mean	**1.54**	**1.47**	**0.82**	**-0.75**	0.08	**-1.32**	**-0.21**
	SE	**0.69**	**0.39**	**0.31**	**0.38**	0.29	**0.58**	**0.08**
	p-value	**0.02**	**<0.01**	**<.0.01**	**0.04**	0.78	**0.02**	**<0.01**
Health-Related Quality of Life[e]								
SF-12 PCS	Mean	-0.24	-.82	0.00	0.76	0.18	-0.47	0.19
	SE	0.80	0.49	0.40	0.50	0.49	0.84	0.12
	p-value	0.76	0.09	0.99	0.13	0.71	0.57	0/09
SF-12 MCS	Mean	-1.63	**-1.33**	**-1.64**	1.27	**1.06**	**2.20**	**0.35**
	SE	1.33	**0.70**	**0.58**	0.70	**0.51**	**1.01**	**0.16**
	p-value	0.22	**0.05**	**<.0.01**	0.07	**0.03**	**0.02**	**0.02**

[a]The organization of work indicators are not standardized; therefore, the associations presented are for a 1-unit change in the independent variable.
[b]Excludes self-employed; for Perceived Supervisor Control n = 273, for Work Safety Climate n = 269
[c]Relative risk regression models with Score tests
[d]Nominal logistic region models with Wald chi-square tests
[e]Linear regression models with tests

Table 4. Multivariate Associations of Work Organization with Health Indicators, Latina Woman Manual Workers, Western North Carolina, 2010.

Organization of Work Indicators	Health Indicators										
	Musculoskeletal Symptoms[a]					Depression (CES-D)[b]			Mental Health-Related Quality of Life (SF-12 MCS)[b]		
	1 to 3 versus none		4 to 6 versus none								
	Odds Ratio	95% CI	Odds Ratio	95% CI	Overall P-value	Mean	SE	P-value	Mean	SE	P-value
Models without Supervision Indicators (n=319)											
Demands											
Heavy Load	2.19	0.90, 5.30	1.78	0.64, 4.96	0.21	0.59	0.71	0.40	-0.28	1.42	0.84
Awkward Position	**1.60**	**1.05, 2.42**	**2.00**	**1.05, 2.42**	**0.02**	**1.43**	**0.49**	**<0.01**	-1.10	0.83	0.18
Psychological Demand	**1.51**	**1.06, 2.15**	**1.89**	**1.11, 3.20**	**0.02**	0.65	0.35	0.06	**-2.08**	**0.69**	**<0.01**
Decision Latitude											
Skill Variety	**0.61**	**0.41, 0.89**	**0.85**	**0.45, 1.58**	**0.04**	**-1.07**	**0.40**	**<0.01**	1.08	0.80	0.18
Job Control	1.00	0.72, 1.38	0.79	0.44, 1.40	0.71	**0.80**	**0.32**	**0.01**	0.32	0.65	0.62
Personal Characteristics											
Age	1.00	0.97, 1.04	1.04	0.99, 1.08	0.13	-0.01	0.03	0.66	0.09	0.06	0.13
Years Lived in US	**1.03**	**0.99, 1.03**	**0.99**	**0.88, 1.00**	**<0.01**	0.09	0.06	0.11	-0.28	**1.42**	**<0.01**
Indigenous vs. Non-Indigenous Language	**3.56**	**1.57, 8.02**	**5.20**	**1.95, 13.87**	**<0.01**	-0.26	0.69	0.70	1.21	1.56	0.43
Poultry vs. Non-Poultry	0.73	0.37, 1.45	0.63	0.24, 1.66	0.55	0.94	0.67	0.16	-3.85	**1.26**	**<0.01**
Models with Supervision Indicators (n=269)											
Demands											
Heavy Load	2.19	0.90, 5.30	1.78	0.64, 4.96	0.21	0.58	0.82	0.47	0.74	1.42	0.60
Awkward Position	**1.81**	**1.56, 2.85**	**2.25**	**1.20, 4.21**	**0.01**	**1.34**	**0.52**	**0.01**	-1.30	0.90	0.15
Psychological Demand	1.32	0.90, 1.93	1.81	1.05, 3.14	0.08	**0.71**	**0.36**	**0.05**	**-2.17**	**0.71**	**<0.01**
Decision Latitude											
Skill Variety	**0.55**	**0.33, 0.90**	**1.01**	**0.53, 1.94**	**0.02**	**-0.85**	**0.42**	**0.04**	0.55	0.89	0.54
Job Control	1.03	0.72, 1.38	0.79	0.44, 1.40	0.71	**1.32**	**0.42**	**<0.01**	-0.09	0.85	0.91
Support											
Perceived Supervisor Control	0.92	0.50, 1.67	0.56	0.25, 1.23	0.29	0.30	0.52	0.56	2.10	1.18	0.07
Work Safety Climate	0.94	0.85, 1.05	1.02	0.87, 1.19	0.38	-0.16	0.09	0.07	**0.30**	**0.16**	**0.05**
Personal Characteristics											
Age	1.01	0.97, 1.05	1.04	0.99, 1.09	0.27	-0.01	0.04	0.84	0.13	0.07	0.06
Years Lived in US	**1.04**	**0.99, 1.09**	**0.96**	**0.90, 1.03**	**0.04**	0.08	0.06	0.19	**-0.29**	**0.11**	**0.01**
Indigenous vs. Non-Indigenous Language	**3.61**	**1.24, 10.48**	**5.41**	**1.55, 18.90**	**0.01**	-0.50	0.78	0.52	0.65	1.73	0.70
Poultry vs. Non-Poultry	0.95	0.42, 2.12	0.69	0.22, 2.10	0.80	0.65	0.72	0.36	**-3.71**	**1.32**	**<0.01**

[a]Logistic regression models with Wald chi-square tests
[b]Linear regression models with F tests

1-16. Work Organization and Musculoskeletal Health: Clinical Findings from Immigrant Latino Poultry Processing and Other Manual Workers

ABSTRACT

Objective: Determine the potential role of differential exposure to work organization hazards in musculoskeletal disorders among immigrant Latino workers.

Method: Self-reported work organization data were obtained from immigrant Latino workers in poultry processing and non-poultry, manual occupations (N=742). Clinical evaluations for epicondylitis, rotator cuff syndrome and back pain were obtained from a subsample (n=518).

Results: Several work organization hazards (e.g., low job control, high psychological demands) were elevated among poultry processing workers. Job control predicted epicondylitis (*OR*=0.77) and rotator cuff syndrome (*OR*=0.79); psychological demand predicted rotator cuff syndrome (*OR*=1.30) and back pain (*OR*=1.24); awkward posture and repeated movements predicted all three outcomes; and management safety commitment predicted rotator cuff syndrome (*OR*=1.65) and back pain (*OR*=1.81).

Discussion: Immigrant poultry processing workers are exposed to greater work organization hazards that may contribute to occupational health disparities.

INTRODUCTION

Comprehensive and critical reviews of the literature are drawing attention to the "organization of work" (or "work organization") and its implications for occupational health outcomes.[1,2,3,4] Work organization is not a single attribute, rather it is a constellation of factors at multiple levels that shape production methods, the way jobs are designed and performed (i.e., work processes), as well as the management and human resource policies and activities used within and across industrial sectors.[5] Essentially, "work organization" is a short-handed way of describing the inputs and manifestation of "how work gets done," and it underlies all aspects of workers' experiences on the job.

Work organization likely plays a key role in the creation and escalation of health inequalities on the job and off.[1,6,4] The fundamental argument is that capitalist-oriented labor market policies result in disproportionate exposure of some groups of individuals to pathogenic job designs and work characteristics, health-compromising supervisory practices, and injury-prone safety climates. Landsbergis and colleagues,[1] for example, point out that immigrants and other racial and ethnic minorities are more likely to find themselves in precarious employment arrangements typified by temporary or limited term employment with few protections, and that their jobs expose them to low levels of control and high levels of psychological demand. These and other manifestations of work organization have been linked with discrete occupational health outcomes like work-related musculoskeletal disorder[7-9] and safety-related behavior,[10,11] as well as a variety of other health outcomes such as hypertension, heart disease and depression.[12-14]

Several gaps remain in the work organization and occupational health literature. One key gap is the general lack of research documenting the linkage between macro-level sources of variation in work organization to job-related hazards in the daily lives of health disparate workers, like immigrants. Specifically, most previous research uses community-based population samples of immigrant workers[15,16] or occupation-specific samples of such poultry processing,[17] day-laborers,[18] or workers in the household services[19] or food services.[20] Although valuable, neither general population samples nor occupation-specific samples of these approaches are able to link workers' reported job characteristics such as low job control or psychological demand to organizational or macro-level forces giving rise to these experiences. Put differently, without explicit comparisons of comparable workers in similar, yet distinct work arrangements, it is difficult to discern whether differences in job-related experiences are attributable to the way the work is organized or if they are attributable to some other social or cultural factor.

Another limitation is the relative paucity of research examining clear "occupational health" outcomes. Several studies demonstrate the presumed ill-effects of work organization factors like job control and psychological

demand on both general and discrete indicators of health like self-rated health,[21] heart disease[13] or depression.[12] Comparatively less work organization research has examined more traditional occupational health outcomes like work-related musculoskeletal problems. The research that has examined musculoskeletal problems is based largely on self-reported symptoms,[7] with almost all of the studies using objective indicators of musculoskeletal problems occurring in Europe.[22-29] Notable US exceptions are Gillen and colleagues' study of hospital workers[30] and Silverstein and colleagues' study of manufacturing workers.[31]

The goal of this analysis is to determine the potential health threat of work organization to one health disparate population, immigrant Latino workers in the United States (US). To accomplish this goal, we use data obtained from a community-based study of immigrant workers in poultry processing and other manual jobs. Poultry processing provides a good model for focusing on the study of work organization because it provides a clear illustration of how forces at multiple levels shape workers' everyday experiences on the job. Like most organizations involved in the international supply chain of food commodities, poultry processing is a vertically integrated industry dominated by a small number of large corporations that control the entire production process, from hatcheries through producing fresh or cooked chicken products ready to retail.[32] The high level of mechanization involved in modern poultry processing, one aspect of the vertical integration and consolidation of the industry, has brought a host of changes in how poultry processing work is done:[33] workers perform rapid repetitive motions for 8 hours or more, there is close physical proximity among workers, the assembly line sets the work speed and results in chronic exposure to ambient noise, and, some suggest, that poultry processors deliberately overlook safety standards to minimize their production costs.[34]

In this analysis we use data collected from poultry processing workers and immigrant workers in other manual occupations to: 1) describe variation in job design (i.e., job control, psychological demands, heavy loads, and awkward postures), and management and supervisory practices (i.e., abusive supervision and safety climate) experienced by immigrant Latino poultry and non-poultry manual workers; and 2) delineate variation in upper-body musculoskeletal clinical findings attributed to features of job design and management and supervisory practices.

MATERIALS & METHODS

Study Design

The data for this analysis are from a cross-sectional survey of Latino poultry and non-poultry manual workers. The sample design targeted enrolling 138 males and 138 females in each of the two worker categories (i.e., poultry workers and non-poultry manual workers), for a final sample of 552. Because of the relatively few female workers encountered, sample size was increased beyond the planned 552. The survey consisted of an in-home interview followed by a physical exam conducted at a data collection clinic held within one month on the interview.

Study Site

Data were collected in Burke, Surry, Wilkes, and Yadkin Counties in western North Carolina. These counties are rural and considered "new settlement" areas for Hispanic/Latino residents.[35] Based on the 2010 US census, the total population of the four counties is 272,331, with 19,310 (7%) of that Hispanic.

Sampling

The issues that Latino immigrants face in the United States make them a complex cohort to conduct research with because they are often a hidden and difficult to reach population. The research team did not have access to workplaces, and no census existed of Latino manual workers in the area. Therefore, community-based sampling was used to assure that a representative sample would be selected.[36] A sample frame was developed of dwellings where Latinos lived in the study area. The study team and a community-based organization partnered to map areas mostly populated by Latino residents (enclaves). The research team also surveyed other areas of the counties to identify other dispersed Latino residences. To identify such dwellings, surveyors looked for cultural or behavioral indicators known to characterize Latino residents. The lists of enclave and dispersed dwellings contained 4,376 possible Latino dwellings, with about two-thirds in residential

enclaves. The lists were randomized, and assigned proportionately to recruit two-thirds from enclaves and one-third from dispersed dwellings.

Recruitment

Members of the Latino community were hired as recruiters; 2 to 4 recruiters worked in each study county. Recruiters visited randomly selected dwellings in order; if no one was home, recruiters returned at different times and on different days. Residents were screened for inclusion criteria: self-identified as being Latino or Hispanic, worked 35 hrs or more per week in a manual labor job, and were 18 yrs or older. Manual labor jobs were defined as employment in non-managerial jobs in industries such as landscaping, construction, restaurant work, hotel work, child care, or manufacturing. Non-poultry manual workers with previous work in poultry only qualified if lifetime employment in poultry production or processing was 6 months or less, and not within the past 2 years. Work in poultry processing was defined as any type of non-supervisory work in a poultry processing plant with job tasks on the production line ranging from receiving through sanitation but not including workers in quality control. Employees of poultry production farms were excluded. More than one resident per dwelling could be recruited, if eligible. Of 1681 dwellings selected, 965 were screened, for a screening rate of 57%. A total of 1,526 residents were screened. Of those eligible, 78% (N=742) were interviewed; 70% of those interviewed attended the data collection clinic for a physical examination (n=518). The clinic and interview samples differed such that men, younger participants, and those who spoke an indigenous language in the household during childhood were less likely to attend the clinic.

Data Collection

The data collection clinics took place on Sundays at seven different clinics in locations throughout the study area. Participants were given the date, location, and an appointment time for the clinic when interviewed at their home. Those who attended the clinic were given a $30 incentive and also provided with a meal on-site. Health screenings were provided for participants and family members, including body mass index, non-fasting glucose testing, blood pressure, skin screening, and vision screenings. Health education counseling based on these tests was provided.

On the day of the clinic, a short questionnaire was administered to assess any changes in occupation or health since the interview and if subjects reported any pain of the elbows, shoulders, or lower back for two consecutive days in the last 30 days. Musculoskeletal examinations were conducted by board-certified physicians with fellowship training in sports medicine.

Measures

Musculoskeletal Outcomes. The dependent variables in this study are three clinical outcomes based upon results of the physical exam completed during the data collection clinic. Rotator cuff syndrome was defined as presence of pain with resisted abduction, internal rotation, external rotation, or forward flexion of the shoulder, or tenderness to palpation over the bicipital groove or lateral shoulder.[37] Epicondylitis was defined as presence of pain at the lateral epicondyle with resisted active wrist extension, at the medial epicondyle with resisted active wrist flexion, or tenderness to palpation over the medial and lateral epicondyle regions.[37] Low back pain was defined as presence of pain with active flexion, extension, side-bending to right or left, or twisting to right or left, or tenderness to palpation anywhere in the lumbar region.

Work Organization Predictors. Self-reported information obtained from the baseline interviewer-administered questionnaire was used to operationalize six variables in two distinct domains of work organization. The job design domain was assessed with variables reflecting frequency of exposure to job control, psychological demand, heavy loads, and awkward posture and repetitive movements. Job control and psychological demand were assessed using items modified from the Job Content Questionnaire,[38] where response options ranged from “seldom/never” coded 1 through “almost always” coded 4. *Job control* reflects the average of three items ($\alpha = 0.80$), whereas *psychological demands* reflects the average of four items ($\alpha = 0.71$); higher values indicate greater exposure to each concept. Exposure to heavy loads and awkward posture and repetitive movements were measured with an established physical workload instrument[39] used in previous research with immigrant Latinos.[17] *Heavy load* was assessed by computing the average of 12 items ($\alpha = 0.81$),

and *awkward posture and repetitive movements* was assessed by computing the average of 6 items (α = 0.77) coded such that higher values indicate greater exposure.

The management and supervision domain of work organization was also assessed with two instruments. The experience of abusive supervision was assessed with an established 7-item instrument[40] that has been used in previous research with immigrant Latinos.[17,41] *Abusive supervision* is the calculated mean of all 7 items (α = 0.67) coded such that higher scores indicate greater abusive supervision. Finally, the commitment of managers and supervisors to safety was assessed with a single item from an established perceived safety climate scale[42] used in previous research with immigrant Latinos.[43] Participants were asked "How much do supervisors seem to care about your safety?". Individuals responding "they are only interested in doing the job fast and cheaply" were coded 1 for *poor safety commitment*, whereas individuals reporting "they could do more to make my job safe" or "they do as much as possible to make my job safe" were coded zero on this variable.

Covariates. All models adjusted for the effects of age, gender and indigenous language because these characteristics differentiated the clinical from the interview samples. *Age* was coded continuously. Gender was coded such that female was coded 1 and males were coded zero. *Indigenous language* was assessed by asking individuals what type of language was spoken by adults in the household when the participant was a child. Individuals reporting the use of any indigenous language (e.g., Quiche, Aguacateco) were coded 1, whereas individuals reporting the use of either English or Spanish in the household during childhood were coded zero.

Analyses

Data were summarized by using means and standard deviations (SDs) for continuous variables, and frequencies and percents for categorical variables. All analyses accounted for the sampling structure of the data, clustering on county of residence and dwelling unit. Unadjusted associations between work organization factors and poultry/non-poultry work were tested using Rao-Scott Chi-Square tests for categorical variables and ANOVA for continuous variables. Logistic regression models were used to assess the bivariate associations of these work organization factors with clinical findings of upper body musculoskeletal outcomes (epicondylitis, rotator cuff, and back injuries). These bivariate models were subsequently adjusted for age and indigenous language. A final model was then run for each outcome, including all work organization factors simultaneously and adjusting for age and indigenous language. All analyses were completed using SAS version 9.2 (SAS Institute, Inc, Cary, NC). A p-value of 0.05 was considered statistically significant.

RESULTS

The sample contained more men (57%) than women (43%), and over 70% of the sample was 39 years of age or younger (Table 1). Over half of the sample reported less than 6 years of education, but nearly 20% reported 10 or more years of education. Half of the sample immigrated from Mexico, over one-third (38.1%) were from Guatemala, and the remainder were predominantly from other Central American countries. Spanish was the dominant language of the sample, although 24.5% reported speaking an indigenous language. Over 40% of the sample had been in the US for more than 10 years, while a comparable percentage of participants had been in the US for 6 or fewer years and between 7-10 years.

Average scores on the work organization variables were generally modest, recognizing most had possible scores ranging from 1 to 4 (Table 2). Scores for each of the job design variables and for abusive supervision were approximately "2," which was anchored with the "sometimes" descriptor. Approximately 40% of workers reported a poor safety climate in their workplace.

Scores on all of the work organization variables differed significantly by major occupational group. The design of poultry processing jobs was generally poorer than jobs outside of poultry. Poultry processing workers reported less frequent opportunities to exert control on their job, greater exposure to psychological demands, and more frequent exposure to awkward postures and repetitive movements than non-poultry workers. Poultry processing workers reported less exposure to heavy loads than non-poultry workers. In terms of supervisory practices, poultry workers reported less abusive supervision than non-poultry workers, but a greater proportion of poultry workers than non-poultry workers reported a poor safety climate.

Rotator cuff syndrome was a common injury. Physical exams identified 167 participants (32.4%) affected by rotator cuff syndrome, followed by 156 (30.2%) with low back pain and 136 (26.4%) with epicondylitis. Preliminary bivariate analyses yielded no evidence of differences in any of the three injuries between poultry and non-poultry workers.

Bivariate analyses suggested that several work organization variables were associated with clinical indicators of musculoskeletal problems (Table 3). Job control was associated with two of the three outcomes: for every one-unit increase in job control, the odds of clinical identification of epicondylitis and of rotator cuff problems decreased by 23% and 21%, respectively. Psychological demand was associated with all three outcomes: every one unit increased in psychological demand was associated with a 24-30% increase in the odds of each upper-body musculoskeletal outcome. Awkward postures and repetitive movements was associated with all three outcomes: every one unit increase in this element of job design was associated with a 29-34% increase in the odds of identifying epicondylitis, rotator cuff, and back problems. Finally, poor safety commitment was associated with both rotator cuff and back problems: individuals with a poor safety commitment were 66% and 89% more likely than individuals with good commitment to safety to evidence rotator cuff and back problems, respectively. Heavy load and abusive supervision were not associated with any of the outcomes.

Many of the bivariate results held after adjusting for age, gender and indigenous language (Table 4, Model 1 for each outcome). Epicondylitis was associated with job control in the expected direction such that greater job control was associated with lower odds of epicondylitis. Rotator cuff problems were associated with job control, psychological demands, awkward and repeated movements, and poor safety commitment. Finally, clinically identified back problems were associated with psychological demands, heavy loads, awkward postures and repeated movements, as well as poor safety commitment.

In multivariate models incorporating all work organization variables simultaneously and adjusting for age and indigenous language, epicondylitis was only predicted by one factor (Table 4, Model 2 for each outcome). For every one-unit increase in exposure to awkward posture and repeated movements the odds of finding epicondylitis increased by 60% (CI=1.14 – 2.225). None of the work organization factors were associated with rotator cuff problems in multivariate analyses. The odds of back problems were 55% (CI=1.03 – 2.33) more likely among workers whose supervisors demonstrate poor safety commitment in contrast to those whose supervisors are more committed to safety.

DISCUSSION

Despite growing interest, the evidence base linking work organization to inequalities in occupational health outcomes is relatively sparse. Outside of general indicators of health,[21] depression[12] and heart disease,[13] little US-based research has focused on clinical indicators of poor occupational health outcomes like musculoskeletal problems.[1] Further, many of the existing studies are not able to deliberately link observed measures of job design and management practices to the overarching business model. This study addresses many of the gaps in previous research by comparing workers in a highly mechanized, vertically integrated production facility to similar workers not exposed to this model of work organization.

Our results suggest the organization of work in poultry processing is pathogenic. This study is not the first to characterize poultry processing in this way;[33,17,43] however, it is one of the first to compare similar workers inside and outside the poultry processing plants. Like Lipscomb and colleagues,[34] we find that, in contrast to manual workers outside the poultry processing industry, poultry processing workers have less opportunity to control their work, they experience more regular psychological demands, their jobs require awkward postures and repetitive motions more frequently, and management is perceived as having a poor commitment to safety. These findings are meaningful because they shed light on the often unseen and potentially under-prioritized occupational hazards associated with vertical integration and mechanization.

Analyses from data obtained from immigrant Latino workers suggest that several work organization factors are associated with clinical indicators of poor occupational health. Like previous research using European samples, results from adjusted bivariate analyses indicated that greater levels of job control are associated with lower odds of physician identified epicondilytis and rotator cuff problems, and that greater psychological demands are associated with higher odds of physician diagnosed rotator cuff and back problems.[7-9] We also

found that greater exposure to awkward postures and repetitive movements and poor safety commitment were associated with greater odds of all three outcomes. Our findings contribute to this literature by documenting comparable associations in a US-based sample of workers, most of whom are vulnerable because of their ethnicity and documentation status.

The overall pattern of results, in connection with previous research, is suggestive of a possible source of health disparities. Our results suggest that, among immigrant Latinos in North Carolina, poultry processing workers have greater exposure to work organization hazards like low job control, elevated psychological demand, and repetitive work than non-poultry manual workers, and that these exposures are linked with increased risk for poor musculoskeletal outcomes. This observation, coupled with reports that the poultry processing workforce is dominated by members of racial and ethnic minority groups, and increasingly foreign born workers,[33] supports a basic precept in the occupational health disparities literature. That is, capitalist oriented labor market policies result in disproportionate exposure of racial and ethnic minorities to pathogenic job designs and work characteristics, health compromising supervisory practices, and injury-prone safety climates that culminate to create an unequal burden of illness and disease among these workers relative to more privileged workers.[1,6,4]

Although the previous occupational health disparities suggestion is compelling, it needs to acknowledge that there is minimal evidence of it in these data. There was no evidence that rates of the musculoskeletal outcomes were higher among poultry processing workers relative to non-poultry processing workers. The only tangible evidence is that our multivariate results do indicate a greater risk, although not significantly greater, of all three outcomes for poultry processing workers in contrast to non-poultry processing workers. Further, this elevated risk is reduced and the odds ratio reversed once all of the work organization factors are included in the model. Although neither the main effect of major occupation nor the attenuation of effect are significant, the pattern is completely consistent with the occupational health disparities hypothesis. That is, differences in work organization factors account for, or explain, elevated risk of poor health outcomes among health disparate workers. More research with larger samples is needed to definitively test this hypothesis.

The results of this study need to be interpreted in light of its limitations. Perhaps the greatest limitation is that these data are cross-sectional; consequently, causal inferences cannot be made. A second limitation is that study participants were sampled from a discrete geographic region; consequently, the generalizability of study findings is unknown. It could also be argued that requiring only one positive exam element for injury diagnosis is too inclusive. Using a stricter case definition requiring two positive findings would have decreased the injury prevalences by one third to one half. However, gaining specificity in this manner would reduce sensitivity. A higher threshold for injury diagnosis would result in fewer false positives but could miss milder cases early in the disease process that have the potential for significant future morbidity. All of the clinical exams were held on Sundays when participants were off-duty for the day; thus, injuries which flared only while or very shortly after working would not have been detected.

Limitations notwithstanding, this research makes several meaningful contributions to the literature. The results document how job characteristics systematically differ between workers in a vertically integrated production facility relative to similar workers not exposed to this model, and they suggest that the organization of poultry processing workers has several pathogenic features. The results also contribute to the literature by documenting robust associations between several work organization factors and clinically identified upper-body musculoskeletal problems. Although additional research is needed with a larger sample, the overall pattern of results suggests that the organization of work may contribute to occupational health disparities in upper-body musculoskeletal problems.

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Table 1. Sociodemographic characteristics of Latino workers in North Carolina, by major occupation.

	Total Sample (N=742)		Poultry Processing Workers (n=403)		Non-Poultry Processing, Manual Workers (n=339)	
Personal Characteristics	N	Col%	N	Row%	N	Row%
Sex						
Male	423	57.0	230	54.4	193	45.6
Female	319	43.0	173	54.2	146	45.8
Age						
17 to 29 years	250	37.7	123	49.2	127	50.8
30 to 39 years	229	34.5	112	48.9	117	51.1
40 to 49 years	120	18.1	78	65.0	42	35.0
50 or more years	64	9.7	43	67.2	21	32.8
Educational Attainment						
0 to 6 years	428	57.8	253	59.1	175	40.9
7 to 9 years	171	23.1	82	48.0	89	52.0
10 or more years	142	19.2	67	47.2	75	52.8
Country of Birth						
Mexico	371	50.0	167	45.0	204	55.0
Guatemala	283	38.1	169	59.7	114	40.3
Other	88	11.9	67	76.1	21	23.9
Language						
Speaks Spanish	556	75.5	293	52.7	263	47.3
Speaks Indigenous Language	180	24.5	106	58.9	74	41.1

Years in US						
Less than 3 years	42	5.7	31	73.8	11	26.2
3 to 6 years	179	24.5	92	51.4	87	48.6
7 to 10 years	212	29.0	91	42.9	121	57.1
More than 10 years	298	40.8	183	61.4	115	38.6

Table 2. Variation in work organization among poultry and non-poultry Latino manual workers in eastern NC (N=742).

	Total M (SE)	Poultry M (SE)	Non-Poultry M (SE)	p-value
Job Design				
Job Control	1.93 (0.03)	1.70 (0.04)	2.21 (0.05)	<.0001
Psychological demand	2.49 (0.03)	2.74 (0.04)	2.18 (0.04)	<.0001
Heavy load	2.06 (0.02)	1.99 (0.03)	2.15 (0.04)	0.0007
Awkward posture & repeated movements	2.12 (0.03)	2.29 (0.04)	1.92 (0.04)	<.0001
Supervisory Practices				
Abusive Supervision	2.37 (0.02)	2.31 (0.03)	2.46 (0.03)	<.0001
Poor Safety Commitment	0.40 (0.02)	0.50 (0.02)	0.27 (0.03)	<.0001

Table 3. Bivariate association of work organization factors with clinical findings of upper-body musculoskeletal outcomes among immigrant workers in NC (N=518).

	Epicondylitis OR (95% CI)	Rotator Cuff OR (95% CI)	Back OR (95% CI)
Primary Job			
Poultry processing (yes versus no)	1.32 (0.91 – 1.92)	1.29 (0.92 – 1.81)	1.10 (0.79 – 1.54)
Job Design			
Job Control	0.77* (0.61 – 0.97)	0.79* (0.65 – 0.97)	1.00 (0.84 – 1.19)
Psychological demand	1.25 (1.00 – 1.56)	1.30** (1.07 – 1.59)	1.24* (1.03 – 1.50)
Heavy load	0.87 (0.63 – 1.21)	1.15 (0.87 – 1.53)	1.17 (0.89 – 1.54)
Awkward posture & repeated movements	1.33* (1.03 – 1.71)	1.34** (1.07 – 1.68)	1.29* (1.03 – 1.60)
Supervisory Practices			
Abusive Supervision	1.30 (0.83 – 2.05)	0.92 (0.64 – 1.31)	1.13 (0.81 – 1.58)
Poor Safety Commitment (yes vs no)	0.28 (0.84 – 1.96)	1.66*** (1.16 – 2.38)	1.89*** (1.33 – 2.68)

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$ (two tailed)

Table 4. Multivariate associations of work organization factors with clinical findings of upper-body musculoskeletal outcomes among immigrant workers in NC (N=518).

	Epicondylitis OR (95% CI)		Rotator Cuff OR (95% CI)		Back OR (95% CI)	
	Model 1‡	Model 2†	Model 1‡	Model 2†	Model 1‡	Model 2†
Primary Job						
Poultry Processing (yes versus no)	1.21 (0.81 – 1.79)	0.98 (0.60 – 1.59)	1.25 (0.88 – 1.77)	0.96 (0.62 – 1.47)	1.04 (0.74 – 1.48)	0.96 (0.62 – 1.49)
Job Design						
Job Control	0.77* (0.60 – 0.97)	0.79 (0.59 – 1.05)	0.79* (0.64 – 0.97)	0.79 (0.61 – 1.03)	1.00 (0.84 – 1.19)	0.98 (0.79 – 1.23)
Psychological demand	1.23 (0.98 – 1.55)	1.05 (0.79 – 1.40)	1.30** (1.06 – 1.59)	1.10 (0.86 – 1.41)	1.24* (1.02 – 1.50)	1.14 (0.90 – 1.45)
Heavy load	1.05 (0.73 – 1.50)	0.81 (0.50 – 1.30)	1.32 (0.96 – 1.82)	1.08 (0.71 – 1.63)	1.43* (1.04 – 1.95)	1.09 (0.72 – 1.64)
Awkward posture & repeated movements	1.32* (1.01 – 1.73)	1.60** (1.14 – 2.25)	1.35** (1.07 – 1.69)	1.28 (0.95 – 1.74)	1.31* (1.05 – 1.63)	1.26 (0.94 – 1.67)
Supervisory Practices						
Abusive Supervision	1.46 (0.90 – 2.37)	1.49 (0.91 – 2.45)	0.95 (0.66 – 1.38)	0.98 (0.66 – 1.44)	1.25 (0.87 – 1.79)	1.32 (0.88 – 1.97)
Poor Safety Commitment (yes vs no)	1.20 (0.77 – 1.87)	1.01 (0.61 – 1.65)	1.65** (1.14 – 2.40)	1.34 (0.90 – 2.01)	1.81*** (1.25 – 2.63)	1.55* (1.03 – 2.33)

‡ Separate models were fit for each element of work organization, controlling for the effects of age, gender and indigenous language.
† Single model estimating the independent associations of elements of work organization simultaneously, controlling for the effects of age, gender and indigenous language.
* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$ (two tailed)

Aim 2

To document the incidence of selected MSDs and skin disorders in Latino poultry processing workers and controls (non-poultry, Latino manual laborers); and assess the mediating and moderating effects of occupational, structural, and socio-cultural factors on this incidence.

2-1. The Effects of Work Organization on the Health of Immigrant Manual Workers: A Longitudinal Analysis

ABSTRACT

This analysis uses a longitudinal design to examine the associations of work organization and health outcomes among Latino manual workers. Participants included 247 Latino workers who completed baseline and one-year follow-up interviews and clinical exams. Outcome measures were epicondylitis, rotator cuff syndrome, back pain, and depressive symptoms. Independent measures were measures of job demand, job control, and job support. Workers commonly experienced rotator cuff syndrome (6.5%), back pain (8.9%), and depressive symptoms (11.2%); fewer experienced epicondylitis (2.4%). Psychological demand was associated with rotator cuff syndrome; awkward position and decision latitude were associated with back pain. Decreased skill variety but increased decision latitude was associated with elevated depressive symptoms. Work organization factors are important for health outcomes among vulnerable workers. Further research is needed to expand upon this work, particularly cultural perspectives on job support.

INTRODUCTION

The way in which work is organized affects worker health. Work organization is conceptualized at three levels, external context (e.g., economic developments, regulation and policy), organizational context (e.g., organizational restructuring, alternative employment arrangements), and work context (e.g., culture and climate, task attributes, worker roles).[1] Work context reflects the components of the job demand-control-support model.[2-4] For immigrant workers, the components of work context are particularly important. Immigrant workers constitute a vulnerable population with little control over the work environment. Most of these workers are employed in manual industries with the highest rates of injury and fatalities, including agriculture, meat processing, food service, personal care, and construction.[5-9] Within these industries, immigrant workers are concentrated in jobs described as "3-D", dirty, demeaning, and dangerous,[10] and which are the lowest-skilled and the most dangerous.[11] The manual work in which most immigrant workers are engaged provides little flexibility in how the work can be done, and includes structural constraints, such as high speed and extreme force, that increase the risk of injury.[12] Immigrant workers in the US experience rates of occupational injury and mortality greater than the native worker population.[13]

Analyses have begun to delineate the associations of work context factors with the health of immigrant workers. For example, Swanberg and colleagues report that abusive supervision and awkward postures were associated with occupational illness among immigrant farmworkers in Kentucky.[14] Grzywacz and colleagues' analysis of National Agricultural Workers Survey (NAWS) data shows that psychological demand is associated with poor self-reported health and elevated depressive symptoms.[15] Grzywacz and colleagues [report that manufacturing workers with high psychological demand and low control are more likely to experience diagnosed musculoskeletal injuries (epicondylitis, rotator cuff syndrome).[16] Arcury and colleagues report that, among immigrant Latino women workers employed in manual jobs, greater job demand (heavy load, awkward posture, greater psychological demand) is associated with more musculoskeletal and depressive symptoms, as well as increased risk of epicondylitis, rotator cuff syndrome, and carpal tunnel syndrome; that less job control (lower skill variety and decision latitude) is associated with more musculoskeletal symptoms, as well as increased risk of epicondylitis and carpal tunnel syndrome; and that greater support (perceived supervisor's power, safety climate) is associated with fewer depressive symptoms.[17,18]

Investigations of work context and the health of immigrant workers have relied on cross-sectional data. Documenting a causal link between the work context of immigrant workers and their health has not been possible because immigrants may experience poor health from factors unrelated to work. The goal of this analysis is to determine the effects of the job demand, job control, and job support components of work context

on the presence of epicondylitis, rotator cuff syndrome, back pain, and depressive symptoms among immigrant Latino manual workers using longitudinal data collected at a one year interval.

METHODS

This analysis uses data from a study comparing Latino poultry processing workers occupational injuries with those among other Latino manual workers.[19-22] Baseline data were collected in 2009-2010; follow-up data were collected in 2010-2011. The study was approved by the Wake Forest School of Medicine Institutional Review Board. All participants provided signed informed consent.

Participants

Participants for the baseline data collection were recruited from a four county area in western North Carolina. Two procedures were used to locate potential participants. First, dwellings in Latino neighborhoods in the four counties were mapped and listed. Second, the four counties were surveyed to identify dispersed dwellings with Latino residents; these dispersed dwellings were identified either by having local informants (store employees, clergy) indicating their location or by physical symbols indicative of Latino residents (e.g., parked vehicles with Mexican flag or Virgin of Guadalupe decals; satellite dishes from the company with Spanish language channels). Two-thirds of the 4,376 potential Latino dwellings that were listed were in neighborhoods. Dwellings were randomly listed with two-thirds from neighborhoods and one-third from dispersed dwellings.

Interviewers visited randomly selected dwellings and screened residents for the inclusion criteria: self-identified as Latino or Hispanic, worked 35 hours or more per week in a manual job, and aged 18 years or older. More than one resident per dwelling could be recruited. Manual labor in poultry processing was defined as non-supervisory work in a poultry processing plant with job categories from receiving through sanitation. Other manual labor was defined as employment in non-managerial jobs in industries such as landscaping, construction, restaurant work, hotel work, child care, and manufacturing. Non-poultry workers with previous work in poultry were excluded if they had more than 6 months employment in poultry processing, or had worked in poultry processing in the previous two years. Of 1,681 dwellings contacted, 965 were screened, for a screening rate of 57%. Of 1,526 individuals screened, 957 were eligible for enrollment, with 742 completing interviews (77.5% participation rate).

Participants who did not have a diagnosis of carpal tunnel syndrome or of a dermatological condition at the baseline data collection were invited to participate in a one-year follow-up. A total of 268 participants met the inclusion criteria and 254 were recruited to the follow-up (94.8% participation rate). Monthly contacts with telephone calls or in person by the interviewers helped to retain participation. At the end of the year, the participants were invited to participate in a follow-up data collection, with 247 completing the follow-up for a retention rate of 97.2%.

Data Collection

Baseline data collection included an interviewer-administered questionnaire which collected participant personal characteristics, the items to construct the work organization measures, and the items to construct the depressive symptoms measure, and a clinical evaluation conducted by a physician to diagnose epicondylitis, rotator cuff syndrome, and back pain. The baseline interviews were completed in the participants' homes. The clinical evaluations were completed in a series of research clinics conducted in central locations within the four research counties within one month of when the participants completed the baseline interviews. Follow-up data collection included a short interviewer-administered questionnaire that included information to construct the depressive symptoms measure and a clinical evaluation to diagnose epicondylitis, rotator cuff syndrome, and back pain. The follow-up questionnaire also included items to measure changes in employment, which occurred for only 12 participants and is not considered in this analysis. The follow-up interviews and clinical evaluations were completed in a series of research clinics conducted in central locations in the four research counties.

Measures

Measures for the work context domains job demand, job control, and job support were constructed from the baseline interview data. The job demand measures, heavy load and awkward position, were based on the establish workload instrument.[23] Response options ranged from "seldom/never" (1) through "almost always" (4). Heavy load was the mean of 12 items (α = 0.83), and awkward position was the mean of 6 items (α = 0.78). High values for each indicated greater exposure. Psychological demand, the final job demand measure, was assessed with the mean of 4 items modified from the Job Content Questionnaire[24] (α = 0.70). Response options ranged from "seldom/never" (1) through "almost always" (4). High values indicated greater psychological demand. Job control measures included skill variety (α = 0.71) and decision latitude (α = 0.83), each based on 3 items modified from the Job Content Questionnaire.[24] Response options ranged from "seldom/never" (1) through "almost always" (4). High values indicated greater variety and latitude. These measures have been used previous research with immigrant Latino workers.[17]

The support measure, perceived supervisor control, was assessed with seven items from an established instrument.[17, 25] Response options ranged from "strongly disagree" (1) through "strongly agree" (4). Perceived supervisor control is the mean of the seven items (α = 0.64) coded such that higher scores indicate greater perceived control. The second support measure, work safety climate, was assessed with the Perceived Safety Climate Scale.[14, 19, 26, 27] Nine of the items in the scale used a four-point Likert format. The tenth item included three response categories. After an analysis of internal consistency, one of the nine four-point Likert format items was discarded due to lack of fit within the scale. A total Work Safety Climate was calculated by summing the remaining nine items (α = 0.72). Values for the scale ranged from 9 to 39, with higher values indicating better work safety climate. Measures of perceived supervisor control and work safety climate were not applied to women who reported being self-employed.

Physician diagnosed epicondylitis was defined as self-reported pain at either epicondyle area on 2 or more days in the previous month and one of the following on exam: presence of pain at the lateral epicondyle with resisted active wrist extension, pain at the medial epicondyle with resisted active wrist flexion, or tenderness to palpation over the medial and lateral epicondyle regions physical exam.[22, 28] Rotator cuff syndrome was defined as self-reported pain at the shoulder on 2 or more days in the previous month and one of the following on exam: presence of pain with resisted abduction, internal rotation, external rotation, or forward flexion of the shoulder, or tenderness to palpation over the bicipital groove or lateral shoulder. Low back pain was defined as self-reported low back pain on 2 or more days in the previous month and one of the following on exam: presence of pain with active flexion, extension, side-bending to right or left, or twisting to right or left, or tenderness to palpation in the lumbar region. Depressive symptoms were assessed with the Spanish validated short version of the Center for Epidemiological Studies Depression scale (CES-D).[29] This 10-item version of the scale delineates the frequency and severity of current depressive symptoms.[30] Items were scored in a 4-point scale and summed. Possible scores range from 0 to 30 (α = 0.72); greater scores reflect higher levels of depressive symptoms. Elevated depressive symptoms were defined as having a score of 10 or higher.

Personal and work characteristics considered in the analysis are age in years, gender, indigenous language, and industry. Indigenous language indicates that an indigenous language was spoken in the participant's home when a child. Industry indicates whether the participant worked in poultry processing or in another industry.

Analysis

Descriptive statistics were used to describe the personal, work organization, and health characteristics for the overall sample. Next, logistic regression models were fit to examine the association between baseline work organization characteristics and prevalence of rotator cuff syndrome, back pain, and elevated depressive symptoms at one year. All models were adjusted for diagnosis of condition at baseline, gender, age, years lived in US, indigenous language, and industry, while accounting for the stratification and clustering of sample design. Two sets of multivariate logistic models were fit with and without the job support measures. Adjusted odds ratios (OR) and 95% confidence intervals (CI) were reported. Multivariate analysis was not completed for epicondylitis due to the small number of cases. All analyses were performed using SAS 9.3 (Cary, NC), and p-values less than 0.05 were considered statistically significant.

RESULTS

Participant Personal, Work Organization and Health Characteristics

The mean age of the participants was 31.6 years (SD = 9.1) (Table 1). About one-half of the participants were female. One in five spoke an indigenous language. About one-third (36.0%) worked in poultry processing. Very few (4.9%) had changed jobs in the previous year. The mean and standard deviations for each of the work organization scales are presented in Table 1. The number of participants with musculoskeletal injuries and depression decreased during the year (Table 2). At the follow-up, 6 participants (2.4%) were diagnosed with epicondylitis, 16 (6.5%) with rotator cuff syndrome, 22 (8.9%) with back pain, and 27 (11.2%) with depression.

Effects of Work Organization and Health Characteristics

The associations of job demand and job control measures with rotator cuff syndrome, back pain, and elevated depressive symptoms were very similar in the models with and without the job support measures (Table 3). Psychological demand increased the odds of having rotator cuff syndrome (Odds Ratio (OR) = 4.09, 95% CI =1.51-11.12 without the job support measures in the model, and OR = 3.80, 95% CI =1.42-10.08 with the job support measures in the model). Awkward position increased the odds of having back pain (OR = 2.43, 95% CI =1.19-4.97 without the job support measures in the model, and OR = 4.20, 95% CI =1.54-11.49 with the job support measures in the model), while decision latitude decreased the odds of having back pain (OR = 0.15, 95% CI = 0.04-0.53 only with the job support measures in the model). Skill variety decreased the odds of having elevated depressive symptoms (OR = 0.45 95% CI =0.25-0.80 without the job support measures in the model, and OR = 0.39, 95% CI =0.20-0.76 with the job support measures in the model). Decision latitude increased the odds of having elevated depressive symptoms (OR = 1.92, 95% CI =1.06-3.48 without the job support measures in the model, and OR = 2.60, 95% CI =1.33-5.09 with the job support measures in the model). The job support measures were not significantly associated with any of the outcomes.

DISCUSSION

Rotator cuff syndrome, back pain, and depression are common among the Latino manual workers who participated in this study. Psychological demand has a causal association with the occurrence of rotator cuff syndrome, and awkward posture has a causal association with back pain among these workers. Decision latitude decreased the odds of back pain among these workers. Skill variety is protective of elevated depressive symptoms, while decision latitude increases the odds of elevated depressive symptoms. The low prevalence of epicondylitis does not allow for multivariate analysis. Job support measures do not have statistically significant associations with any of the health measures.

The percentage of participants with epicondylitis is lower among the Latino manual workers participating in this study (2.4% at follow-up) than reported by Fan and colleagues for largely non-Hispanic white manufacturing workers at 12 Washington State worksites (5.5%).[31] The level of rotator cuff syndrome among the participants in this study (6.5% at follow-up) is similar to the prevalence of 7.5% in the same 12 Washington State worksites.[32,33] Bonauto and colleagues' analysis of Workers' Compensation claims for non-traumatic back disorders among Washington State workers does not provide comparative data on prevalence, but does document that more Spanish language workers compared to English language workers have Workers' Compensation claims for back disorders.[34] The percentage of Latino manual workers participating in this study with elevated depressive symptoms at follow-up (11.2%) is relatively high compared to other studies. For example, Fan and colleagues report 5.2% of Washington state workers with depression, but this varies by occupation, with those in manual occupations (i.e., truck drivers) having a greater odds of having depression compared to those in management occupations.[35] Using data from a national study of farmworkers, most of whom are Latino manual workers, Grzywacz and colleagues report that 8.7% had elevated depressive symptoms.[15]

Specific work context characteristics increase the odds of these immigrant workers experiencing rotator cuff syndrome, back pain, and elevated depressive symptoms. Taken together, these results build on previous research indicating that work organization factors affect the health of immigrant and manual workers.[14,17,18, 36] Swanberg and colleagues find that immigrant livestock and crop workers experience high job demand, little job control support, little job support, and high rates of occupational injury.[14] Psychological demand increases the

odds of having rotator cuff syndrome a year later among the Latino manual workers in this study. Silverstein and colleagues report that the associations of work organization factors, such as structural constraints, decision latitude, and job satisfaction, with rotator cuff are suggestive.[33]

Awkward position, a measure of job demand, increases the odds of the Latino manual workers in this study having back pain a year later, and decision latitude, a measure of job control, decreased the odds of these workers having back pain a year later. Smith and colleagues find that being in a high strain job (one with high demand and low control) increases the incidence of shoulder symptoms.[37]

Skill variety, a measure of job control, decreases the odds of the Latino manual workers in this study having elevated depressive symptoms a year later, while decision latitude increases the risk of these workers having elevated depressive symptoms. Grzywacz and colleagues report that greater psychological demand is associated with elevated depressive symptoms among Latino farmworkers.[15] Similar to earlier analyses, job support does not contribute to any of the health outcomes among the Latino manual workers in this study.[18]

The positive association of job control with depression is surprising; the expected effect of greater job control would be to decrease depressive symptoms. However, this result is consistent with earlier, cross-sectional analysis with the female participants in this study.[17] The three items used to construct the job control measure are reasonably reliable ($\alpha = 0.83$). These three items are not complicated questions (How often are you allowed to make your own decisions about your work? How often do you have the freedom to decide how you do your work? How often do you have a lot of say about what happens on your job?). A possible explanation is that the "control" provided to these workers, largely with limited formal education, working in jobs that are not familiar to them, but which they fear losing, is perceived as a risk that could cause failure and economic jeopardy. The more choices that a worker has, the more errors the worker can make. This interpretation is consistent with analyses indicating that the well-being of Latino immigrant workers is associated with perceived supervisor control. Arcury and colleagues report a positive association of perceived supervisor control on mental health related quality-of-life.[17] Swanberg and colleagues argue that supervisor attitudes toward safety increase safety among immigrant farmworkers.[14] Similarly, Hoppe and colleagues report that supervisor support increases well-being among Latino warehouse workers.[38] Future work organization research should focus on how Latino manual workers' perceptions of decision latitude and supervisor power affect worker health and well-being.

The results of this analysis should be considered within its limitations and strengths. Some workers with injuries or elevated depressive symptoms may have left the work force. Workers with part-time employment may experience different rates of injury. These data are from one region of one state, which limits the generalizability of the results to other locales. However, the study has a number of strengths, including a longitudinal design and strong sample design, a large sample size and high participation rate, extensive collection of information, and use of existing work organization measures.

This analysis provides additional evidence that work context characteristics, particularly job control and job demand, are associated with the presence of clinically diagnosed musculoskeletal injuries and self-reported depressive symptoms among immigrant manual workers. It suggests that future conceptual development of the organization of work model[1] and job demand-control-support model[2, 3, 4] needs to consider different "cultural" contexts for how job control and job support affect health, particularly psychological health. The vulnerability of many manual workers includes a lack of familiarity with the work environment, the belief that any error that they make will result in a penalty, and greater familiarity with a hierarchical employment and social system. Having greater control in some aspects of work provides the opportunity for flexibility, as in the time work begins and ends, and improves life in such areas as work-family balance. Greater control in other aspects of work may provide the opportunity for greater creativity and fulfillment. It also provides the opportunity for making mistakes.

Future research on work organization and health among immigrant workers should expand the use of longitudinal designs that will allow specifying which work organization characteristics are causally related which health outcomes. This research should also expand measurement of the work organization characteristics and the types of health outcomes considered, with preference given to objective measures, such as clinical evaluation. This research should try to build alliances with employers so that better exposure measurement

can be considered; unfortunately, experience with employers shows that they are little interested in research on the health of immigrant and other manual workers.[39] Future research would benefit from a large sample that is diverse in occupation, gender, immigration status, and ethnicity that would allow comparisons of health outcomes and delineation of work organization effects. Funding for such large studies is difficult to obtain; efforts focused on comparisons of specific populations should endeavor to expand the measures used.

In conclusion, aspects of work context have causal associations with health outcomes among immigrant manual workers, some of which are not consistent with expectations based on previous research in non-immigrant populations. Further research is needed to expand upon this work. Policy initiatives need to consider how work organization affects occupational health.

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Table 1: Personal and Work Organization Characteristics, Latino Manual Workers, Western North Carolina, 2009-2011 (n=247).

Personal and Work Organization Characteristics	n	%	Mean	SD
Personal Characteristics				
Age			31.6	9.1
Gender				
Female	124	50.2		
Male	123	49.8		
Indigenous language	50	20.3		
Industry				
Poultry	89	36.0		
Other	158	64.0		
Changed job	12	4.9		
Work Organization				
Job Demand				
Heavy load			2.1	0.6
Awkward posture			2.1	0.8
Psychological demand			2.4	0.8
Job Control				
Skill variety			2.1	0.8
Decision latitude			2.0	1.0
Support				
Perceived supervisor control (excludes self-employed)			2.4	0.5
Work safety climate (excludes self-employed)			24.9	3.4

Table 2: Health Characteristics at Follow-up, Latino Manual Workers, Western North Carolina, 2009-2011 (n=247).

Health Outcomes	n	%
Epicondylitis	6	2.4
Rotator cuff syndrome	16	6.5
Back pain	22	8.9
Elevated depressive symptoms	27	11.2

Table 3. Effects of Worker Organization Characteristics on Health Characteristics, Latino Manual Workers, Western North Carolina, 2009-2011 (n=247).

Work Organization	Health Characteristics								
	Rotator Cuff Syndrome*			Back Pain*			Elevated Depressive Symptoms*		
	Odds Ratio	95% CI	P-value	Odds Ratio	95% CI	P-value	Odds Ratio	95% CI	P-value
Models without Supervision Indicators (n=247)									
Job Demand									
Heavy load	0.80	0.16-3.95	0.78	1.35	0.60-3.20	0.46	0.64	0.24-1.71	0.38
Awkward posture	1.77	0.79-3.98	0.16	2.43	1.19-4.97	0.01	1.64	0.70-3.81	0.25
Psychological demand	4.09	1.51-11.12	0.00	0.57	0.27-1.19	0.13	0.61	3.10-1.22	0.16
Job Control									
Skill variety	1.02	0.40-2.61	0.96	1.16	0.61-2.22	0.64	0.45	0.25-0.80	0.00
Decision latitude	1.39	0.65-2.93	0.37	0.58	0.27-1.24	0.16	1.92	1.06-3.48	0.03
Models with Supervision Indicators (n= 215)									
Job Demand									
Heavy load	0.59	0.10-3.59	0.57	2.27	0.78-6.53	0.12	0.77	0.27-2.16	0.62
Awkward posture	2.10	0.83-5.27	0.11	4.20	1.54-11.49	0.00	1.23	0.48-3.16	0.65
Psychological demand	3.80	1.42-10.08	0.00	0.65	0.31-1.36	0.25	0.82	0.41-1.66	0.59
Job Control									
Skill variety	0.78	0.26-2.34	0.66	1.45	0.59-3.51	0.40	0.39	0.20-0.76	0.00
Decision latitude	1.48	0.28-3.49	0.36	0.15	0.04-0.53	0.00	2.60	1.33-5.09	0.00
Support									
Perceived supervisor control	3.45	0.77-15.48	0.10	3.00	0.79-11.40	0.10	0.55	0.19-1.56	0.26
Work safety climate	1.00	0.80-1.26	0.96	1.04	0.90-1.20	0.55	1.04	0.87-1.24	0.61

*Analyses adjusted for diagnosis of condition at baseline, gender, age, years lived in US, indigenous language, and industry.

2-2. One-year Incidence of Carpal Tunnel Syndrome in Latino Poultry Processing Workers and Other Latino Manual Workers

ABSTRACT

Objective: To determine the incidence of carpal tunnel syndrome (CTS) over one year in Latino poultry processing workers.

Methods: Symptoms and nerve conduction studies were used to identify Latino poultry processing workers (106 wrists) and Latinos in other manual labor occupations (257 wrists) that did not have CTS at baseline, and these individuals were then evaluated in the same manner one year later.

Results: Based on wrists, the one-year incidence of CTS was higher in poultry processing workers than non-poultry manual workers (19.8% vs. 11.7%, p = 0.022). Poultry workers had a higher odds (1.89; p = 0.089) of developing CTS over one year compared to non-poultry manual workers.

Discussion: Latino poultry processing workers have an incidence of CTS that is possibly higher than Latinos in other manual labor positions. Latino poultry workers' high absolute and relative risk of CTS likely results from the repetitive and strenuous nature of poultry processing work.

INTRODUCTION

Carpal tunnel syndrome (CTS) is a condition that typically results in some combination of numbness, tingling, pain, and weakness in the affected hand. It occurs secondary to damage or irritation of the median nerve at the wrist [Gelberman et al., 1981], and therefore is a common work-related condition in manual labor occupations requiring repetitive use of the hands [Frost et al., 1998]. It is estimated to affect 2.7% of the general population, results in $500 million in healthcare costs in the United States yearly, and is a leading cause of workers' compensation claims [Atroshi et al., 1999, Stevens et al.,1988, Herbert et al.,1999]. The Bureau of Labor statistics reports that the incidence of CTS among workers in the manufacturing industry is 2.4/10,000 [BLS, 2011]. Although significant, the incidence rate may be underestimated by 40% or more [Leigh, 2012]. Workers often do not report musculoskeletal disorders, and physicians are often not trained to identify musculoskeletal disorders as occupational disorders, therefore contributing to underreporting of these conditions [Azaroff et al.,, 2002].

Poultry processing, one segment of the manufacturing industry, typically requires repetitive hand movements to hang, kill, pluck, clean, eviscerate, cut, package, and box poultry at a rapid pace. Workers also frequently clean and repair equipment, assemble boxes, and move heavy pallets [U.S. Department of Labor, 2001; Fink, 1998]. Throughout the United States many poultry processing workers are now immigrant Latinos [Fink, 1998], and this group of workers faces unique challenges because of language and cultural barriers and reluctance to complain about work conditions [Marín et al., 2009a; Marín et al., 2009b]. It has recently been demonstrated that Latino poultry processing workers have a high prevalence of CTS, which exceeds the prevalence of CTS in other manual laborers and affects between 6.5 and 59.2% of poultry processing workers, depending on the methods used to define CTS [Cartwright et al., 2009b]. However, there are no data on incidence of CTS in this population.

Latino workers represent 15% of the United States workforce, [US. Dept. of Labor, 2012] yet they have higher than average injury and fatality rates [Smith, 2012]. Latino workers, especially those who are foreign born, are concentrated in occupations such as manufacturing with the highest prevalence of labor law violations [Pinedo et al., 2011]. While it is widely agreed in the literature that reported injury rates do not reflect real injury rates due to underreporting [Smith, 2012], underreporting is especially problematic among Latino workers. These workers belong to a vulnerable population, which is often hidden and afraid to report their injuries because they fear retaliation [Smith, 2012]. Furthermore, many of the new settlement areas where Latinos have migrated in the past two decades and where the majority of poultry production takes place are located in the southern

United States [Passel et al., 2010; National Chicken Council, 2010]. Most southern states have statutes that are unfavorable to collective bargaining and unions do not have a strong presence, further contributing to the underreporting of injuries. Because these workers are hard to reach, and there is often no access for outside groups to conduct occupational health research at these worksites, the literature addressing prevalence and incidence of injuries among Latino workers is limited.

As Latino workers are projected to become one of the fastest growing groups in the US workforce [Toossi, 2012], it is important to have better data regarding the incidence of injury rates among this group of workers. The purpose of this study is to assess the incidence of CTS development over one year in Latino poultry processing workers, and to identify factors associated with incident CTS.

METHODS

Participants

Prior to the initiation of data collection, this study was approved by the Institutional Review Board at Wake Forest School of Medicine. All participants signed informed consent, and they were paid $40 for each data collection clinic they attended. This study was part of a larger project to evaluate multiple health issues facing Latino poultry processing workers, and the data collection methods below have also been described elsewhere [Cartwright et al., 2012b].

Starting in June 2009, Latinos in poultry and non-poultry manual labor occupations were recruited from four counties in western North Carolina to participate in a study of neurologic, musculoskeletal, dermatologic and pulmonary conditions related to work. Community-based sampling of dwelling units was performed with a focus on areas with a high proportion of Latinos, and those that self-identified as Latino or Hispanic, were 18 or older, and worked in manual labor occupations were recruited. More than one resident per dwelling could be recruited, if eligible. Work in poultry processing was defined as having a non-supervisory position in a poultry plant, which included jobs from receiving through sanitation. Non-poultry manual labor positions included landscaping, construction, restaurant work, hotel work, child care, and manufacturing. If non-poultry workers had previously worked more than 6 months in poultry processing, or had worked in poultry processing in the past two years, they were excluded from the study. Those that enrolled in the study underwent an hour-long interview, which focused on many aspects of their health and occupation. They then attended a data collection clinic and all participants, including those without symptoms, underwent testing, including a questionnaire, a hand diagram, and nerve conduction studies related to CTS. Based on the case definition of CTS described below, those without CTS at the baseline data collection clinic were then invited to attend a second data collection one year later. The final follow-up data collection clinic occurred in November 2011, and in total there were 12 data collection clinics, which occurred on Sundays evenly distributed throughout the study period. Since a small number of participants were expected to change jobs between baseline and follow-up, the final analyses were calculated using two different methods; one based on the initial classification of the participants into poultry or non-poultry groups (even if they changed jobs) and the second excluding all participants that had a change in job status during follow-up. It was found that excluding those with a job change did not alter the data substantially, so the reported results are based on the first method, in which participants were categorized based on their initial classification of poultry or non-poultry groups..

Over the first two years of the study 1,526 individuals were screened, 957 were eligible for enrollment, 742 underwent interviews, 518 attended baseline data collection clinic, and 513 had nerve conduction studies and filled out hand diagrams at the baseline data collection clinic (1,026 wrists). Two-hundred sixty four participants were identified as not having CTS at baseline and were invited to return to a second data collection clinic one year later. Of those, 173 (65.5%) returned for one year follow-up. This group included 50 poultry workers and 123 non-poultry workers without CTS in either wrist. In addition, there were 6 poultry workers and 11 non-poultry workers that were invited back for the dermatologic portion of the study that had no CTS in one of their wrists, and they were included when the data was analyzed on a wrist, rather than an individual, basis. This resulted in 106 total wrists without CTS in the poultry group and 257 total wrists without

CTS in the non-poultry group. Of note, at follow-up 5 poultry and 6 non-poultry had changed jobs and 2 poultry and 9 non-poultry were unemployed, but these participants were all analyzed based upon the group in which they were initially classified.

Clinical Evaluations

Each participant's baseline height, weight, and body mass index (BMI) were obtained. Participants were asked if they had numbness, pain, or weakness in their hands for two or more days in the previous month, and if they answered affirmatively, they completed the Katz hand diagram to describe the distribution of symptoms. The hand diagrams were scored "unlikely" (0), "possible" (1), "probable" (2), or "classic" (3) for CTS based upon previously published methods for scoring of the diagram, and each diagram was scored by two clinicians (MSC and FOW) blinded to the participant's occupation and nerve conduction results [Katz & Stirrat, 1990]. The hand diagrams were performed at both the baseline and one year follow-up visits. No disagreements in hand diagram scoring occurred.

Nerve Conduction Studies

Study participants underwent bilateral nerve conduction studies using a Teca TD10 Electromyograph (Teca Corporation, Pleasantville, NY) at baseline and follow-up. Studies were performed by experienced technicians blinded to the participant's occupation and clinical evaluations. If necessary, hands were warmed to 32 degrees Celsius, and median and ulnar antidromic sensory studies were performed, stimulating the wrist and recording with ring electrodes 140 mm distally on the 2^{nd} and 5^{th} fingers. The onset and peak latencies were recorded, and those with non-recordable median sensory potentials underwent orthodromic median motor studies stimulating at the wrist and recording from the abductor pollicis brevis muscle.

Measures

CTS was defined using a combination of symptoms, as reported through the Katz hand diagram, and nerve conduction study abnormalities. If the hand diagram was scored a 1, 2, or 3, then the participant was assigned a score of "1" for symptoms; if not, the participant was assigned a "0." Peak median and ulnar sensory latencies were compared. If the median was less than 0.49 ms longer than the ulnar, it was scored a "0"; if it was 0.50 to 0.79 ms longer, it was scored a "1"; and if it was greater than 0.80 ms longer, it was scored a "2." The symptom score and nerve conduction score were then added, and a total score of 0 was defined as "no CTS," 1-2 as "possible CTS," and 3 as "CTS." Similar CTS case definitions, with 0.50 ms and 0.80 ms cut-offs for peak latency difference, have been used in previous studies [Werner et al., 2001]. This scoring system was applied to each wrist that was studied, and those that scored a 0 bilaterally during the initial visit were invited to return one year later. In addition, others invited back for the dermatologic portion of the study with a 0 in just one wrist were also invited to participate. In addition to defining CTS at the wrist level, individuals were defined as having "no CTS" if both wrists were scored as "0," "possible CTS" if one or both wrists was scored a "1 or 2", and "CTS" if either wrist was scored a "3." Statistical analyses were performed considering both the wrist level and individual level for defining CTS.

In order to potentially identify factors that may increase the risk of CTS, poultry workers underwent standardized interviews regarding their work schedule and environment. They were asked to identify which of the following tasks they performed: cutting, eviscerating, washing, trimming, deboning, receiving, hanging, killing, plucking, packing, sanitation, chilling, and other. Those who performed a single task greater than 50% of the time were categorized into that task for statistical analyses. If they performed multiple duties and no single task occupied more than 50% of their time, they were categorized into "multiple tasks." Many of the tasks require similar movements; four groups were created. The groups include: packing, sanitation, chilling, and other (category 1); cutting, eviscerating, wash-up, trimming, and deboning (category 2); receiving, hanging, killing, and plucking (category 3); and multiple jobs (category 4).

Statistical Analyses

In general, descriptive statistics were calculated as means and standard deviations for continuous variables, and percentages and frequencies for discrete variables. Baseline personal characteristics were compared between the poultry and non-poultry groups using Student's t-tests for continuous variables and chi-square tests of association for categorical variables. To calculate CTS incidence, the percentage of wrists that went from a baseline CTS score of 0 to possible (score of 1-2) and definite (score of 3) CTS at one year were calculated for both groups and compared using Fisher's exact test. In addition, the percentage of individuals was calculated that went from no CTS (bilateral score of 0) at baseline to unilateral or bilateral CTS at one year, as defined by both the strict (only definite CTS) and less strict (possible or definite CTS) definitions of CTS. The incidence of CTS at the individual level was also compared between the poultry and non-poultry groups using chi-square tests of association or Fisher's exact test when the expected value for any cell was 5 or fewer observations.

At the wrist level, adjusted odds ratios and 95% confidence intervals were calculated using multivariate logistic regression to determine predictors of CTS incidence. The model included poultry work, age, BMI, and gender and controlled for dwelling clustering, correlation between wrists in an individual, and data collection site strata. In only poultry workers, CTS incidence was described by age, BMI, gender, and job task as means and standard deviations or percentages and frequencies Bivariate analyses comparing one-year incident CTS and risk factors were assessed using logistic regression and controlling also for dwelling clustering, correlation between wrists in an individual, and site strata. All wrist-level analyses were performed on two distinct groups; one group with all wrists included (363 wrists) and the other group with only those wrists from individuals with bilateral CTS (346 wrists). Since no meaningful differences were detected using these two populations, all wrist-level results reported in this manuscript include all wrists free of CTS at baseline. All p-values were considered significant at the 0.05 level and statistical calculations were performed using SAS Version 9.2 (SAS, Cary, NC).

RESULTS

The baseline personal characteristics for the poultry processing workers and non-poultry workers are described in Table I, and there were no statistically significant differences between the poultry and non-poultry workers in regards to age, BMI, gender, spoken language, and level of education. The one-year incidence of CTS, in all participants, poultry processing workers, and non-poultry workers is described in Table II. At the wrist level, 19.8% of poultry workers developed possible or definite CTS at one year compared to 11.7% of non-poultry workers ($p = 0.022$). At the individual level, the increased incidence of CTS in the poultry workers compared to the non-poultry workers did not reach statistical significance. However, statistical significance was approached when evaluating the development of bilateral CTS using the less strict definition (12.0% v. 4.9%, $p = 0.095$) and when evaluating the development of unilateral CTS using the strict definition (4.0% v. 0.0%, $p = 0.082$).

Table IIIa includes the adjusted odds ratios for the development of CTS at the wrist level when controlling for type of work, age, BMI, and gender. Of these variables, only poultry work was associated with an increased odds ratio that approached statistical significance at 1.89 ($p = 0.089$). Table IIIb is similar, but includes the adjusted odds ratios for the development of CTS at the participant level. Similar to the wrist level results, the highest odds ratio is for poultry work (1.81), but it does not reach statistical significance ($p = 0.139$). Finally, when only those in poultry work were assessed to determine factors that may increase the incidence of CTS, none of the assessed variables (age, BMI, gender, poultry task) approached statistical significance (Table IV).

DISCUSSION

One of the challenges of CTS, from both a clinical and research standpoint, is defining the presence of the condition. The diagnosis can be based on symptoms, examination findings, nerve conduction studies, neuromuscular ultrasound, response to surgery, or a combination of these parameters [Rempel et al, 1998; Keith et al., 2009; Stevens, 1997; Cartwright, 2012a]. In research settings, in particular, defining the presence of CTS may be limited by time and financial constraints. In addition, CTS can also be described on either a

wrist or individual level, and different cut-offs can be applied to alter the accuracy of each diagnostic test. Given these diagnostic challenges, the incidence data in this study are presented in a variety of manners to increase clinical relevance and allow for comparison to previous studies. Using a strict definition of CTS, in which both clinical and electrodiagnostic abnormalities must be present, two wrists on two separate poultry workers went from no evidence of CTS at baseline to definite CTS at one year, and none of the non-poultry manual workers developed definite CTS. This resulted in 1.9% of wrists and 4.0% of individuals developing CTS after one year in poultry processing. When a less strict definition of CTS was applied, 19.8% of wrists and 28.0% of poultry workers developed CTS over one year, compared to 11.7% of wrists and 17.9% of individuals in non-poultry manual laborers, with the data based on the wrist level reaching statistical significance ($p = 0.022$). Based on these findings, it is possible that Latinos employed in poultry processing have a higher one-year incidence of CTS than Latinos employed in other manual labor positions.

There are only a few prospective studies of CTS incidence in the literature. Silverstein and colleagues examined workers in manufacturing at baseline and one year, using symptoms and nerve conduction studies to define CTS, and found that at one year 1.05% of 479 wrists developed CTS [Silverstein, 2010]. This is slightly less than the 1.9% (strict definition) and certainly less than then 19.8% (less strict definition) of wrists in poultry workers that developed CTS at one year. On an individual rather than wrist level, Werner and colleagues found that 4.5% of auto assembly workers developed CTS over one year, using clinical symptoms and nerve conduction studies (latency 0.5 ms or greater in the median compared to ulnar sensory response) to define CTS [Werner, 2005]. Using similar criteria, Gell and colleagues found a 7% incidence of CTS over an average of 5.4 years in industrial and clerical workers, or 1.2% per year [Gell at al., 2005]. Direct comparison of the incidence in auto assembly, industrial, and clerical workers to poultry workers is challenging because the case definitions of CTS differ in these studies, but on an individual level our study found between 4.0% (strict definition) and 28% (less strict definition and similar to the definition used by Werner and Gell) of poultry workers developed CTS over one year. Other studies, using only clinical symptoms to define CTS, have detected higher incidence rates at one year, but not as high as the 19.8% of wrists and 28.0% of individuals detected amongst poultry workers in this study. For example, Andersen and colleagues used symptoms obtained through surveys to determine that 5.5% of 5,658 computer users in Denmark developed CTS at one year. Of interest, Nathan and colleagues examined 148 industrial workers at baseline and again 17 years later, using symptoms and nerve conduction studies to define CTS, and found that 28% of workers developed CTS over this extended follow up [Nathan, 2005].

Another finding of note in this study is that traditional risk factors for CTS, such as higher age, higher BMI, and female gender did not predict the development of CTS over one year in this population of manual workers. Our previous examination of the prevalence of CTS in Latino manual workers did show a modest association between CTS and higher age and BMI, but not female gender [Cartwright et al., 2012b]. The reason these traditional risk factors do not appear to carry as much importance for the incidence of CTS in this population is not known, but it is possible that the manual labor performed by this group is a greater risk factor than higher age and BMI and female gender, as has been suggested in other studies of CTS incidence in occupations requiring forceful exertion [Burt et al., 2013].

While this study is one of the few prospective investigations of CTS, and it provided significant insight into this condition in poultry processing workers, it did have some limitations. First, although the study initially started with a large number of participants, the final analyses included just 56 poultry workers and 134 non-poultry workers with no CTS at baseline and full one-year follow up data. A larger study population would have increased the power to detected statistically significant differences at the individual level. Second, there are certain types of nerve conduction studies, such as palmar mixed comparison studies, that are more sensitive for the diagnosis of CTS than the antidromic sensory responses used in this study. We did not use the more sensitive studies because they are more technically challenging, especially in the field setting. Using these more sensitive nerve conduction studies might have increased the incidence of CTS in both groups slightly. Third, the comparison group in this study also had a relatively high one-year incidence of CTS, which likely occurred because some were involved in occupations requiring repetitive wrist movements, such as

landscaping, construction, restaurant work, and manufacturing. While this is an appropriate comparison group, the high incidence of CTS in this group made it more challenging to document statistically significant increases in the poultry workers. Fourth, the length of time each worker was employed in their current position was not included in the analyses. It is difficult to speculate how this may have affected the results, since it is possible that a longer employment might lead to more cumulative trauma and a higher likelihood of CTS, or conversely a worker that is intrinsically more resistant to the development of CTS might stay in the same job longer, so they are less prone to develop CTS over the length of the study. Either way, this is a limitation of the current study. Finally, we used a hand diagram, rather than a detailed history and physical examination, to diagnose CTS. This accepted approach was used because a detailed clinical evaluation would not have been feasible with the number of participants in this study, but a detailed history and examination might have slightly increased our diagnostic accuracy for CTS.[Rempel et al, 1998]

Given the high one-year incidence of CTS amongst poultry workers, the increased incidence compared to other manual laborers, and our previous finding of an increased prevalence of CTS in poultry workers compared to non-poultry manual laborers [Cartwright et al., 2012b], it is possible that poultry processing predisposes workers to the development of CTS. The current study did not identify any specific job tasks that significantly increased the risk of CTS, but the study of CTS prevalence in poultry workers did identify an association with performing multiple jobs (odds ratio = 2.66, $p = 0.0035$) and a trend towards a positive association in those that were involved in cutting, eviscerating, wash-up, trimming, and deboning (odds ratio = 1.57, $p = 0.0661$).

The increased risk of CTS in the current group of poultry workers, with at least 4.0% of workers developing CTS over one year, likely results from the strenuous and repetitive nature of poultry processing. Employers and regulators should consider this risk in an effort to improve the overall health of this vulnerable population. While the benefit of specific interventions to decrease the incidence of CTS has not been proven, policies to provide more rest from repetitive hand movements, improve ergonomics, and increase screening for CTS should be considered to help decrease the high incidence of CTS in this group of workers [Dick et al., 2011].

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Table I. Baseline Personal Characteristics in the Poultry (N = 50) and Non-poultry (N = 123) Laborers

Characteristic	All Laborers Mean [SD] or N (column %)	Poultry Mean [SD] or N (column %)	Non-poultry Mean [SD] or N (column %)	p-value
Age	30.6 [8.5]	30.5 [9.6]	30.6 [8.0]	0.972
BMI	27.9 [4.6]	27.6 [4.6]	28.0 [4.6]	0.619
Gender				
Male	90 (52.0)	25 (50.0)	65 (52.9)	0.734
Female	83 (48.0)	25 (50.0)	58 (47.2)	
Spoken Language				0.145
Indigenous	36 (20.9)	14 (28.0)	22 (18.0)	
Non-indigenous	136 (79.1)	36 (72.0)	100 (82.0)	
Education				0.722
0 – 6 yrs	85 (49.1)	26 (52.0)	59 (48.0)	
7 – 9 yrs	50 (28.9)	15 (30.0)	35 (28.5)	
10+ yrs	38 (22.0)	9 (18.0)	29 (23.6)	

Table II. The One-year Incidence of Carpal Tunnel Syndrome in Poultry and Non-poultry Workers

	All Workers N (column %)	Poultry N (column %)	Non-poultry N (column %)	p-value
*By Wrists (N = 363)**				0.022
Developed Possible CTS	49 (13.5)	19 (17.9)	30 (11.7)	
Developed Definite CTS	2 (0.6)	2 (1.9)	0 (0.0)	
*By Individuals (N=173); Possible or Definite CTS***				
Developed Unilateral CTS	24 (13.9)	8 (16.0)	16 (13.0)	0.606
Developed Bilateral CTS	12 (6.9)	6 (12.0)	6 (4.9)	0.095
Developed Unilateral or Bilateral CTS	36 (20.8)	14 (28.0)	22 (17.9)	0.137
*By Individuals (N=173); only Definite CTS**				
Developed Unilateral CTS	2 (1.2)	2 (4.0)	0 (0)	0.082
Developed Bilateral CTS	0 (0)	0 (0)	0 (0)	---
Developed Unilateral or Bilateral CTS	2 (1.2)	2 (4.0)	0 (0)	0.082

* Fisher's exact test
** Chi-squared test

Table III. Adjusted Odds Ratios for the Incidence of Carpal Tunnel Syndrome (N = 363 wrists)

Characteristic	AOR*	95% CI	p-value
Type of Work			0.089
Poultry	1.89	(0.91, 3.96)	
Non-poultry **	---	---	
Age †	1.01	(0.96, 1.06)	0.708
BMI †	1.02	(0.95, 1.09)	0.597
Gender			0.558
Male	1.23	(0.61, 2.49)	
Female **	---	---	

* Adjusted odds ratio
** Reference category
† Treated as continuous variables, adjusted odds ratios reported for a one point increase in the variable of interest

Aim 3: To delineate the impact of selected MSDs and skin disorders among Latino poultry processing workers and controls on workers' health-related quality of life (QOL), both cross-sectionally and over time.

3-1. Social Isolation Among Latino Workers in Rural North Carolina: Exposure and Health Implications

ABSTRACT

Background: Immigrant Latinos frequently experience social isolation in their receiving communities. This paper investigates the prevalence of social isolation among immigrant workers in a new settlement area and delineates the association between social isolation and physical and mental health outcomes.

Methods: Interviews were conducted in Spanish with immigrant Latino manual workers (N=743) in western North Carolina. The CES-D and the SF-12 questionnaires assessed health outcomes. A social isolation scale was used to assess degree of social isolation.

Results: Nearly 1 in 5 workers (19.5%) reported the highest level of social isolation. Social isolation was associated with higher depressive symptoms and poorer physical and mental health, related to quality of life.

Discussion: Social isolation is a common experience among immigrant Latinos that may have negative implications for physical and mental health. Community outreach efforts to minimize experiences of isolation may be useful in protecting immigrant mental health.

INTRODUCTION

Social ties and familism - frequently defined as strong feelings of loyalty, cohesion, strong connection, and centrality of the family [1] - are core characteristics of Latin American culture [1,2]. With globalization and a changing global economy many people from Latin America make the decision to migrate to places with better employment opportunities. The United States (US) is a major migration destination for Latin American immigrants because of its proximity and relative economic stability. The migration journey has physical and psychological difficulties. Immigrants have to leave their families, the places innate to them, and a set of rules and social norms familiar to them [3]; and they often encounter physical and emotional traumas during the journey and at their destination in the US. Recent immigrants to the US encounter situations that are unfamiliar and stressful, including a different dominant language, a limited social network, concerns about legal status, and discrimination [4].Over the past two decades, the population of Latinos in rural areas and areas that had not previously experienced Latino immigration has increased. These areas are found mostly in the Southeast and Midwest of the US and are referred to as "new settlement" communities [5]. North Carolina had the sixth-greatest growth in Latino population from 2000-2010 of any state. The Latino population in North Carolina went from 378,963 in 2010 to 800,120 in 2010 [5]. Such new settlement areas are in contrast with places like the border areas of the Southwest, or the urban centers of the Northeast and Midwest, where there have been sizable Hispanic populations as far back as the Spanish colonization [6].

The establishment of agribusiness and meat processing companies is responsible for much of the growth of Latino population in rural parts of the new settlement areas [7,8]. Such companies are often established in rural areas because of economic benefits offered to them by local governments. These companies hire immigrants from different parts of the world; however, the majority are from Latin America [9,10]. Despite their reliance on immigrants, new settlement areas lack the infrastructure necessary to offer basic services to new settlers. Because these are small areas, immigrants experience resentment from locals because both groups have to compete for limited resources [11], giving rise to conflict and xenophobic attitudes that encourage immigrants to remain hidden and socially isolated.

Humans are social and require interactions with others to reproduce and survive [12-14]. Epidemiological studies assessing the effects of social interactions and social isolation on health have taken place for several decades. The earliest theories of social isolation are attributed to Emile Durkheim and John Bowlby [8]. Their theories maintain that the structural arrangements of social institutions influence resources available to individuals, and therefore, their behavioral and emotional responses [15]. Studies have consistently shown that lack of social ties and networks affect mortality and morbidity [12,16,17]. The available evidence also suggests that social isolation is as strong a risk factor for morbidity and mortality as are smoking, high blood pressure, obesity, or a sedentary lifestyle [18].

Several studies have shown the effects of social isolation on health; however, few studies have been conducted among immigrants. The existing literature related to immigrants has mainly studied social networks and the positive effects these have on health [1,19-22], and other studies have considered the importance of social isolation and its effect on adherence to HIV treatments [23,24]. There have been no studies of the potential significance of social isolation on the physical and mental health of Latino immigrants in new settlement communities. The purposes of this paper are to 1) determine the prevalence of social isolation among immigrant Latino workers, 2) to delineate the demographic and acculturative sources of variation in social isolation, and 3) to document associations of social isolation with physical and mental health outcomes.

METHODS

Participants

The variables analyzed in this manuscript were obtained from a cross-sectional study of Latino immigrant manual workers intended to assess the prevalence and incidence of occupational illnesses and diseases [25-27]. All participants had to self-identify as Latino or Hispanic, be immigrant manual workers, 18 years of age or older, and work 35 hours or more per week. Manual work was defined as employment in non-managerial jobs in industries such as landscaping, construction, restaurant work, hotel work, child care, or manufacturing.

The study took place in four western rural counties in North Carolina designated as new settlement areas for Hispanic/Latino residents [29]. These groups of workers are often hidden and hard to reach. The research team did not have access to workplaces, and no census existed of Latino manual workers in the area. Therefore, community-based sampling was used to assure that a representative sample would be selected [29]. A total of 4,376 possible Latino dwellings were identified; 1,681 dwellings were selected, and 965 were screened, for a screening rate of 57%. A total of 1,526 residents were screened; 957 of those screened were eligible, and 743 were interviewed. Upon meeting the inclusion criteria and consenting participation, up to 3 residents from the same dwelling could be part of the study.

Data Collection

Face-to-face interviews were conducted in Spanish by trained native Spanish-speaking interviewers. The interview took approximately 60 minutes to complete and included information on demographics, work history, work environment, symptoms and disabilities, and psychosocial characteristics. The interviewers explained the purpose, procedures, risks and benefits of the study, answered questions, and obtained written informed consent. The respondents were given a $10 incentive in appreciation of their participation. Participant recruitment and data collection procedures were approved by the Wake Forest School of Medicine Institutional Review Board.

Measures

Social Isolation

Social isolation was measured using an 8-item scale used in previous research with immigrant Latinos [23]. Five of the eight items (e.g., “How often do you feel there is no one you can turn to?”) used a 4-point response set that ranged from *never* to *always* (4). The remaining three items (e.g., “Do you feel there are people who really understand you?”) used a 4-point response set that ranged from *definitely yes* to *definitely no*. For each of the items, participants who reported 1 or 2 were recoded as 0, and those who reported 3 or 4 were recoded as 1. After the responses were recoded the scores were summed. The total scores could range from 0-8, and a greater score reflected greater social isolation. As expected, the summed scores were skewed; therefore, based on the distribution of the scores, we created three categories: 0, 1, and 2 or higher. We characterize participants with scores of 2 or higher as “high social isolation.”

Self-rated health

Immigrant health was measured using the validated Spanish version of the SF-12. [30]. Proprietary scoring procedures were used to create mental (MCS-12) and physical (PCS-12) component summary scores that range from 0-100, have a mean score of 50 and have a standard deviation of 10. Higher scores reflect better perception of health (Cronbach’s α=0.62). The self–rated health question was used to create a dichotomous variable (excellent/very good/good and fair/poor).

Depression

Depression was measured using the Spanish validated short version of the Center for Epidemiological Studies Depression scale (CES-D), which has demonstrated utility in immigrant Latino samples [31]. The short version of the CES-D is a 10-item instrument used to determine the frequency and severity of current depressive symptoms in community samples [32]. Items were scored in a 4-point scale (ranging from rarely or none of the time, to most or all of the time), and summed. Possible scores range from 0 to 30 (Cronbach’s α=0.73); greater scores reflect higher levels of depression [3].

Covariates

Age was assessed continuously and classified into four categories (17-25, 26-35, 36-45, $\geq$ 46). Gender is a binary variable, females were coded one and males were coded zero. Education was assessed by asking the number of years completed. Marital status was assessed by asking whether the person was married or living as married with their spouse in the US, married without their spouse in the US, or not married. Parental status was assessed continuously and classified into two categories (no children in the household, and $\geq$1 children in the household). Country of origin was assessed by asking participants where they were born. Indigenous origin was assessed by asking participants in what language they were spoken to as children. This was classified into two categories: a non-Spanish indigenous language spoken to as a child, or no indigenous language spoken to as a child. The latter category included those who listed only Spanish or English as their childhood language. Years in the US and NC were assessed continuously and classified into three categories (<5 yrs, 6-10 yrs, and >10 yrs). Comfort speaking English was determined by asking participants to self-assess how well they speak English and was classified in three categories (not at all, somewhat/a little, and well).

Analysis

Data were summarized using means and standard deviations (SDs) for continuous variables, and frequencies and percentages for categorical variables. All analyses accounted for the study sample design, and clustering in county of residence and dwelling unit. Associations between social isolation and participant characteristics were explored using Rao-Scott Chi-square tests. Outcomes included dichotomous self-rated health, PCS-12, MCS-12 and CES-D. Unadjusted associations between social isolation and these outcomes were explored with a Rao-Scott Chi-square test for categorical outcomes and ANOVA tests for continuous outcomes. Multivariate linear regression models were fit to test associations of social isolation with physical health, mental health, and depressive symptoms scores, adjusting for covariates. All analyses were completed

using SAS version 9.2 (SAS Institute, Inc, Cary, NC). A p-value of 0.05 or less was considered statistically significant.

RESULTS

Univariate analyses are presented in Tables I and II. Of the 743 workers interviewed 57% were males, and over half (61.6%) were 35 years or younger (Table I). The majority of participants (57%) reported having 6 or fewer years of education. Over half the workers were married, lived with their spouses in the US, and had one or more children in the household. The majority of the participants were from Mexico or Guatemala (88%), had been living in the US for 6 years or more (74.4%), and reported not speaking English at all (58.8%).

Over half (58.7%) of the workers reported “most of the time/always” or “yes/definitely yes” to one social isolation question, and nearly one in five (19.5%) had high social isolation, which was indicated by two or more signs of social isolation (Table II). High social isolation was more prevalent among workers with 6 years of education or less (22.4%, $p< 0.05$), who were not married or lived without their spouse in the US (52.7%, $p<0.05$), and who had no children in the household (23.8% $p< 0.05$). High social isolation was also prevalent among workers from Guatemala (27.1%, $p<0.01$) and El Salvador (32.6%, $p<0.01$), workers who were spoken to in an indigenous language as children (27.6%, $p<0.05$), who have lived in the US ten years or less (43%, $p<0.05$), and who reported not feeling comfortable speaking English at all (22.9%, $p<0.01$).

Bivariate analyses indicated significant associations of social isolation with physical and mental health (Table III). Physical health and mental health scores decreased with increasing social isolation scores, depression scores increased with increasing social isolation scores, and poor/fair health was most often reported by those with high social isolation scores. Multivariate analyses presented in Table IV confirmed these associations, indicating that individuals with high social isolation had poorer physical ($\beta=-3.16$, $p< 0.05$) and mental health ($\beta=-4.17$, $p< 0.01$), and greater depressive symptoms ($\beta= 3.54$, $p<0.01$) than those who reported no signs of isolation after adjusting for gender, age, education, marital status, parental status, country of birth, indigenous language spoken to as a child, years living in the US, and comfort speaking English.

Poor health outcomes were also associated with other factors (Table IV). Women reported poorer mental ($\beta=-1.88$, $p< 0.05$) and physical ($\beta=-1.05$, $p< 0.05$) health and greater depressive symptoms ($\beta=0.61$, $p=0.05$) than men. Those without children in the household ($\beta=0.98$ $p< 0.05$), those from El Salvador and other countries (excluding Mexico and Guatemala $\beta=2.37$ and 2.67 respectively, $p< 0.01$), and those who reported comfort speaking English as somewhat/a little and well ($\beta= 1.65$ and 2.04 respectively, $p< 0.01$) reported greater depressive symptoms. Those from Guatemala and other countries (excluding Mexico and El Salvador) reported worse physical health-related quality of life.

DISCUSSION

Fast economic growth of the southeast region in the United States has triggered an increased migration of foreign-born Latino immigrants to those areas. The rapid growth of Latino populations in those areas has strained the existing infrastructure necessary to provide basic services . The lack of infrastructure and the conflicts that emerge due to competition for resources with the local communities isolate immigrants in these communities [11]. Ample evidence exists that social isolation has negative effects on health [12,15-17,33]. The impact of social isolation among immigrant Latino workers in new settlement areas remains under-studied, in-part because they remain hidden due to fear of authorities and deportation.

Nearly one in five Latino immigrants reported high social isolation. That is, they reported experiences of two or more manifestations of social isolation most of the time or always. Approximately 60% of participants reported feeling at least one manifestation of isolation regularly. High rates of social isolation among immigrant Latinos in new settlement areas can be attributed to factors such as the limited resources and social services that are characteristic of rural communities [10]. The local government services that exist frequently have limited experience and lack cultural competence to effectively help new immigrants settle into the community.

Furthermore, community organizations that might enhance the sense of belonging among these new settlers and facilitate resources are often absent in these areas [34]. Also, spatial segregation between Latino immigrants and non-Hispanic whites is greater in new settlement areas [35] contributing to social isolation of the immigrants. Latino immigrants to these new settlement communities also face hostility, discrimination, and exploitation [1,36], which make them more likely to voluntarily segregate from the local communities [37], thereby perpetuating social isolation.

The distribution of high social isolation followed a predictable pattern. Social isolation was significantly more prevalent among those who had less education. McPherson and colleagues (2006) reported that those who have higher education have more people they can talk to about issues important to them. Those who are not married or whose partner is not in the US are more likely to report social isolation; studies have shown that people who report discussing important matters with their spouse are likely to have access to their partner's social networks [38]. Children give adults the opportunity to expand their social networks and interact with institutions such as schools [39]. We found that those without children in their household reported more social isolation.

Strong feelings of social isolation were also associated with acculturative stress predictors. In this study, immigrants from Central America reported more social isolation, which is consistent with Hovey and colleagues' findings that Central American immigrants experience increased levels of acculturative stress [40]. Further, the possibility of returning home is less tangible for Central American immigrants because there are more physical barriers, more borders to cross, and more hostilities to encounter, which likely minimizes the opportunity to visit and increases feelings of separation and isolation [41]. High social isolation was also more prevalent among immigrants who were spoken to in an indigenous language as children. This finding is consistent with previous research indicating that indigenous immigrants are discriminated against by both non-Hispanic Americans and Latinos who do not identify themselves as indigenous, which likely contributes to social withdrawal and feelings of isolation [41].

Social isolation was strongly associated with poorer health outcomes among immigrant Latinos in new settlement areas. These findings are consistent with the existing literature that links social isolation to poor physical and mental health outcomes [6,19]. Social isolation is believed to affect physical health through stress processes, which can increase blood pressure and suppress the immune system [14,21].

The stress explanation for the association of social isolation and physical health is supported by evidence suggesting that social support reduces the physiological response to both anticipated and experienced stressors [42]. Recognizing that immigrants confront many stressors in the process of migration as well as in their day-to-day lives in their new settlement community [19,21], social isolation and the presumed absence of social support systems likely have substantial health consequences. Poorer health outcomes among those with high social isolation may also be attributed to lack of access to healthcare services. Future research will need to explore these and other explanations linking social isolation to poorer health outcomes among immigrants.

Even though we found that social isolation is linked to poor health outcomes, the results should be interpreted in light of the study's limitations. These results are derived from a study in which the main focus was occupational injuries among Latino immigrant workers. Therefore, those not in the labor force and who could be more isolated are not represented in this sample. The sample was not random; community-based sampling was used instead. There was also no measurement of the size of the networks or strengths of social relationships. Social isolation was based on the perceptions of the participants; however, other studies have shown that the size of a person's network is not as important as the individual's perception of whether he/she is socially isolated [12,15]. Lastly, this study is not generalizable to all Latino communities in the US.

CONCLUSION

A substantial segment of the Latino population in one new settlement area reported social isolation, and those with higher social isolation possessed poorer physical and mental health. Although consistent with a larger body of evidence indicating that social isolation has a significant health threat, the health-related consequences of social isolation among immigrant Latinos in new settlement areas remains undocumented. As immigrants continue to settle in rural communities and future generations become vital in the development of those communities it is essential to integrate them. Our results, therefore, contribute to the scientific literature of social isolation and health, and offer insight into segments of the immigrant population most at risk for social isolation.

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Table I. Characteristics among immigrant Latino manual workers.

Characteristics	N	%
Sex		
Male	423	56.9
Female	320	43.1
Age		
17 to 25 years	158	21.3
26 to 35 years	299	40.3
36 to 45 years	181	24.4
46 or more years	104	14.0
Years of Education		
0 to 6 years	429	57.8
7 to 9 years	171	23.1
10 or more years	142	19.1
Marital Status		
Married/Living as married w. spouse in US	476	64.4
Married without spouse in the US	58	7.9
Not married	205	27.7
Country of Birth		
Mexico	371	49.9
Guatemala	284	38.2
El Salvador	46	6.2
Other	42	5.7
Indigenous language spoken to as a child		
Yes	181	24.6
No	556	75.4
Parental Status		
No children in household	193	26.0
$\geq$1 Children in household	550	74.0
Years in NC		
Less than 5 years	238	32.6
6 to 10 years	265	36.3
More than 10 years	227	31.1
Years in the US		
Less than 5 years	187	25.6
6 to 10 years	247	33.7
More than 10 years	298	40.7
Comfort Speaking English		
Not at all	436	58.8
Somewhat/ A little	255	34.4
Well	51	6.9
Occupation		
Poultry	403	54.2
Non-poultry	340	45.8

Table II. Prevalence of social isolation by demographic and acculturative characteristics

Outcomes	Social Isolation Score [N(%)]			
	0	1	2+	Chi-Square P-value
OVERALL	162 (21.8)	436 (58.7)	145 (19.5)	
Demographic Characteristics				
Sex				
Male	90 (21.3)	252 (59.6)	81 (19.2)	0.88
Female	72 (22.5)	184 (57.5)	64 (20.0)	
Age				
17 to 25 years	44 (27.9)	86 (54.4)	28 (17.7)	0.15
26 to 35 years	61 (20.4)	169 (56.5)	69 (23.1)	
36 to 45 years	37 (20.4)	118 (65.2)	26 (14.4)	
46 or more years	19 (18.3)	63 (60.6)	22 (21.2)	
Years of Education				
0 to 6 years	79 (18.4)	254 (59.2)	96 (22.4)	**<0.01**
7 to 9 years	34 (19.9)	113 (66.1)	24 (14.0)	
10 or more years	49 (34.5)	68 (47.9)	25 (17.6)	
Marital Status				
Married/Living as married w. spouse in US	116 (24.4)	287 (60.3)	73 (15.3)	**<0.01**
Married without spouse in the US	5 (8.6)	38 (65.5)	15 (25.9)	
Not married	41 (20.0)	109 (53.2)	55 (26.8)	
Parental Status				
No children in household	27 (14.0)	120 (62.2)	46 (23.8)	**<0.01**
≥1 Children in household	135 (24.6)	316 (57.4)	99 (18.0)	
Acculturative Characteristics				
Country of Birth				
Mexico	94 (25.3)	230 (62.0)	47 (12.7)	**<0.01**
Guatemala	43 (15.1)	164 (57.8)	77 (27.1)	
El Salvador	8 (17.4)	23 (50.0)	15 (32.6)	
Other	17 (40.5)	19 (45.2)	6 (14.3)	
Indigenous language spoken to as a child				
Yes	36 (19.9)	95 (52.5)	50 (27.6)	**<0.01**
No	124 (22.3)	339 (61.0)	93 (16.7)	
Years in NC				
Less than 5 years	47 (19.8)	146 (61.3)	45 (18.9)	0.12
6 to 10 years	47 (17.7)	157 (59.3)	61 (23.0)	
More than 10 years	60 (26.4)	128 (56.4)	39 (17.2)	
Years in the US				
Less than 5 years	39 (20.9)	113 (60.4)	35 (18.7)	**<0.01**
6 to 10 years	34 (13.8)	153 (61.9)	60 (24.3)	
More than 10 years	82 (27.5)	166 (55.7)	50 (16.8)	
Comfort Speaking English				
Not at all	66 (15.1)	270 (61.9)	100 (22.9)	**<0.01**
Somewhat/ A little	67 (26.3)	148 (58.0)	40 (15.7)	
Well	28 (54.9)	18 (35.3)	5 (9.8)	

Table III. Health Outcomes

Outcomes	Overall		Social Isolation = 0		Social Isolation = 1		Social Isolation = 2+		Chi-Sq P-value
	N	%	N	%	N	%	N	%	
Self- Rated Health									
Excellent / VG/Good	320	43.8	77	48.4	185	43.0	58	40.9	0.38
Fair / Poor	411	56.2	82	51.6	245	57.0	84	59.1	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**ANOVA P-value**
Physical Health (SF-12)	43.3	6.4	44.9	6.4	43.3	5.8	41.0	7.4	**<0.01**
Mental Health (SF-12)	39.5	8.8	40.1	8.9	40.3	8.6	36.1	8.4	**<0.01**
CES-D	5.9	4.5	5.5	4.0	5.1	4.3	8.8	4.3	**<0.01**

3-2. Self-Reported Skin Symptoms and Skin-Related Quality of Life Among Latino Immigrant Poultry Processing and Other Manual Workers

ABSTRACT

Background. Manual labor employment occurs in environments with exposures likely to impact skin-related quality of life (SRQOL).
Objectives. The objectives of this paper are to 1) document the dimensions of SRQOL, 2) examine its association with skin symptoms, and 3) identify the predictors of SRQOL in Latino manual workers.
Methods. A population-based survey of 733 Latino manual workers obtained Dermatology Life Quality Index (DLQI) and skin symptoms in the prior year.
Results. Two-thirds of workers were employed in production. Skin symptoms in prior year were reported by 23%. Impaired SRQOL was reported by 23%. In multivariate analyses, reduced SRQOL was associated with age, occupation, childhood indigenous language use, and experience of skin symptoms in the prior year.
Conclusions. Despite overall high SRQOL high, exposures in some immigrant occupational groups produce reduce SRQOL. This rural, immigrant population faces significant obstacles to obtaining dermatological care; efforts are needed to improve their SRQOL.

INTRODUCTION

Manual work in many industries occurs in environments that produce exposures likely to cause cutaneous injuries and illnesses. Such exposures can include chemicals, metals, vegetation, wet work, and animal products. In addition, work often takes place in temperature, humidity, and sunlight extremes than can adversely affect skin and exacerbate existing skin conditions. Tools in the workplace can also traumatize skin with resultant scarring.

The incidence of job-related skin disease resulting in lost work time was 3.3 illnesses per 10,000 workers in 2011; rates were considerably higher in some industry sectors, such as manufacturing at 4.6/10,000 [Bureau of Labor Statistics, 2012]. Because occupational skin disease is frequently underreported, the true incidence of job-related skin disease is likely higher than the Bureau of Labor Statistics estimate. Underreporting occurs, in part, because workers risk negative consequences for reporting workplace injury or illness to the sources (e.g., workers' compensation claims) used for compiling such statistics [Azaroff et al., 2002].

Contact dermatitis accounts for most occupational skin disease [Diepgen et al., 1999; Cherry et al., 2000]. Epidemiologic studies report occupational skin disease among manual workers employed in a range of industries including construction [Stocks et al., 2011; Block et al., 2003], food manufacturing and processing [Viinanen et al., 2011; Pichardo-Geisinger et al., 2013], food preparation [Vester et al., 2012], cleaning [Meding et al., 1990; Nielsen, 1996; Mirabelli et al., 2012], healthcare [Machovcová et al. 2012], and farm work [Arcury et al., 2007; Irby et al., 2009].

Although skin disease itself has been documented, evidence for its impact on skin-related quality of life (SRQOL) among manual workers is sparse. Most analyses are restricted to clinical samples. For example, all studies found by a recent review of the impact of occupational contact dermatitis on SRQOL [Lau et al., 2011] were recruited either from clinics or from work injury claims listings. However, many skin diseases are not treated clinically, particularly in low socioeconomic status worker populations. Such workers may not recognize a skin disease if symptoms are mild [Quandt et al., 2005, 2008], may lack access to specialty care [Feldman et al., 2009] or rely on self-treatment [Arcury et al., 2006; Cathcart et al. 2008], and may not be able to take time from work to obtain medical evaluation. The few published studies of SRQOL conducted in the general population include a longitudinal study of Latino migrant farmworkers in the southeastern United States (304 workers with a total of 1048 observations), which found that effects of skin disease on SRQOL were reported in about one in six observations [Quandt et al., 2008]. A small study of 25 poultry processing workers from a non-clinical population found a broad range of effects of skin conditions on SRQOL, with one in two reporting some effect [Quandt et al., 2005].

Examination of SRQOL among a broader worker population is necessary to understand the magnitude of the impact skin disease has on different components of SRQOL. Such studies can heighten recognition of skin disease in these populations, encourage greater awareness of skin disease in primary care, and lead to expansion of access to specialty care. Understanding SRQOL effects also may enhance strategies for reducing the impact of skin disease on workers' lives, if the underlying skin disease cannot be avoided or controlled.

The Latino or Hispanic population in the US grew dramatically in the first decade of the twenty-first century, by 43%, compared to a growth rate of 10% for the total US population [Ennis et al., 2011]. This coincided with dispersal, first noted in the 1990s, of Hispanic residence across the US, from a concentration in long-established settlements, largely in the western US, to "new settlement" areas in parts of the Southeast and Midwest that previously had few Hispanic residents [Fry, 2008; Kandel et al., 2004]. These immigrants were rapidly incorporated into the workforce, many in manual occupations that placed them at high risk for occupational injuries and illnesses [Orrenius et al., 2009].

This paper draws on a site-based sample of Latino manual workers recruited from the general population in western North Carolina, USA. As this study sample comes from a rural area with limited specialty care available and is in a new settlement area for Latinos in the US, their access to dermatological care is limited, making them an important population in which to measure the impact of skin disease on SRQOL in workers employed among a wide variety of industries. The objectives of this paper are to 1) identify the dimensions of SRQOL most affected in Latino manual laborers, 2) examine the association of SRQOL and skin symptoms, and 3) identify the predictors of SRQOL in this population.

METHODS

Sampling and Recruitment

Data were collected as part of a larger study of occupational health among Latino manual laborers. The study used a cross-sectional design to collect information on SRQOL and skin ailments from Latino poultry processing and other manual laborers. Workers were recruited from March 2009 to August 2010.

Procedures for sampling and recruitment have been reported previously [Arcury et al., 2013; Pichardo-Geisinger et al., 2013]. In brief, a site-based sampling method was used to recruit a representative sample [Arcury and Quandt, 1999; Parrado et al., 2004]. A sample frame was developed of dwellings where Latinos lived in the study area. The list contained 4,376 possible Latino dwellings.

Recruiters visited randomly selected dwellings in order. Residents were screened for inclusion criteria: self-identified as being Latino or Hispanic, worked 35 hours or more per week in a manual labor job, and 18 years of age or older. Manual labor jobs were defined as employment in non-managerial jobs in industries such as landscaping, construction, restaurant work, hotel work, child care, or manufacturing. Because the aim of the larger study was to compare poultry and non-poultry workers, non-poultry manual workers with previous work in poultry only qualified if lifetime employment in poultry production or processing was 6 months or less, and not within the past 2 years. Work in poultry processing was defined as any type of non-supervisory work in a poultry processing plant with job categories from receiving through sanitation. Employees of poultry production farms were excluded. More than one resident per dwelling could be recruited, if eligible. Of 1681 dwellings selected, residents were screened in 965, for a dwelling screening rate of 57%. Of the 716 dwellings where residents were not screened, 114 appeared to be vacant, no one answered the door at 362, residents refused to be screened at 123, 97 addresses could not be found by the recruiters, dog and other safety concerns prevented screening at 11, and 9 structures were not residences. In the 965 dwellings where residents were screened, a total of 1,526 adult residents were screened. Of those eligible, 742 (78%) were interviewed and 215 refused to be interviewed. One participant was recruited in 318 dwellings, 2 in 156, 3 in 36, and 4 in 1 dwelling.

Data Collection

Data collection procedures were approved by the Wake Forest School of Medicine's Institutional Review Board. Data were collected in face-to-face interviews by Spanish speaking interviewers. All interviewers attended a series of training sessions, which included procedures for obtaining informed consent, interviewing techniques, and maintaining confidentiality. Informed consent was obtained from all participants. Consent was obtained after dwelling residents were screened for eligibility.

The survey instrument included demographic and background questions: age, occupation, education, language most often spoken in the childhood home (indigenous or non-indigenous [Spanish or English]), and self-rated health. Skin symptoms were queried by asking if each of a list of 12 skin symptoms (taken from the Nordic Occupational Skin Questionnaire [Flyvhom et al., 2002]) had been experienced for hands, wrist, or forearms in the past 12 months. The symptoms were: redness, dry skin with scaling/flaking, fissures or cracks, weeping or crusts, tiny water blisters (vesicles), papules, rapidly appearing itchy wheals/welts (urticarial), itching, burning/prickling/stinging, tenderness, aching or pain, or other. The Spanish translations for these symptoms were derived from our previous research with immigrant Latino workers [Vallejos et al. 2005]. A skin-specific health-related QOL instrument, the Dermatologic Life Quality Index (DLQI) [Finlay, 1998], was administered. The DLQI is designed to be completed quickly by persons 16 years and older. It consists of 10 items in which the respondent rates the effect of any skin condition on different aspects of life over the previous week (e.g., "Over the last week, how itchy, sore, painful or stinging has your skin been?"). Responses include: not at all (0), a little (1), a lot (2), and very much (3). The DLQI was originally developed in English and has been translated and validated in multiple languages. The questions form six subscales for different areas of life (Symptoms and Feelings, Daily Activities, Leisure, Personal Relationships, Work, and Treatment) and a total score. In order to ensure fidelity to the original DLQI, we received permission from Dr. Andrew Y. Finlay, its developer, to create a validated version using the technique he requires for all new versions (see website for further details: http://www.dermatology.org.uk/index.asp?portal/quality/dlqiinstruc.html). Briefly, we undertook a series of interviews with persons in the target population to adjust vocabulary and idioms on the existing validated American Spanish DLQI to the local Spanish-speaking population. This slightly revised version then was subjected to back and forward translation. It was submitted to Dr. Finlay and approved for use.

Measures

A measure of skin symptoms was created by summing the number of individual symptoms reported as present during the past 12 months. Possible values ranged from 0 to 12.

The Dermatological Life Quality Index subscales and total were computed as recommended [Finlay, 1998]. Each question was scored from 0 to 3. The scores were summed to produce subscale scores that ranged from 0 to a maximum of 6 (with the exception of the Work subscale and the Treatment subscale, which each had a maximum of 3). Scores were calculated only for participants who had answered at least eight of the ten questions. This criterion excluded nine participants from the original sample. The total scale score ranged from 0 (no impairment of life quality) to 30 (maximum impairment of life quality). These were first classified according to Hongbo and colleagues into categories of "no effect on life quality" (scores 0-1), "small effect…" (scores 2-5), "moderate effect…" (scores 6-10), "very large effect…" (scores 11-20), and "extremely large effect…" (scores 21-30) [Hongbo et al., 2005].

As would be expected in a non-clinical population, the total DLQI scores and the subscores had a positive skew. Scores therefore were collapsed to three dichotomous outcome variables in order to explore which work tasks and demographic variables were most strongly associated with elevated DLQI scores. First, the total DLQI scores were split into scores 0 or 1 versus scores greater than 1. The two subscale scores (for the Symptoms and Feelings and the Work subscales) were split into scores of 0 versus 1 and above.

Occupation was obtained by categorizing workers into major Standard Occupation Classification (SOC) groups based on the primary job reported by the worker. Because of small numbers in several of the major SOCs, the occupational groups were collapsed into four broad groups for analysis, based on likely similarity of skin exposures: Production (n=481); Construction and Extraction, plus Installation, Maintenance, and Repair, plus Transportation and Material Moving (n=100); Food Preparation and Serving Related, plus Personal Care and Service, plus Other (n=101); and Building and Grounds Cleaning and Maintenance, plus Farming/Fishing/Forestry (n=51).

Analysis

Descriptive statistics of the sample were calculated as frequencies and percentages of discrete measures. Bivariate associations between dichotomized outcomes and demographic characteristics were examined using Chi Square tests of association. Multivariate logistic regression modeling accounting for clustering by dwelling and site strata was used to assess the relationship between DLQI outcomes and sample characteristics. Predictors in the generalized mixed effects modeling included age categorized as 18-24, 25-30, 31-40, 41+ years, gender, occupation as outlined above, education (0-6 yrs, 7-9 yrs, 10+ yrs), language (indigenous versus non-indigenous), self-rated health (fair/poor versus good or better), and self-reported skin symptoms. Adjusted odds ratios and 95% confidence intervals were estimated. Significance was accepted at $p<0.05$ with all analyses being generated using SAS version 9.2 (Cary, NC, USA).

RESULTS

The average (± SD) age of workers was 33.8 (± 10.2) years, with the largest proportion in their 30s (Table I). Over half (57%) were male. Over half of the workers (66%) had production occupations; most of these were employed in poultry processing. Educational status was generally low, with over half (57%) reporting six or fewer years of formal education completed. Almost a quarter (24%) reported having spoken an indigenous language in childhood. Over half (56%) rated their general health as fair or poor.

The number of different skin symptoms reported ranged from 0 to 12, and averaged 0.79 (± 1.81). No symptoms were reported by 566 workers (77.2%), 1 symptom by 32 (4.4%), 2 to 3 symptoms by 77 (10.1%), 4 to 6 symptoms by 5.6%, and 7 or more by 17 (2.3%). The most frequently reported symptoms were itching (14.9%), redness (10.3%), tenderness (8.7%), welts or wheals (8.1%), and burning/prickling/stinging (7.7%).

Mean total score reported for the DLQI was low: 0.65 (± 1.55). However, DLQI scores of 1 or higher were reported for 22.5% of observations. A “small effect” of skin disease on quality of life was reported for 14.4%, “moderate effect” for 2.3%, and a “large effect” for 0.1%. “No effect” was reported for 83.1% of observations.

The strongest association of reported skin symptoms with SRQOL was seen in the Symptoms and Feelings subscale (Table II), for which 19.9% of observations showed some effects, evidenced by a score of 1 or greater. On the Work subscale, 15.0% of observations showed effects. The Leisure, Daily Activities, and Personal Relationship subscales showed relatively low association (6.0%, 4.4%, and 4.0%, respectively). The Treatment subscale showed almost no association (1.0%).

In bivariate analyses of personal and work characteristics and DLQI total and subscale scores (Table III), younger age was associated with poorer SRQOL. Males reported significantly poorer scores on the work subscale than did females, with a similar trend noted for total DLQI scores. Both total DLQI and the subscales differed by occupation, with employment in Production/Building and Grounds/Farming having worse SRQOL compared to the other occupations. Indigenous language was associated with poorer SRQOL in both the total and subscale scores. Poorer self-rated health was associated with poorer SRQOL for symptoms and feelings. Reporting skin symptoms in the previous year was associated with poorer scores on both total and subscale DLQI.

In multivariate analyses (Table IV), the effect of a single age group, 25-30 years, remained strongly associated with poorer SRQOL for the total DLQI score and the Work subscale. Workers 25-30 years of age had greater odds of reporting total DLQI score (adjusted odds ratio 3.05; 1.28,7.03 95% confidence interval), and Work (AOR 2.76; 1.19,6.40 CI) than workers 41 years and older. Occupation remained associated with DLQI only for the Work subscale. Compared to Production workers, those in Construction and related occupations had lower odds of reduced Work DLQI (OR 0.24; 0.07,0.79 CI), suggesting better SRQOL among Construction workers than Production workers. In contrast, those in Building and Grounds Maintenance and related occupations had greater odds of increased Work subscale (OR 4.79; 1.62,13.69 CI), suggesting that Building and Grounds Maintenance workers have poorer SRQOL than Production workers. The odds of DLQI scores suggesting impaired SRQOL were greater for indigenous language speakers for total DLQI (AOR 2.94; 1.51,5.70 CI) and both subscales: Symptoms and Feelings (AOR 2.06; 1.15,3.71 CI) and Work (AOR 2.48; 1.26,4.89 CI).

Self-reported skin symptoms were associated with poorer SRQOL for the total score (OR 52.20; 27.7,98.4 CI), Work subscale (OR 42.13; 24.7,72.0 CI), and the Symptoms and Feelings subscale (OR 63.96; 31.4,129.1 CI). Sex, education, and self-rated health were not associated with SRQOL in the multivariate analyses.

DISCUSSION

This study indicates that approximately one in five Latino manual laborers at the selected sites in Western North Carolina reports an effect of skin conditions on their quality of life. As would be expected in a general worker population, this frequency is far lower than that seen in studies of clinical populations. A previous review of studies using the DLQI where a general population sample was contrasted with a clinical sample found that mean DLQI scores from the general population samples ranged from 0 to only 0.05 [Lewis and Finlay, 2004]. By comparison, our sample of Latino manual workers averages 0.65, substantially higher than the previous general population samples reviewed. This average is substantially lower than studies of patients with occupation-linked skin diseases such as latex allergy [Niehaus et al. 2008], hand eczema [Boehm et al. 2012; Diepgen et al. 2013], contact dermatitis [Hutchins et al. 2001; Lau et al. 2011], and atopic dermatitis [Yano et al. 2013], where mean DLQI scores range from 4.5 to 11.1.

In other studies reporting DLQI subscale scores, the Symptoms and Feelings and the Work subscales generally show the largest impacts [Boehm et al. 2012; Lau et al. 2011; Hutchins et al. 2001]. In this study population, most of the adverse effects were related to interference with work and problems caused by the experience of symptoms or feelings about one's skin disease with about 20% and 15%, respectively, of respondents self-reporting one or more skin symptoms. This is similar to findings among Latino migrant farmworkers in North Carolina [Quandt et al., 2008]. As both studies focused on migrant or immigrant workers who come to the US for economic reasons and often are responsible for supporting extended families in the US or in their country of origin, skin conditions that impair the ability to work may be particularly bothersome. However, unlike migrant farmworkers, the workers in the present study are, for the most part, residing in the US with kin and living in less isolated surroundings so that it is somewhat surprising that there was no greater reporting of skin conditions affecting leisure activities or personal relationships. The work/school and symptoms/feelings subscales may be linked, as our previous work has shown that symptoms that disturb sleep—symptoms like "itchy, sore, painful, or stinging" that are covered in the symptoms/feelings subscale—are particularly worrisome to workers who feel economic pressure to work [Rao et al., 2002].

This sample of workers has relatively good skin health: 77.1% reported no symptoms in the 12 months prior to interview. However, those most commonly experienced include itching, which is a highly prevalent skin symptom and source of considerable morbidity [Weisshaar et al. 2009], and wheals, which are a known symptom of urticaria and linked to handling poultry products [Fisher 1982], poison ivy, and various chemicals [Adisesh et al., 2013], occupational risks for manual workers across all the industry sectors represented in this sample.

The factors associated with poor SRQOL were age, speaking an indigenous language, occupation, and self-reported skin symptoms. Skin ailments may be more common in this 25-30 year age group because they have had sufficient exposures to reduce SRQOL; affected workers may eventually drop out of the work force or change jobs to reduce exposures, producing the "healthy worker effect". That is those with severe enough skin conditions due to work will tend to drop out of the labor force or at least change job to one with fewer adverse health effects. The explanation for indigenous language associated with poor SRQOL is less easy to explain. Most of the indigenous workers are originally from Guatemala or southern Mexico, and have significant American Indian ancestry. This may be reflected in genetic differences, which result in greater exacerbation of skin conditions. In a subsample of this study sample who received a clinical skin evaluation, indigenous language was associated with a greater overall level of skin disease, including both infectious and inflammatory conditions [Pichardo-Geisinger et al., 2013]. Alternatively, indigenous language speakers are generally less acculturated in their countries of origin and may have had less access to medical care or have lived in poorer quality housing, factors that can also result in greater prevalence and impact of skin disease.

SRQOL was associated with occupation, although the association remained significant only for the Work subscale in the multivariate analysis. Production work, which consisted largely of poultry processing workers, was associated with worse SRQOL than that of workers in construction, transportation and similar occupations, but better SRQOL than that of workers doing building and grounds maintenance and farm work. Poultry processing workers, depending upon their job in the plants, are continuously exposed to water, animal protein, chicken feathers, chicken excrement, or cleaning and cooling chemicals, and often wear occlusive gloves. Although workers in the construction category are at risk for skin disorders, continuous exposure may be restricted to a small proportion of workers, such as those in construction who do cement or tile work or those in transportation who work with petroleum products. Both building and grounds maintenance workers and farmworkers can be exposed to chemicals, different types of plants, and weather extremes. A longitudinal surveillance study of Latino farmworkers found high rates of infectious and inflammatory skin disease, as well as skin trauma [Arcury et al., 2007]. A large study of professional cleaners found higher rates of hand dermatitis than in a comparison population. Hand dermatitis was associated with cleaning outdoor areas and schools and using particular chemicals and cleaning products [Mirabelli et al., 2012]. This study suggests that these different levels of exposures common to different industries are reflected in differences by industry in SRQOL.

The experience of any skin symptoms during the previous 12 months was associated with increased odds of reporting poorer total and subscale SRQOL. The large odds ratios reflect the overwhelming number of those who reported symptoms also reporting poor SRQOL. This is somewhat surprising considering that the symptom data were for the previous year and the SRQOL was reported for only the previous week. This suggests that the skin conditions underlying these workers' symptoms are likely to be chronic and cause chronically low SRQOL. It is notable that clinical data for a subset of these workers collected on a non-work day showed infectious skin diseases of the feet (tinea pedis and onychomycosis) to be the most commonly diagnosed skin diseases. Skin symptom data in the current analysis were focused on hands, wrists and forearms, suggesting that inflammatory diseases may be the source of substantial morbidity. Such conditions may be more likely to be revealed in survey data than clinical data, as their visible signs may be more transient and not present on a non-work day.

These findings should be interpreted in light of their limitations. The study is cross-sectional, so the duration of reduced SRQOL cannot be assessed. Workers were recruited from only one area of the US. Because no census of Latino residents exists and this population is relatively hidden, a true population-based random sample was not possible. A site-based sampling strategy with assistance from community leaders was used instead. The true number of eligible individuals in the sampled dwellings is unknown, as some individuals may have absented themselves when the recruiter visited; and it is not possible to know how many there were and how many would have been eligible. The occupational categories used required combining categories because of small cell sizes. The study is cross-sectional, so causation or time-relationships among work, symptoms, and SRQOL cannot be determined. Atopic status was not assessed; it might have varied among

subgroups and its inclusion in multivariable analyses might have altered the results. Nevertheless, the study has significant strengths. First, inclusion of workers from the multiple industries employing members of this ethnic population presents a broad picture of SRQOL. Second, the industries represented (e.g., poultry processing, construction, food service, farm work) are those in which, nationally, a large proportion of Latino immigrants are employed and which have a high proportion of Latino employees.

This paper adds to the sparse literature on the effect of skin illness on manual workers. It indicates that a small, but significant, number of Latino manual workers suffer from reduced quality of life due to skin ailments. Several barriers stand in the way of improving this situation. First, specialty healthcare such as dermatology is relatively scarce in rural communities, and wait times are often long [Uhlenhake et al., 2009]. Second, these workers are largely non-English speaking, which can present barriers in obtaining care in the US. Finally, many manual workers lack health insurance and may not perceive skin conditions as serious enough to warrant the out of pocket expenses resulting from seeking treatment. This suggests that policy changes to increase access to care are needed, as well as greater patient education for self-care of skin ailments.

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Table I. Sample personal and work characteristics of 733 immigrant manual workers who participated in survey interviews.

	n[a]	%
Age		
18-24 years	133	18.2
25-30 years	193	26.4
31-40 years	239	32.6
41+ years	167	22.8
Sex		
Female	315	43.0
Male	418	57.0
Occupation		
Production	481	65.5
Construction/Installation & Repair/Transportation	100	13.6
Food Prep/Personal Care & Service/Other	101	13.8
Building & Grounds/Farming	51	7.0
Education		
0-6 years	420	57.4
7-9 years	170	23.2
10+ years	142	19.4
Language of childhood		
Indigenous	171	23.5
Non-indigenous	556	76.5
Self-rated health		
Fair/poor	407	56.2
Good or better	317	43.8
Skin symptoms		
No 12 month symptoms	563	77.1
12 month symptoms	167	22.9

[a] Varying n-values in the subsamples are attributable to missing data.

Table II. Frequency and percent of sample reporting Dermatological Life Quality Index (DLQI) subscale scores from 0 to 3 or 5, with higher numbers indicating greater impact of skin conditions on DLQI domains.

Score	Symptoms & Feelings		Daily Activities		Leisure		Work[a]		Personal Relationships		Treatment[a]	
	n	%	n	%	n	%	n	%	n	%	n	%
0	587	80.1	701	95.6	690	94.0	622	85.0	704	96.1	726	99.1
1	91	12.4	27	3.7	29	4.0	101	13.8	28	3.8	6	0.8
2	46	6.3	4	0.6	13	1.8	5	0.7	1	0.1	1	0.1
3	5	0.7	1	0.1	2	0.3	4	0.6	0	0	0	0
4	3	0.4	0	0	0	0	--	--	0	--	--	--
5	1	0.1	0	0	0	0	--	--	0	--	--	--

Table III. Bivariate associations between Dermatological Life Quality Index (DLQI) measures and personal and work characteristics, n (col %)

Characteristic	DLQI Total Score[a] n = 733			Symptoms & Feelings Subscale[b] n = 733			Work Subscale[b] n = 732		
	Not affected at all	Affected in varying degrees	p-value[c]	Not affected at all	Affected in varying degrees	p-value[c]	Not affected at all	Affected in varying degrees	p-value[c]
Age			<.0001			<.0001			0.0003
18-24 years	113 (18.6)	20 (16.1)		110 (18.8)	23 (15.7)		114 (18.4)	19 (17.3)	
25-30 years	138 (22.7)	55 (44.4)		133 (22.7)	60 (41.1)		147 (23.7)	46 (41.8)	
31-40 years	206 (33.9)	33 (26.6)		198 (33.8)	41 (28.1)		206 (33.2)	32 (29.1)	
41+ years	151 (24.8)	16 (12.9)		145 (24.7)	22 (15.1)		154 (24.8)	13 (11.8)	
Sex			0.0991			0.2078			0.0309
Male	339 (55.7)	79 (63.7)		328 (55.9)	90 (61.6)		344 (55.3)	73 (66.4)	
Female	270 (44.3)	45 (36.3)		259 (44.1)	56 (38.4)		278 (44.7)	37 (33.6)	
Occupation[d]			<.0001			0.0412			<.0001
Group 1	393 (64.5)	88 (71.0)		384 (65.4)	97 (66.4)		405 (65.1)	75 (68.2)	
Group 2	93 (15.3)	7 (5.7)		86 (14.6)	14 (9.6)		95 (15.3)	5 (4.6)	
Group 3	90 (14.8)	11 (8.9)		83 (14.1)	18 (12.3)		89 (14.3)	12 (10.9)	
Group 4	33 (5.4)	18 (14.5)		34 (5.8)	17 (11.6)		33 (5.3)	18 (16.4)	
Education			0.7110			0.9512			0.2306
0-6 years	348 (57.2)	72 (58.1)		335 (57.2)	85 (58.2)		353 (56.8)	66 (60.0)	
7-9 years	139 (22.9)	31 (25.0)		136 (23.2)	34 (23.3)		141 (22.7)	29 (26.4)	
10+ years	121 (19.9)	21 (16.9)		115 (19.6)	27 (18.5)		127 (20.5)	15 (13.6)	
Language			<.0001			<.0001			<.0001
Indigenous	117 (19.4)	54 (43.9)		115 (19.8)	56 (38.6)		121 (19.6)	50 (45.9)	
Non-indigenous	487 (80.6)	69 (56.1)		467 (80.2)	89 (61.4)		496 (80.4)	59 (54.1)	
Self-rated health			0.0595			0.0143			0.1221
Fair/poor	329 (54.5)	78 (63.9)		313 (54.0)	94 (65.3)		338 (55.0)	68 (63.0)	
Good or better	273 (45.5)	44 (36.1)		267 (46.0)	50 (34.7)		277 (45.0)	40 (37.0)	
Skin symptoms			<.0001			<.0001			<.0001
No 12 month symptoms	545 (89.9)	18 (14.52)		534 (91.4)	29 (19.9)		548 (88.5)	14 (12.7)	
12 month symptoms	61 (10.2)	106 (85.5)		50 (8.6)	117 (80.1)		71 (11.5)	96 (87.3)	

[a] Total Score: 0 or 1 = Not affected at all or affected a little; >1 = Affected a lot or very much.
[b] Subscales: 0 = Not affected at all; >0 = Affected in varying degrees.
[c] p-value from Chi Square tests of association.
[d] Group 1=Production; Group 2=Building & Grounds, Farming, Outdoor; Group 3=Construction, Installation, Transportation; Group 4=Food Preparation, Personal Care, Service, Other

Table 4: Multivariate logistic regression analyses to examine the association of total Dermatological Life Quality Index (DLQI) score, Symptoms and Feelings subscale, and Work subscale with selected personal and occupational characteristics.

Characteristic	Total DLQI (n=716)		Symptoms & Feelings Subscale (n=716)		Work Subscale (n=715)	
	AOR[a]	95% CI	AOR	95% CI	AOR	95% CI
Age						
18-24 years	1.59	(0.59, 4.27)	1.08	(0.44, 2.65)	1.85	(0.62, 5.53)
25-30 years	3.05	(1.28, 7.30)	2.15	(0.97, 4.76)	2.76	(1.19, 6.40)
31-40 years	1.30	(0.52, 3.21)	1.08	(0.47, 2.48)	1.88	(0.76, 4.68)
41+ years	---[b]	---	---	---	---	---
Sex						
Male	1.02	(0.54, 1.92)	1.00	(0.57, 1.76)	1.63	(0.85, 3.12)
Female	---	---	---	---	---	---
Occupation[c]						
Group 1	---	---	---	---	---	---
Group 2	0.33	(0.10, 1.04)	0.90	(0.30, 2.68)	0.24	(0.07, 0.79)
Group 3	0.79	(0.29, 2.13)	1.64	(0.79, 3.37)	2.03	(0.75, 5.53)
Group 4	2.26	(0.79, 6.46)	1.38	(0.44, 4.37)	4.75	(1.65, 13.69)
Education						
0-6 years	---	---	---	---	---	---
7-9 years	1.40	(0.73, 2.70)	1.03	(0.52, 1.90)	1.40	(0.72, 2.74)
10+ years	1.49	(0.62, 3.57)	1.46	(0.61, 3.03)	0.71	(0.27, 1.85)
Language						
Indigenous	2.94	(1.51, 5.70)	2.06	(1.15, 3.71)	2.48	(1.26, 4.89)
Non-indigenous	---	---	---	---	---	---
Self-reported health						
Fair/poor	1.13	(0.64, 1.99)	1.49	(0.87, 2.56)	0.95	(0.52, 1.74)
Good or better	---	---	---	---	---	---
Skin symptoms						
No symptoms	---	---	---	---	---	---
12 Month symptoms	52.20	(27.7, 98.4)	42.13	(24.7,72.0)	63.69	(31.4,129.1)

[a] Adjusted odds ratios and 95% CI from clustered, stratified multivariate logistic regression modeling comparing participants who reported skin-related quality of life being affected in varying degree due to skin problems versus those who reported little effect or none at all.

[b] Reference Category

[c] Group 1=Production; Group 2=Building & Grounds, Farming, Outdoor; Group 3=Construction, Installation, Transportation; Group 4=Food Preparation, Personal Care, Service, Other

3-3. Upper Body Musculoskeletal Symptoms of Latino Poultry-Processing Workers and a Comparison Group of Latino Manual Workers

ABSTRACT

Background: Upper body musculoskeletal injuries are often attributed to rapid work pace and repetitive motions. These job features are common in poultry processing, an industry that relies on Latino immigrants. Few studies document the symptom burden of immigrant Latinos employed in poultry processing or other manual jobs.
Methods: Latino poultry-processing workers (n = 403) and a comparison population of 339 Latino manual workers reported symptoms for six upper body sites during interviews. We tabulated symptoms and explored factors associated with symptom counts.
Results: Back symptoms and wrist/hand symptoms lasting more than one day were reported by over 35% of workers. Poultry-processing workers reported more symptoms than comparison workers, especially wrist and elbow symptoms. The number of sites at which workers reported symptoms was elevated for overtime workers and workers who spoke an indigenous language during childhood.
Conclusions: Workplace conditions facing poultry processing and indigenous language speaking workers deserve further exploration.

INTRODUCTION

Upper body musculoskeletal injuries are often attributed to rapid work pace and repetitive motion patterns, insufficient recovery time, heavy lifting and forceful manual exertions, non-neutral body postures, mechanical pressure concentrations, partial or whole-body vibration, and local or whole-body exposure to cold [National Research Council, 1998; National Research Council, 2001; Punnett & Wegman, 2004; van Rijn et al., 2010]. Many of these job features are common in the poultry processing industry [Armstrong et al., 1982; OSHA, 1993; Campbell, 1999; OSHA, 2004].

The poultry processing industry has been repeatedly identified as one with a high proportion of jobs involving a limited number of tasks performed repetitively that result in ergonomic strain to the upper body, and particularly, the upper extremities [Armstrong et al., 1982; Hall, 1989; Campbell, 1999; Nowell, 2000; Government Accountability Office, 2005; Lipscomb et al., 2005; Quandt et al., 2006; Lipscomb et al., 2007; Lipscomb et al., 2008]. The birds are taken from their transport cages, hung by their feet on hooks and stunned on an overhead moving belt. They are killed, plucked, eviscerated, butchered, often de-boned, and packaged – all at a speed of more than one bird per worker every two seconds [The Humane Society of the United States, 2012]. This efficiency can only be accomplished by workers who work at high rates of speed for long periods without breaks. Working in awkward positions and repeating the same movements, workers risk musculoskeletal injuries [Government Accountability Office, 2005].

In the final decades of the twentieth century, the poultry processing industry in the United States grew rapidly, became increasingly centered in non-metropolitan areas of the South, and came to be reliant on an ethnic minority and immigrant workforce [Fink, 1998; Grey and Woodrick, 2002; Government Accountability Office, 2005]. After peaking at 246,000 in 2002, employment in poultry processing has been more stable with the most recent employment estimate being 227,000 for 2010. [Bureau of Labor Statistics, 2011]. Poultry processing operations are rooted in Southern states, in part because of their large low-wage workforce and 'right-to-work' status, which undermines strong unions, reduces labor costs, and allows operations to exist on thin economic margins [Fink, 2003]. Mexico and Guatemala are the source of the majority of the industry's immigrant workers [Government Accountability Office, 2005]. The increased number of immigrant workers from Mexico and Guatemala working in poultry processing has been reported in rural western North Carolina, the location of this study [Fink, 2003; Quandt et al., 2005; Quandt et al., 2006].

The physical stress of poultry processing work is often exacerbated by supervisors who push to keep the line moving at the desired speed. Frequently, supervisors do not speak the same language as the immigrant Latino workers; they intimidate these workers and treat them with disrespect [Marín et al., 2009]. Additionally, there are important differences among the immigrant Latino workers. Many from Guatemala and southern Mexico were raised in communities in which an indigenous language (e.g., Aguacateco, Quiche, Ajobal, Accomogual) was the primary language [Fink, 1998; Fink, 2003], while most of the immigrants from central and northern Mexico were raised speaking Spanish.

These differences in childhood language and place of birth among Latino immigrant workers might be expected to correlate with symptoms on two accounts. First, new immigrants who speak an indigenous language often face discrimination and limited access to culturally appropriate occupational safety and health information and training [Farquhar et al., 2008]. Second, on average, new immigrants raised in indigenous communities of Guatemala and Southern Mexico are of smaller stature [Bogin et al., 1992; Bogin & Rios, 2003; Smith et al., 2003] than most Latino immigrants due to a variety of factors including poverty-associated nutrition and infectious disease insults during development. An elevated prevalence of musculoskeletal symptoms might be expected among indigenous-speaking immigrant workers if employers do not allow for accommodations in the work process or design of work tasks to fit
their smaller average stature [Pheasant, 1991].

Although the industry is recognized as hazardous, data on prevalence of upper body musculoskeletal symptoms among poultry-processing workers is sparse, especially for Latinos and Latinos speaking indigenous languages [Quandt et al., 2006; Lipscomb et al., 2007]. In an earlier study of Latino poultry workers in western North Carolina, 46% reported pain, stiffness, cramps or weakness in arms or hands within the previous 30 days, and 36% reported similar symptoms in the neck or back [Quandt et al., 2006]. A study of Black female poultry processing workers in eastern North Carolina found the prevalence of upper extremity and neck symptoms to be more than two times higher among the poultry workers than in those of similar economic status employed in other jobs in the same region [Lipscomb et al., 2007]. Comparative estimates of the prevalence of upper body symptoms among Latino workers in other manual occupations are also sparse. The aims of this paper are to, 1) describe the prevalence of upper body musculoskeletal symptoms reported at six specific body sites by Latino poultry processing workers and a comparison population of Latino manual workers in western North Carolina; and 2) identify occupational and demographic factors associated with the number of upper body sites for which Latino workers report symptoms.

METHODS

Study Design, Sampling and Recruitment

During 2009 and 2010, we conducted a cross-sectional study of Latino poultry workers and other Latino manual workers living in communities surrounding three poultry processing plants in western North Carolina. Potential participants were recruited in person by Spanish-speaking study personnel who visited housing units that were randomly selected from a comprehensive list of housing units with Spanish-speaking residents developed by community-based and study personnel. One thousand five hundred and twenty-six adults were screened for eligibility; 957 of the individuals screened were eligible for participation.

Potential participants were eligible for inclusion if they were adults who self-identified as Latino or Hispanic and were working ≥35 hours per week at the time of recruitment in poultry processing or other manual labor jobs. Poultry processing work was defined as work other than supervision or quality control in a poultry processing plant. The comparison sample of Latino manual workers was recruited from the same communities. To be included in the comparison sample, a worker had to be employed for pay in a manual job, excluding jobs in poultry processing or poultry production. Chicken catchers were excluded from both groups.

Data Collection

Of the 957 individuals who screened eligible for the study, trained data collectors enrolled 742 (78%) individuals who completed face-to-face, interviewer-administered questionnaires. The face-to-face interviews were conducted in Spanish by native Spanish speaking interviewers. The interview took approximately 60 minutes to complete and included information on work history, work environment, symptoms and disability, and demographic characteristics. Interview techniques, questionnaire contents, human subject protection, and ethics were covered at a 1-day training session. Each interviewer was required to conduct a practice interview prior to beginning data collection. The interviewers explained the purpose, procedures, risks and benefits of the study; answered questions; and obtained written informed consent. Respondents were given a $10 incentive for their participation. All procedures were approved by the Wake Forest University Health Sciences Institutional Review Board. To ensure data quality, study staff met with each interviewer at least weekly to collect and review completed questionnaires. Cartwright et al. [2012] and Mirabelli et al. [2012] describe additional details about the implemented data collection, sampling, and recruitment procedures.

Measures

Upper body musculoskeletal symptoms potentially related to manual work and particularly poultry processing work were the focus of this study. Six upper body sites- (1) neck, (2) upper and/or lower back, (3) forearms, (4) wrist/hands, (5) shoulders, and (6) elbows- were assessed by interviewer administered questionnaire. For each body site, the primary question was, “Have you at any time during the last 12 months had an ache, pain, discomfort, or numbness”. To identify workers experiencing more chronic pain, each worker who reported “yes” for symptoms during the past 12 months for a particular body site was asked whether they experienced an ache, pain, discomfort, or numbness at that body site in the past 12 months that lasted longer than one day. To measure the extent of a worker’s upper body musculosketal symptoms we counted the number of sites for which (s)he reported symptoms lasting longer than one day. The resulting count variable was categorized into three ordered levels (no upper body sites with symptoms 1-3 upper body sites with symptoms, and 4-6 upper body sites with symptoms).

The primary occupational exposure of interest was work in the poultry processing industry and the comparison group was manual work in other industries. Additionally, study investigators categorized participating workers into eight major Standard Occupation Classification (SOC) groups based on the primary job reported by the worker. Because of small numbers in several of the eight major SOCs, the occupational groups were collapsed into three broad groups for analysis: production; occupations more likely to include outdoor work (Farming, Fishing, and Forestry; Construction and Extraction; Building and Grounds Cleaning and Maintenance; and Transportation and Material Moving); and occupations less likely to include outdoor work (Food Preparation and Serving Related; Personal Care and Service; Installation, Maintenance, and Repair; and Other). To measure the length of a worker’s usual work week, we asked, “How many hours per week do you usually work on all jobs?” The range of responses was 18 hours/week to 65 hours/week, and the responses were categorized into three groups (< 40 hours/week, 40 hours/week, and > 40 hours/week).

Age was reported in years and categorized into three groups (18-29, 30-39, and > 40), and education was reported as the highest grade of school completed and categorized into two groups (0-6, and > 7), which reflects whether participants completed a primary level of education. Interviewers classified workers as male or female by observation. The language(s) spoken in the household when the worker was a child was assessed as a measure of national and ethnic heritage and was categorized into two groups (indigenous, and non-indigenous). If a worker identified an indigenous language (e.g., Quiche, Aguacateco) as a household language, (s)he was placed into the indigenous group. Workers reporting the use of either English or Spanish in the household during childhood were placed into the nonindigenous group.

Data Analysis

All the statistical analyses took account of our stratified cluster sampling design. Descriptive statistics were used to describe the overall sample. Bivariate associations between work type (poultry vs. non-poultry) and various demographics were examined using Rao-Scott chi-square tests. Since the number of body parts that experienced pain was categorized into three ordered levels (0, 1-3, and 4-6), we first attempted to fit ordinal logistic regression models to examine the association between work type and body pain. However, Scores tests indicated that the proportional odds ratios assumption did not hold. Therefore, nominal logistic regression models were used instead to allow the association between predictors and outcome to differ across outcome levels. Finally, following the example of Messing et al. [2009], we stratified by gender and ran separate models for men and women. All analyses were performed using SAS 9.2 (Cary, NC) and a p-value of <0.05 was considered statistically significant.

RESULTS

The sample included 403 poultry workers and 339 manual workers not employed in poultry processing (Table I). The workers were young, had completed limited formal education and included almost as many women as men. Over 16 percent of the sample regularly worked more than 40 hours per week, and nearly one quarter reported than an indigenous language was spoken in their childhood home. The poultry workers differed significantly from non-poultry workers in the following characteristics: they had completed less formal education, were older, and worked more hours/week. The vast majority of the poultry workers were classified into the broad SOC of Production workers, whereas non-poultry workers were more evenly dispersed among broad SOCs. Based on the job tasks they performed, the best broad SOC for one poultry processing worker was ‘Installation, Maintenance, and Repair Occupations’ and the best broad SOC for three other poultry processing workers was ‘Transportation and Material Moving Occupations’.

Among all workers, the back and wrists/hands were the sites with the highest prevalence of reported upper body musculoskeletal symptoms (Table II). Prevalence of symptoms at these sites was five times the prevalence of elbow symptoms, and the difference in symptoms by upper body site was highly significant. For each body site, poultry-processing workers reported greater prevalence of symptoms than other manual workers. Elevated prevalence of symptoms for poultry workers was most pronounced for the wrist/hands and elbow.

Percent of upper body sites with musculoskeletal symptoms by possible explanatory variables are displayed in Table III. Workers who reported upper body musculoskeletal symptoms tended to report symptoms at several sites. One hundred and twenty-three workers (16.6%) reported symptoms at 4-6 upper body sites, 304 workers (41.0%) reported symptoms at 1-3 upper body sites, and 315 (42.4%) did not report upper body symptoms at a single upper body site. Workers in the poultry processing industry, those who usually worked > 40 hours/week, those with less formal education, those in production occupations, and workers addressed by adults in an indigenous language as a child, reported symptoms at more sites than the respective comparison groups.

In the multinomial logistic regression model, the strongest predictors of the number of symptoms reported were hours worked per week and the childhood language (Table IV). The odds of reporting symptoms increased monotonically with increasing hours of work. Workers who usually worked > 40 hours/week had greater odds (OR = 7.5, 95% CI 3.1, 17.5) of reporting upper body symptoms at 4-6 sites than no sites relative to their counterparts who usually worked < 40 hours/week. Workers who reported an indigenous language as a child had greater odds (OR = 3.7, 95% CI 2.1, 6.6) of reporting upper body symptoms at 4-6 sites vs. none than other workers. Work in the poultry processing industry was positively associated with reporting upper body symptoms at 4-6 sites vs. none (OR = 1.8; 95% CI: 0.8, 4.0), but the strength of the association was moderate and not significant. Work in the group of broad SOCS that included Farming, Fishing and Forestry was positively and significantly associated with reporting symptoms at 4-6 sites However, even after combining broad SOC groups to achieve larger cell counts, the confidence intervals surrounding the odds ratios for the SOC groups were wide.

Sex-specific models (data not shown) revealed results similar to those in Table IV. The biggest difference between the female and male sex-specific models was with regard to formal education. The negative association between more years of formal education and symptoms at 4-6 sites shown in Table IV was stronger and still statistically significant in the female-specific model, while in the male-specific model this association was weaker and not statistically significant, although still negative.

DISCUSSION

These results demonstrate a high prevalence of upper body musculoskeletal symptoms among Latino manual workers in Western North Carolina. The symptoms and the six body sites at which they are reported are associated with occupational injuries and illnesses commonly reported in the poultry processing industry [OSHA Poultry Processing Industry eTool, 2012]. Over 35% of workers reported symptoms of ache, pain, discomfort, or numbness at their upper and/or lower back in the past year that lasted greater than one day and, a similar percent reported these symptoms at their wrists/hands. More than 25% of workers reported these symptoms at the shoulders and at the forearms. At all six sites, the prevalence of symptoms was somewhat greater among poultry workers than among other manual workers. Usually working greater than 40 hours/week was the strongest predictor of reporting symptoms at 1 or more sites compared to none in our multinomial logistic regression model which adjusted for industry (poultry, other), broad occupations, age, gender, education and childhood language.

Workers who reported working greater than 40 hours per week as compared to less than 40 hours per week had 7.5 times greater odds of reporting symptoms at 4-6 sites. Although direct comparisons cannot be made because of differences in the way that symptoms were reported, two earlier studies that examined symptoms among poultry workers in North Carolina reported elevated levels of musculoskeletal symptoms similar to those reported in the current study.

Regarding upper extremities (UEs), forty-six percent of workers reported pain, stiffness, cramps, or weakness in arms or hands in the past 30 days in the seminal occupational illness and injury study in Latino poultry processing workers in Western North Carolina [Quandt et al., 2006]. Greater than thirty-five percent of the Black female poultry workers in Eastern North Carolina surveyed by Lipscomb et al. [2007] reported hand/wrist symptoms (pain, aching, stiffness, burning, numbness or tingling) in the past year that lasted at least a week or occurred on more than three occasions. Regarding back symptoms, greater than 20% of Black female workers reported low back symptoms in the past year [Lipscomb et al., 2007], while 36% of Latinos reported symptoms in the neck or back in the past thirty days [Quandt et al., 2006].

A strength of this study is the comparison of symptom prevalence of Latino poultry-processing workers to that of Latino manual workers in other industries. In our initial cross tabulation, work in poultry processing was significantly associated with reporting symptoms at more upper body sites. However, this association was no longer significant after adjustment for hours worked per week, broad occupations, age, gender, education and childhood language. The precarious and relatively unsafe nature of the jobs that Latino manual workers are able to obtain outside of poultry processing may be part of the explanation. Other reports have noted that Latino immigrants are concentrated in jobs with precarious employment arrangements and industries such as agriculture and construction with elevated injury rates [Quinlan, 2001; Pransky et al., 2002; Dong and Platner, 2004; Arcury and Quandt, 2007; Dong et al., 2010]. Our comparison group of Latino manual workers were representative of their community, and a substantial portion were employed in construction and agriculture. Nevertheless, at each individual upper body site, we found the prevalence of symptoms was higher in Latino poultry-processing workers than in the comparison Latino manual workers; and the difference was most pronounced for the wrist/hands and the elbows. The elevated prevalence of wrist/hand symptoms in poultry-processing workers reported in this study is congruent with the elevated prevalence of carpal tunnel syndrome in Latino poultry processing workers reported by Cartwright et al. [2012] in his analysis of a sub-set of the population included in our analysis.

Overtime work (> 40 hours per week) remained a significant positive predictor of the number of sites at which symptoms were reported in our final model. In its discussion of the length of the work week, the National Research Council report on musculoskeletal disorders and the workplace [2001] noted that, particularly for manual work, long working hours can lead to fatigue and greater exposure to risk factors for musculoskeletal disorders. In their study comparing Black women poultry-processing workers and a community comparison group, Lipscomb et al. [2007] reported a significant crude association between overtime work and upper extremity musculoskeletal symptoms, but the association did not remain significant in their final model. The Latino poultry-processing workers in our study were significantly more likely to work > 40 hours per week than the comparison group of Latino manual workers.

One of the most notable results of these analyses is the variation by childhood language in number of upper body sites for which symptoms were reported. An indigenous language was the primary childhood language for nearly a quarter of our sample while Spanish was the childhood language of the remainder. Less than a quarter of workers with an indigenous childhood language reported symptoms at no upper body sites, whereas nearly half of those whose childhood language was Spanish reported symptoms at no sites. After adjusting for work in poultry, broad occupational group, age, education and gender, those with an indigenous childhood language had nearly three times greater odds of reporting symptoms at 1-3 sites and nearly four times greater odds at 4-6 sites. While new immigrant workers from Latin America are often portrayed as similar and grouped together in descriptive analyses [Mosisa, 2002; Toossi, 2002], these results suggest that occupational health conditions may be substantially worse for Latino manual workers of indigenous ethnic and national heritage. Qualitative data have documented that indigenous farmworkers in Oregon face disrespect and discrimination based on their language and culture as well as a lack of occupational safety information and equipment [Farquhar et al., 2008]. Further analyses are warranted to investigate whether indigenous poultry workers face similar obstacles. Additionally, ergonomics is an important determinant of occupational health for manual workers especially those in fast-paced repetitive work environments such as poultry processing [OSHA Poultry Processing Industry eTool, 2012]. A key principle of ergonomics is fitting the job to the worker [Pheasant, 1991]. Employers not taking account of the unique physical stature of indigenous workers from Latin America in the design of poultry processing and other manual work may be another contributor of the elevated prevalence of symptoms among indigenous Latino manual workers in this study.

This study has several limitations that bear consideration when interpreting the findings. First, the survey relied on retrospective self-reports of symptoms rather than physical examinations. Because our sample was asked to recall symptoms in the past year, some memory lapses are to be expected and, the prevalence of upper body symptoms reported here are likely underestimates. A subgroup of the workers in this study completed a physical examination and the high prevalence of carpal tunnel syndrome seen in the subgroup of poultry processing workers who completed the physical exam corroborates the upper body musculoskeletal symptoms reported here [Cartwright et al., 2012]. Second, inherent in the cross-sectional data is an inability to define clearly temporality in the relationships we identified. For example, we do not know if the long hours of work reported preceded or followed the onset of upper body musculoskeletal symptoms. Third, the information we have on the industries and occupations of the manual workers in our sample is somewhat limited. We were forced to rely on worker self-reports for this information because the closed nature of the poultry processing industry foreclosed the traditional approach of sampling from worksites and incorporating employer records of job assignments. Fourth, we were not able to explore the relationship between job tasks and upper body musculoskeletal symptoms. The broad range of industries in which our Latino manual worker comparison sample worked made it impractical to inquire about job tasks for workers outside of poultry processing. However, Cartwright et al. [2012] identified some associations between job tasks and the prevalence of carpal tunnel syndrome in the subgroup of poultry processing workers who completed a physical exam.

In spite of these limitations, this study describes a community sample of Latino poultry processing and other manual workers with high prevalence of musculoskeletal symptoms at six upper body sites. Besides corroborating earlier and concurrent studies that have implicated poultry processing as an industry in which workers face elevated prevalence of upper body musculoskeletal morbidity [Quandt et al., 2006; Lipscomb et

al., 2007; Cartwright et al., 2012], this work presents similar results for Latino manual workers in other industries. Indigenous ethnic and national heritage and hours of work beyond the 'regular' 40 hour week are identified as factors strongly associated with the upper body musculoskeletal symptoms.

These data strengthen the call for more attention to the occupational health concerns of Latino manual workers in poultry processing and other industries and especially those of indigenous ethnic and national heritage by quantifying the musculoskeletal symptoms they experience. Some further research is also indicated. Systematic prospective assessments of occupational injuries and illnesses to the back and neck should be conducted to confirm the self-reported levels of such health conditions and investigate etiology. Reasons for the elevated prevalence of upper body musculoskeletal symptoms in Latino manual workers of indigenous ethnic and national heritage even relative to other Latino manual workers should be further investigated.

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Table I. Description of Latino Poultry and Non-poultry Manual Workers, Western North Carolina

	Total Sample (n = 742)	Poultry workers (n = 403)	Non-poultry workers (n = 339)	
Female	319 (43.0)	173 (42.9)	146 (43.1)	P = 0.97
Indigenous Spoken Language[a]	180 (24.5)	106 (26.6)	74 (22.0)	P = 0.16
Education, 0-6 yrs.	428 (57.8)	253 (62.9)	175 (51.6)	P = 0.003
Age				
< 30 yrs.	293 (39.5)	148 (36.8)	145 (42.8)	
30-39 yrs.	254 (34.3)	125 (31.1)	129 (38.0)	
40+ yrs.	194 (25.2)	129 (32.1)	65 (19.2)	P < 0.0001
Hours worked/wk.				
<40 hrs.	109 (14.8)	34 (8.4)	75 (22.4)	
40 hrs.	507 (68.7)	292 (72.5)	215 (64.2)	
> 40 hrs.	122 (16.5)	77 (19.1)	45 (13.4)	P < 0.0001
SOC[b] categories				
Food Preparation and Serving Related; Personal Care and Service; Installation, Maintenance, and Repair; and Other[c]	122 (16.4)	1 (0.3)	121 (35.7)	
Farming, Fishing, and Forestry; Construction and Extraction; Building and Grounds Cleaning and Maintenance; and Transportation and Material Moving	132 (17.8)	3 (0.7)	89 (26.3)	P < 0.0001
Production	488 (65.8)	399 (99.0)	129 (38.0)	

[a]Language in which adults spoke to the worker when she or he was a child.
[b]Standard Occupational Classification.
[c]Arts, Design, Entertainment, Sports and Media Occupations; Sales and Related Occupations.

Table II. Prevalence (Percent) and Crude Prevalence Ratios of Musculoskeletal Symptoms[a] by Site in Poultry Workers and Non-poultry workers.

Site	Total Sample (n = 742); prevalence (n)	Poultry workers (n = 403); prevalence (n)	Non-poultry workers (n = 339); Prevalence (n)	Crude ratio[b]
Neck	15.9 (118)	17.4 (70)	14.2 (48)	1.2
Upper and/or lower back	36.3 (269)	36.8 (148)	35.7 (121)	1.0
Forearms	27.6 (205)	30.0 (121)	24.8 (84)	1.2
Wrists/Hands	35.2 (261)	40.4 (162)	29.4 (99)	1.4
Shoulders	29.4 (218)	30.8 (124)	27.7 (94)	1.1
Elbows	7.3 (54)	9.4 (38)	4.7 (16)	2.0

[a]Musculoskeletal symptoms in the past 12 months that lasted > one day
[b] Prevalence among poultry workers / prevalence among non-poultry workers

Table III. Number and Percent of Upper Body Sites with Musculoskeletal Symptoms by Possible Explanatory Variables

	Body Sites with Symptoms; n (Percent) n = # of cases			
	0 (total = 315)	**1-3 (total= 304)**	**4-6 (total =123)**	**p value**
Industry				
Poultry	157 (39.0)	166 (41.2)	80 (19.8)	
Non-poultry	158 (46.6)	138 (40.7)	43 (12.7)	0.024
Age in years				
<30	119 (40.6)	121 (41.3)	53 (18.1)	
30-39	119 (46.8)	102 (40.2)	33 (13.0)	
40+	77 (39.7)	80 (41.2)	37 (19.1)	0.32
Gender				
Female	132 (41.4)	135 (42.3)	52 (16.3)	
Male	183 (43.3)	169 (39.9)	71 (16.8)	0.80
Language[a]				
Non-Indigenous	269 (48.4)	214 (38.5)	73 (13.1)	
Indigenous	42 (23.3)	89 (49.5)	49 (27.2)	<0.0001
Education				
0-6 years	166 (38.8)	172 (40.2)	90 (21.0)	
7+ years	149 (47.6)	131 (41.9)	33 (10.5)	0.0003
Work hours per week				
<40 hours per week	58 (53.2)	40 (36.7)	11 (10.1)	
40 hours per week	227 (44.8)	210 (41.4)	70 (13.8)	
>40 hours per week	28 (23.0)	53 (43.4)	41 (33.6)	<0.0001
SOC[b] category				
Food Preparation and Serving Related; Personal Care and Service; Installation, Maintenance, and Repair; and Other[c]	67 (54.9)	43 (35.3)	12 (9.84)	
Farming, Fishing, and Forestry; Construction and Extraction; Building and Grounds Cleaning and Maintenance; and Transportation and Material Moving	55 (41.7)	56 (42.4)	21 (15.9)	
Production	193 (39.6)	205 (42.0)	90 (18.4)	0.003

[a]Language in which adults spoke to the worker when she or he was a child.
[b]Standard Occupational Classification.
[c]Arts, Design, Entertainment, Sports and Media Occupations; Sales and Related Occupations.

Table IV. Possible Explanatory Variables Associated with Number of Upper Extremity Sites with Musculoskeletal Symptoms reported by Latino Manual Workers in Western North Carolina; Adjusted Odds Ratios from Multinomial Logistic Regression Model

	1-3 Sites	4-6 Sites	
	Adjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)	Overall p-value
Industry			
Poultry	0.99 (0.6, 1.7)	1.8 (0.8, 4.0)	0.26
Non-poultry			
Age (in years)			
40+	1.3 (0.9, 2.1)	1.5 (0.8, 2.8)	0.22
30-39	0.95 (0.6, 1.4)	0.7 (0.4, 1.3)	
< 30	1	1	
Gender			
Male	0.7 (0.5, 1.0)	0.6 (0.4, 0.97)	0.07
Female	1	1	
Language[a]			
Indigenous	2.8 (1.8, 4.3)	3.7 (2.1, 6.6)	<0.0001
Non-Indigenous	1	1	
Education			
7+ years	1.1 (0.8, 1.5)	0.6 (0.4, 0.98)	0.053
0-6 years	1	1	
Work hours per week			
>40 hours per week	2.7 (1.4, 5.3)	7.5 (3.1, 17.8)	<0.0001
40 hours per week	1.4 (0.8, 2.2)	1.6 (0.8, 3.3)	
<40 hours per week	1	1	
SOC[b] category			
Production	1.5 (0.8, 3.0)	1.5 (0.5, 4.2)	0.04
Farming, Fishing, and Forestry; Construction and Extraction; Building and Grounds Cleaning and Maintenance; and Transportation and Material Moving	1.9 (0.99, 3.5)	3.4 (1.4, 8.1)	
Food Preparation and Serving Related; Personal Care and Service; Installation, Maintenance, and Repair; and Other[c]	1	1	

[a]Language in which adults spoke to the worker when she or he was a child.
[b]Standard Occupational Classification.
[c]Arts, Design, Entertainment, Sports and Media Occupations; Sales and Related Occupations.

Aim 4: To determine the interpretation of occupational illness and injury symptomatology, self-care behaviors, and barriers to prevention, treatment seeking, and reporting among poultry processing workers.

4-1. "… you earn money by suffering pain:" Beliefs About Carpal Tunnel Syndrome Among Latino Poultry Processing Workers

ABSTRACT

The nature of poultry processing puts workers at risk for developing neurological injuries, particularly carpal tunnel syndrome (CTS). Many poultry processing workers are Latino immigrants. This qualitative analysis uses an Explanatory Models of Illness (EMs) framework to describe immigrant Latino poultry processing workers' (Guatemalan and Mexican) beliefs of CTS. Understanding these workers' CTS EMs provides a foundation for recommendations to reduce the risk factors for this occupational injury. In-depth interviews were completed with 15 poultry processing workers diagnosed with CTS. Systematic qualitative analysis was used to delineate beliefs about causes, symptoms, physiology, treatments, quality-of-life and health implications of CTS. Participants' EMs largely reflect current biomedical understanding of CTS. These EMs are similar for Guatemalan and Mexican workers. Beliefs about causes include factors in the work environment (e.g., repetition, cold) and individual physical weakness. Treatments include over-the-counter medicine, as well as traditional remedies. Most know the future impact of CTS will include chronic pain. These workers know what causes CTS and that curing it would require quitting their jobs, but feel that they must endure CTS to support their families. Latino poultry processing workers, whether Guatemalan or Mexican, have a fairly complete understanding of what causes CTS, how to treat it, and what they must do to cure it. However, situational factors force them to endure CTS. Policy changes are needed to change the structure of work in poultry processing, particularly line speed and break frequency, if the prevalence of CTS is to be reduced.

INTRODUCTION

The per capita consumption of chicken in the United States has increased from 33.7 pounds in 1965 to 81.8 pounds in 2012 [1]. The poultry industry has established processing facilities in rural communities that are vertically integrated and mechanized to meet the high demand for chicken [2-4]. The majority of US chicken processing is now located in the South, including North Carolina [2]. Mechanization has led to great production line speeds, with potential impacts on worker health [5, 6]. Poultry processing workers must hang, cut, eviscerate, trim, debone, and pack chicken at a speed of one bird every two seconds during an eight to ten hour work day [6]. The repetitive nature of the work puts these workers at risk for developing neurological injuries, particularly carpal tunnel syndrome (CTS). CTS results from chronic compression of the median nerve as it passes through the rigid carpal tunnel in the wrist [8]. The common symptoms for CTS are numbness, tingling, and pain in the palmar and lateral aspects of the hand; weakness of hand muscles may occur as the condition progresses.

The poultry processing industry employs a large number of Latin American immigrants [5, 9]. These are vulnerable workers who are often recent immigrants without documents, with limited education and English language proficiency. They rarely advocate for their rights due to language barriers, lack of knowledge of these rights, and a fear of being deported. In western North Carolina, the majority of poultry workers are from Mexico and Guatemala. Cartwright et al. [10] report that the prevalence of carpal tunnel syndrome (CTS) among immigrant Latino poultry processing workers (8.7%) is greater than that among other immigrant Latino manual workers (4.0%). This compares to a CTS rate in the general US population of 3.1% [11].

Explanatory models of illness (EMs) [12, 13] provide a conceptual framework for understanding worker beliefs about an occupational injury and illness. This approach has been used in analyses of Latino farmworker beliefs about pesticide exposure [14], residential pesticide exposure beliefs among Latino women in farmworker families [15], green tobacco sickness among Latino farmworkers [16], and occupational skin disease among Latino farmworkers [17]. EMs have provided the framework for analyses of pesticide beliefs

among American farmers and extension agents [14, 18]. An EMs approach has been used in investigating beliefs about chronic conditions common among Latino immigrant workers, such as tuberculosis [19], and diabetes [20].

The EMs framework is based on the idea that individuals make sense of a condition or illness in the context of their knowledge and experience, and based on this understanding choose and evaluate possible treatment or prevention strategies [12, 13]. EMs address different aspects of illness, including: name, causes, symptoms, physiology, treatments, and health consequences. EMs may be only partly articulated, inconsistent and even self-contradictory. Individual EMs can vary in content. To the extent that individuals' EMs involve shared beliefs, these persons share a common cultural and social orientation [21]. The aspects of people's EMs of illness predispose them to different health behaviors.

The EMs of lay persons are often oriented to the significance of the condition to the patient or family, focusing on the social aspects of the sickness, including the ability to fulfill appropriate roles in the family (e.g., producing income) and community. These lay EMs may overlap with the EMs of health professionals, but differences generally exist between lay and professional EMs. For example, the green tobacco sickness EMs of Latino farmworkers emphasized the anorexia and insomnia, and consequent impaired work performance that resulted from this occupational illness; health care providers identified nausea and dizziness as the most relevant symptoms [16].

This qualitative analysis uses an EMs framework to describe the beliefs of immigrant Latino poultry processing workers with CTS surrounding the causes, symptoms, physiology, treatments, quality-of- life and health implications of CTS. It also compares the CTS beliefs of Mexican and Guatemalan workers. Understanding these beliefs is important for the development of processes to prevent and treat CTS among Latino manufacturing workers.

METHODS

Semi-structured in-depth interviews were conducted with 15 Latino workers who were working in poultry production at the time of the interview. Participants were selected from a larger study (n=287) conducted to assess the prevalence and incidence of illnesses among these workers [10, 22, 23]. Participants for the larger study were recruited in four counties (Burke, Surry, Wilkes, and Yadkin) in western North Carolina from June 2009 through November 2010. These counties are rural and considered "new settlement" areas for Latino residents [24]. Study participants completed a survey to access their personal characteristics, work organization, and symptoms or injuries. Participants then attended a research clinic at which physicians examined them for any musculoskeletal and dermatological injuries.

Recruitment

Participants in the larger study had to be 18 years or older, self-identified as being Latino or Hispanic, and a current worker in poultry production. Those participants diagnosed with possible or definite CTS by a neurologist were eligible for this qualitative study [10]. A possible or definite CTS diagnosis was based on self-reported symptoms and nerve conduction. First, participants reported whether they had numbness, pain, or weakness in their hands for two or more days in the previous month using Katz hand diagrams [25]. Two clinicians, blinded to the participants' occupations and nerve conduction results, scored the hand diagrams as unlikely (0), possible (1), probable (2), or classic (3) for CTS. Second, nerve conduction results were used to compare peak median and ulnar sensory latencies. If the median was less than 0.49 ms longer than the ulnar, it was scored 0; if it was 0.50 to 0.79 ms longer, it was scored 1; and if it was greater than 0.80 ms longer, it was scored 2. The symptom score and nerve conduction score were added and a total score of 1 or 2 was defined as possible CTS, and 3 as definite CTS [10]. Participants diagnosed with possible or definite CTS were placed in random lists stratified by gender and national origin (Guatemala and Mexico). Participants were approached in random order until approximately equal numbers of men and women and Guatemalan and Mexican participants from across the study counties agreed to participate. Interviewers contacted participants

and explained the nature of the in-depth interview study. Appointments were made with those who agreed to participate. Participants who gave signed informed consent and completed the audio recorded interview were given an incentive of $20. The study protocol was reviewed and approved by the Wake Forest School of Medicine Institutional Review Board.

Data collection

Interviews were conducted in Spanish by a native Spanish speaking interviewer who had experience and training in qualitative interview techniques and who was trusted by residents of the study area. Interviews were conducted from September, 2009 through July, 2010. Interviews took approximately 60 minutes to complete. Interview guides were constructed to reflect the Explanatory Models of Illness framework [12,13]. Interview guides asked workers to describe their jobs and how their work was organized, how their jobs affected their health, their self-care behaviors and barriers to prevention and treatment, and injuries and illness reporting they had. Probes were used to elicit descriptions of their working conditions, and their perceptions of the health consequences of their jobs. The EM portion of the interview included seven sets of questions designed to elicit the worker's name for the condition, the explanation of etiology, symptoms attributed to the condition, the expected natural course of the condition, pathophysiology, best treatment, and effects on quality of life.

Data analysis

The interviews were recorded, transcribed, and translated to English. An iterative data analysis process was used, with analysis starting as soon as data collection began. Interview transcripts were read by the study team, and topics were identified for further exploration by the interviewers. Once all data were collected, a list of codes was constructed for topics of interest, with mutually exclusive definitions established. The primary codes used in this analysis were those corresponding to the seven EMs components.

Transcripts and notes were entered into Atlas.ti (Version 6.2) text analysis software; codes were applied to segments of text by one of the study team members. The coding was reviewed by two other team members, and corrections and additions were made. A variable-based analysis was used, such that all segments associated with relevant codes were extracted, reviewed, and summarized. Revisions of these summaries were made until they adequately reflected the interview content. Threats to validity (e.g., focus on extreme cases) were considered in constructing and revising the summaries [26].

RESULTS

Participant characteristics

Participants included 8 women and 7 men (Table 1). They were all from either Guatemala or Mexico and ranged in age from 21 to 60 years of age. Most had less than 6 years of education. About half had been living in the US for less than 10 years, and about half had been working in poultry processing for more than 5 years. Participants worked at variety of jobs: 1 in receiving, 1 in unloading, and 2 in hanging; the primary job for 3 was cutting, with 2 trimming, 1 deboning, 3 in packing, and 2 in sanitation.

CTS Explanatory Model

The participants presented a fairly consistent explanatory model of CTS which largely reflects the current western biomedical understanding of the condition. This model outlines the name, causes, symptoms and treatment of CTS as described and understood by the workers. Mexican and Guatemalan participants generally agreed on the name, causes, symptoms of CTS, and effects on quality of life. Mexican and Guatemalan participants differed in some aspects of their understanding of the pathophysiology and treatment of the condition.

Name: Although some workers called the illness carpal tunnel syndrome, the majority referred to the condition as hand pain (*dolor de las manos*). The participants were also inclusive when discussing the location of the pain associated with CTS. Almost all noted pain in the hands and wrists. However, many also included pain in the arms, shoulder, and back when discussing CTS.

Causes: Participants attributed the causes of CTS to the nature of their work environment in the poultry processing industry and how that work affects them physically (Table 2). Participants discussed five inter-related characteristics of their work environment as salient for developing CTS: repetition, line speed, weight, cutting, and cold. Participants discussed how the repetition of the same set of movements resulted in this condition.

> …from so much movement, from the time I start holding the pistol grip to wash the machines. We start at 7:30 p.m. till 2:00 in the morning. So, let's say we start from that time. We stop using the pistol grip for 30 minutes and use the brush. We have to brush the area where there is grease and our hands don't really get a change to rest, not even for a little bit because we put the pistol grip down and pick up the brush. We have our hands covered by cloth and rubber gloves, but our hands never get to rest, not even for a little while. When we pick up the brush, we have to do it hard again and again. It's almost the same movement. That's why - it's from using so much strength to do it and the strength goes away. (P21, Guatemalan, sanitation)

This sentiment was echoed by a participant who packs chicken pieces in trays and seals them for shipment, who added the effect of lifting heavy weights.

> I think my wrist problem is caused by doing the same job all day long. So then, I think that your muscles get tired. I think your bone might get worn down. Yes, you do the same thing all the time, and I don't think that's normal. How can I explain? Sometimes, the packs are very heavy, and you have to strain with one hand to pick it up. Let's say, you pick it up with one hand and use the other hand to grab it from there. If it were exercise outside of work, it wouldn't be bad because you can exercise, but it is heavy. (P05 Mexican, packing)

Related to the repetitive nature of the job causing CTS were beliefs that the speed of the production line increased the risk of developing CTS. For example, a participant reported,

> Well, working too much is when I'm catching chickens and there are just seven of us, and we have to do it very quickly. Or sometimes, when we are dumping too much and the line is moving very fast. We have to do the job very quickly and, sometimes, I start getting pain right here. (P10, Guatemalan, receiving)

Another component of the repetitive work discussed by the participants was cutting with knives and scissors. Some participants further specified that CTS resulted from needing to use additional force when the knives or scissors were not sharp.

> I think it's from cutting the neck because you have to put your knife in it and pull up, but sometimes the blade gets stuck. That's what I think causes the problem with my hands. That's the only one that makes your hands do awkward movements. (P10, Guatemalan, receiving)

> It's [CTS] from the knife and scissors because you have to cut and cut and use the knife over and over again. It's different too because I'll use it and then, you might use it. And you have to clean it and sharpen it when it's dull. (P30, Guatemalan, trimming)

> Imagine how you get *calambres* [cramps] from the knife. And when your knife isn't sharp, you can forget about it! You might even end up crying on the line. (P30, Guatemalan, trimming)

The workers noted that the work exposed them to cold, as the chickens had to be kept cold to maintain freshness. The cold from the birds added to the risk of injury to their hands.

> And another thing is that if the tenders are very cold, I think that penetrates into your hands. When they aren't injected [with saline for flavor], they aren't as cold, but if they are injected or if they inject them with the water they use, they are colder and we feel that more. That's what we all say, that when the tenders are colder our hands hurt more. (P09 Mexican, packing)

> Because it was very cold and you're there standing up…do you know how cold it is there? I couldn't tell you how cold it is there, but it's very cold and if you're standing there doing nothing, you feel like the cold is even getting into your bones. You feel like you are going to freeze. . . . Sometimes, they give us the wings with chunks of ice. Imagine how your hands hurt from the cold, especially if you need to remove chunks of ice. (P07 Mexican, packing)

Some workers also attributed the development of CTS to their physical weaknesses, such as fatigue and not having enough strength.

> It could be from…how do you say it…*flojera de las manos*. I don't know. I don't know how to explain it. What I'm saying is that your hands aren't strong enough. It could be from that, too. (P19 Mexican, hanging)

Physiology: Workers attributed their illness to specific physiological processes. Some referred changes in their bones, such as the cold getting into their bones or their bones getting worn down.

> I think my wrist problem is caused by doing the same job all day long. All day long. All day long. So then, I think that your muscles get tired. I think your bone might get worn down. Yes, you do the same thing all the time and I don't think that's normal. (P05 Mexican, packing)

Others referred to the blood being cold, and veins moving or stretching.

> I call it *cansancio de los nervios*. I feel that the nerves…by the time we get out of work, I feel debilitated from the hard, physical movements I do with my hand. I feel that all the strength is gone. I feel that the strength of the blood is the problem that I feel. (P21 Guatemalan, sanitation)

> I imagine that with the heat and so much movement the temperature on the inside starts to get too hot. So, when you're working, you don't feel the pain. But when you rest, you do feel it. It starts to cool. It's like the grease from the machines because when the machine isn't working, it doesn't melt. But when we start working and putting hot water on it, it does melt because it gets hot. That's why I imagine that the bones do the same thing. (P21 Guatemalan, sanitation)

As noted in the previous quote, another physiologic factor leading to CTS discussed by the participants reflected beliefs about the mixing of hot and cold. Participants felt that working in the cold and handling cold materials could result in CTS if they too quickly placed their hands into anything warm.

> Maybe getting rid of the cold [would cure hand pain]. I'd say that's how because if you were working in a warm place at another company, like in furniture, I think it would be good because you'd be working in the heat, in a closed environment where you aren't getting exposed to the air conditioning that makes everything cold. (P30, Guatemala, trimming)

Symptoms: The majority of participants reported symptoms in their hand and wrist, with some mentioning symptoms in their arms and shoulders. The common symptom reported was pain. Some participants described the pain as being stuck by a piece of iron or pin.

> Sometimes I hurt a lot at night, and I'm awakened by the pain. Sometimes I'm profoundly asleep, and I wake up because of the pain. (P28 Guatemalan, cutting)

> My wrists hurt and that's pain there, and there's a pain in my arm. In my wrists, it's mild. They don't hurt me a lot. Well, in my arm it feels like a piece of iron is sticking in it all day. I mean that it feels like my arm is a scale and I'm holding up a kilogram all the time. My arm feels tired. (P05 Mexican, packing)

Participants explained the quality of the pain by referring to several different sensations. Over a third of the participants described the symptom as though their hands and arms "went to sleep."

> When it [arm] goes to sleep, it hurts a lot. Sometimes, when I'm sleeping and I roll over, I can feel that it happened; and it hurts. (P30 Guatemalan, trimming)

Participants who stated that their hands and arms went to sleep also stated their hands and arms tingled or were numb.

> Well, the pain in your hands wakes you up. You feel them tingling. They go to sleep. (P11 Mexican, cutting)

> My hands feel numb. I feel the pain in my hands when I'm doing the movements to pack and lift the trays. I feel like a sticking pain in my hands as if I had a needle or pin stuck in my hand here. (P09 Mexican, packing)

Finally, participants reported popping and swelling in their hands.

> It pops because it's bad. There was a time, over in cooked products, that I couldn't handle the boxes because it hurt and I couldn't stand anything. I could only lift the boxes up. (P08 Mexican, unloading)

Treatments: The treatments used by the participants can be assigned to three categories of over-the-counter, traditional, and medical treatments (Table 3). The ways in which the participants reported treating their CTS was generally similar for those from Guatemala and Mexico. However, participants did differ by nationality in some treatment methods.

Regardless of country of origin, participants used similar over-the-counter treatments to relief the symptoms of CTS. The over-the-counter treatment most frequently mentioned were pain relievers in pill form, such as ibuprofen.

> Once when I had first started and my hands were bad and the other was when I went to ask for a pill for the pain. And the only way to obtain the pill was for the doctor to see me. I mean, I didn't go and see him because I wanted to; I went because I had to. (P09 Mexican, packing)

> Let's say that when I get to work and warm up my muscles, then the pain goes away. Later, it starts hurting a little worse and then, it goes away again. So, that's how it goes. If it hurts a lot, I take pills. I take ibuprofen and one thing or another, it either goes away or I forget about it. (P05 Mexican, packing)

Ointments that produced heat were widely used by Guatemalan and Mexican participants to ease pain. These included over-the-counter remedies that were used according to their labels, such as brand-name products as Bengay®, IcyHot®, and Cofal®. They also included ointments that were produced for veterinary use that were used off-label, such as La Tia® (*Unguento Veterinario De La Tia Ointment*).

> Sometimes, I've applied creams called "Icy Hot." I've used that and felt how it got absorbed into my skin. Or I've also applied a cream from Mexico called "La Tia," that also helps a lot. It helps with the

> inflammation. They are veterinary ointments which make the inflammation go away. (P05 Mexican, packing)
>
> Yes, Bengay®. This afternoon, I'm going to apply a little bit because my whole hand hurts. And in the morning, I'm going to be ready to work. (P22 Guatemalan, hanging)

Other forms of heat, particularly soaking hands in hot water, were also used to treat CTS.

Both Guatemalan and Mexican workers used wraps to treat the pain, believing that the pressure of the wraps provided kept the nerves and muscles tight and thus relieved the pain.

> I've just applied wraps. I wrap it here so that it won't hurt and it does calm down a little bit. I think that happens because of the force the nerves make. It's like the nerves get loose, but I put on a wrap here and I feel an improvement. (P10 Guatemalan, receiving)

Massage, a traditional remedy, was commonly used to relieve the pain by Guatemalan and Mexican participants. Participants massaged their hands, usually after their workday, in order to alleviate the pain. Several indicated that they had received hand massages from traditional healers, including a *sobador* or *curandero,* for CTS.

> I would come home and ask my husband to massage my hands because they hurt a lot. That's what I had to do. . . . I had to go to a *sobador*, those people who massage your hands. I've gone to visit one of them before . . .. They also put come warm cream on you, and they start to rub your hands. They are people who are trained especially for that. Sometimes, you have a pinched nerve that is causing you pain; and they make it better, which makes the pain go away. (P11 Mexican, cutting)

All but one of the Guatemalan but none of the Mexican participants reported use of vitamins as a treatment for their hand pain. They believe that the vitamins give then strength and will make the pain go away. Several Guatemalan participants indicated that they used vitamin injections.

> In order to have a longer period of good health, I think that I should take some vitamins. I should give my body some vitamins so that I will feel better, since I already have the illness and it's not going to go away. The most I can do is calm it down. (P22 Guatemalan, hanging)
>
> I used to get some [vitamins] that were called Nervio-Bron. They'd send it from Guatemala, and you found someone who could inject it. You went ahead and took it. It helps you. I had an aunt who always felt weak and tired. So, she recommended it to me and I used it. It did help me. (P31, Guatemalan, deboning)

Mexican participants were more apt to discuss a medical treatment. Four mentioned receiving an injection from a physician. Three participants who discussed getting an injection from a physician referred to a physician working for one of the poultry processing companies as the physician who provided this therapy. The other participant referred to a private physician.

> I don't even remember what the doctors said it was called. They even gave me an injection right here and after that, it didn't hurt anymore. Since I've changed jobs from there it hasn't hurt. . . . [Company Name] doctor did. (P07 Mexican, packing)
>
> I went to see the doctor. He gave me an injection and the pain here went away. Sometimes, you take a pill for the pain to see if it will lessen. (P09 Mexican, packing)

Several of the Mexican, but only one of the Guatemalan, participants discussed having surgery to treat CTS. When speaking about surgery, participants indicated that employers would allow individuals who had surgery to return to work, but they would not hire individuals who had had surgery.

Quality of Life: Participants reported how CTS affected their everyday life. Many reported that the pain either would not let them sleep or would wake them up at night, which consequently affected their performance at work and at home. They also reported the constant pain in their hands as annoying, causing them to be in a bad mood as a consequence of the pain. Some reported that the pain made them feel tired or sluggish and they felt like they did not want to do anything except lie down.

> You can't stand the pain. All you want to do is lie down and rest, and not do anything. (P30 Guatemalan, trimming)

Performing household chores and simple personal tasks such as dressing, undressing, and combing hair was difficult. It was physically difficult for some to lift their children because of the pain, so they would have to tell their children that they were tired or ask someone else to pick them up. Others reported not being able to perform their work properly or calling in to work sick because of the hand pain.

> [The hand pain] affected me a lot because I couldn't do the things I needed to do. This little girl is the one who helped me remove my blouse. I would just bend down and she would take it off for me. (P09 Mexican, packing)

> Changing my clothes or when I take a shower, I always feel pain. If I want to scrub myself, I feel pain. (P21 Guatemalan, sanitation)

Future Impact: A third of the participants believed they would have to quit their job to stop having CTS. However, they also stated that they could not stop working because they needed an income.

> To cure that problem, I will have to stop working. Because if I stop working, [my hand] might start to get its energy back, or I need to let my hand rest during the whole job. (P21 Guatemalan, sanitation)

. . . you earn money by suffering pain. (P20 Guatemalan, cutting)

Several participants stated that if they keep doing their job, the pain would get worse, possibly to the point of their permanently being disabled.

> What I think is that it's better to stop working so that, in that way, I have a little better health. If I keep working, it's going to get worse; and it's going to keep hurting more and more. It's going to hurt so bad that I'm not going to be able to stand it. (P22 Guatemalan, hanging)

> If I continue like this with my problems, the moment will arrive that I won't even be able to move, I won't even be able to do things for myself - take care of my home. There are so many things that you have to do with your hands; and when the moment arrives that you can't do them because I know what having CTS is like and I know the consequences that are going to happen and that the time could come when I wouldn't be able to move, that I might not be able to take care of myself. I know that those could be the consequences. (P05 Mexican, packing)

DISCUSSION

These poultry processing workers with diagnosed CTS present a very clear understanding of its causes, its treatment, its long-term consequences, and its cure. The CTS EMs of these Guatemalan and Mexican workers generally reflect current western biomedical understanding of this occupational injury. As with lay people from most societies, some part of their CTS EMs are not completely congruent with medical knowledge.

For CTS among these workers, these components include the pathophysiology of CTS and some traditional therapies that they use to treat CTS.

CTS is a common occupational injury among all poultry processing workers, especially among those who are Latino immigrants [10]. Many of these immigrant Latino workers are undocumented, making them particularly vulnerable, as they lack access to most health care safety net services. CTS can result in long-term disability for these workers. Even among those who are documented, most do not qualify for workers compensation in North Carolina because state rules require that such claims be based on specific traumatic injuries. The participants in this study all had CTS as diagnosed by neurologists using stringent criteria [10, 25, 27].

The participants are generally consistent with the biomedical model about the actual causes of CTS, particularly characteristics in their work environments: line speed, repetitive motions, and dull tools. They also consider cold temperature to be a cause of CTS. Although this may reflect beliefs related to humoral medicine [28, 29], cold temperatures are now considered a risk factor for CTS within a medical model [30]. Beyond the work environment, participants also state that their own physical failings, whether being weak or fatigued, cause CTS. Latino workers in other industries, particularly agriculture, discuss the importance of physical strength or a strong constitution as protective of occupational injury or illness, such as pesticide poisoning [14, 31].

Although realistic about the actual cause of CTS, participants understand that they can do little to prevent or cure CTS in the current context of poultry processing. The best ways to reduce the incidence and prevalence of CTS are to reduce the speed with which repetitive motions are required (reduce the line speed), and to include rest breaks in the work schedule [32, 33]. However, such changes would raise the costs of poultry processing. In fact, a current policy proposal from the US Department of Agriculture, known as “Modernization of Poultry Slaughter Inspection,” will give companies the option to increase, rather than decrease, line speeds for poultry processing workers [34-36].

The manner in which the participants treat CTS reflects medical pluralism documented for Latin America [37, 38]. Participants select from a range of treatments from multiple health care traditions. Over-the-counter pain relievers (non-steroidal anti-inflammatory drugs) reflect current western medical practice. Participants used standard over-the-counter ointments, off-label ointments meant for livestock, and warm water as treatment, although a recent biomedical review recommends that heat therapy not be used to treat CTS, as it is less effective than placebo [39]. Participants draw on biomedicine in the form of injections and surgery, although the injections appear to be imposed by employer hired physicians, and surgery may mark an individual for job loss. Mexicans use western medical practitioners more than Guatemalans. Most participants use massage, but massage is obtained informally from family members, as well as from traditional practitioners, particularly *sobadores* [40, 41]. Massage is not considered an effective treatment by biomedicine [39]. The use of *sobadores* among the participants extends beyond those being treated for CTS; they make conscious decisions about when the therapy is appropriate for this condition. Guatemalan participants use vitamins to treat CTS, while Mexican participants do not. The use of vitamins in Guatemala is long standing [37]. Injection of vitamins reflects observations by others about the value Latinos place on this mode of treatment [42]. Vitamins or injections of substances other than steroids are not considered effective by biomedicine [39].

These workers are creative in seeking relief for CTS. Other than surgery, little helps with the pain of CTS, and surgery, which is considered effective by biomedicine [39] but may mark them for job loss. Therefore, as with the use of diverse therapies for arthritis [43], it is difficult to refute the use of any of the therapies discussed. However, the use of these therapies may mask the long-term effects of this occupational injury.

The participants’ models of CTS include the belief that it will have long-term negative effects on their health. Although they do know how to limit future injury through quitting their jobs in the poultry processing plant, they face the conundrum of needing to work to live and support their families. However, the work they are doing is destroying their health and diminishing their quality of life. They have few other options for employment because few other jobs are available and these jobs often require documents. This is the core of occupational

injustice [44, 45]. Policy change reducing line speed and providing rest breaks is needed to limit the occupational exposures of these workers.

This study should be considered in light of its limitations. As with many qualitative studies, the small sample, with participants from only two Latin American countries who work in one industry and who live in one area, may limit generalizability to other populations. However, the analysis was conducted among a diverse, vulnerable, and understudied group of workers, which provides credibility in the results. An additional strength is that all participants were diagnosed as having CTS by neurologists using stringent diagnostic criteria. This analysis also provides insightful information that would be difficult to assess through quantitative methods.

Delineating the models of Latinos for work injuries such as CTS is important for improving occupational health and safety. Analyses show that the prevalence and incidence of CTS among these workers is high [10, 46]. The CTS EMs of these workers is largely in accordance with current medical knowledge about the causes, treatment, and long-term sequelae of CTS. However, due to their vulnerable status, organizing and asking for the solutions is not possible. Workers at poultry processing plants in western North Carolina have attempted to organize since 1996, but without success [47-49]. Safety training is not the appropriate response to the problem of CTS among poultry processing and other vulnerable workers, as they know the solutions to this occupational injury but cannot implement them. The most proximate solution would be slowing the line speed and providing rest breaks, or hiring additional workers. Policies are needed that force such changes on employers; yet current policy proposals will increase these speeds [50]. The need these vulnerable workers have for a paycheck keeps them at these jobs, which they consider to be good jobs. The occupational injustices faced by these workers requires continued research to document the prevalence and risk factors for CTS and to develop needed occupational safety policy.

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Table 1. Participant Characteristics, Latino Poultry Processing Workers with Carpal Tunnel Syndrome, 2009-2010 (n=15).

Participant Characteristics	N	%
Country of origin		
Guatemala	7	47
Mexico	8	53
Gender		
Female	8	53
Male	7	47
Age		
20 to 29	4	27
30 to 39	6	40
40 years or older	5	33
Education		
6 years or less	10	67
7 or more years	5	33
Years in US		
Less than 10	6	40
10 or more	9	60
Years in Poultry Processing		
Less than 5	7	47
5 or more	8	53
Job Tasks		
Receiving	1	7
Unloading	1	7
Hanging	2	13
Cutting	3	20
Deboning	2	13
Trimming	1	7
Packing	3	20
Sanitation	2	13

Table 2. Beliefs about the Causes, Symptoms, Quality of Life, and Future Impacts of Carpal Tunnel Syndrome among Latino Poultry Processing Workers with Carpal Tunnel Syndrome, 2009-2010 (n = 15).

Causes, Symptoms, Quality of Life, and Future Impacts	N	%
Causes		
Work Environment		
Repetition	11	73
Line Speed	8	53
Weight	6	40
Cutting	8	53
Cold	6	40
Physical Weakness		
Fatigue	6	40
Lack of strength	3	20
Physiological		
Blood gets cold	1	6
Veins move or stretch	4	27
Bones get worn down	1	6
Body gets worn down (like a machine)	2	13
Hot-Cold	7	47
Symptoms		
Location		
Hands/ Wrist	13	87
Arms	6	40
Shoulder	5	33
Back	6	40
Sensation		
Pain	14	93
Asleep/Tingle/Numb	6	40
Popping/Swelling	4	27
Quality of Life		
Awakened by pain / can't sleep	7	47
Limited in performing house chores	6	40
Limited in performing simple tasks	5	33
Bad mood/shame	2	13
Poor quality of work and not being able to work	3	20
Cannot pick up children and things	3	20
Tired or sluggish	5	33
Not do anything	3	20
Constant pain	8	53
Lack of mobility	3	20
Future Impact		
Have to quit job	6	40
Get worse	5	33
Constant pain	3	20
Being incapacitated	3	20

Table 3. Treatments used for Carpal Tunnel Syndrome among Latino Poultry Processing Workers with Carpal Tunnel Syndrome by Guatemalan and Mexican Nationality, 2009-2010 (n = 15).

Type of Treatment	Total		Guatemalan		Mexican	
	n	%	n	%	n	%
Over-the-counter						
Pain relievers in pill form	9	60	3	43	6	75
Ointments to produce heat (on label)	7	47	2	29	5	63
Wrist band	5	33	2	29	3	38
Traditional						
Ointments to produce heat (off label)	2	13	0	-	2	25
Heat	5	33	3	43	2	25
Massages (including by a *sobador* or *curanderos)*	11	73	5	71	6	75
Vitamins (including injection)	6	40	6	86	0	
Medical						
Injection	3	20	0	-	3	38
Surgery	3	20	1	14	2	25

Project Publications

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Inclusion of Women and Minorities

Please see gender and minority inclusion table.

Inclusion of Children

This research included children ages 18 through 20 years.

Program Director/Principal Investigator (Last, First, Middle):

Inclusion Enrollment Report

This report format should NOT be used for data collection from study participants.

Study Title: Occupational Injuries of Immigrant Poultry Workers: Development and Progression

Total Enrollment: 742 **Protocol Number:**

Grant Number: R01 OH009251

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race				
Ethnic Category	**Females**	**Males**	**Sex/Gender Unknown or Not Reported**	**Total**
Hispanic or Latino	318	424	0	742 **
Not Hispanic or Latino	0	0	0	0
Unknown (individuals not reporting ethnicity)	0	0		0
Ethnic Category: Total of All Subjects*	318	318	0	742 *
Racial Categories				
American Indian/Alaska Native				
Asian				
Native Hawaiian or Other Pacific Islander				
Black or African American				
White				
More Than One Race				
Unknown or Not Reported				
Racial Categories: Total of All Subjects*				*

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)				
Racial Categories	**Females**	**Males**	**Sex/Gender Unknown or Not Reported**	**Total**
American Indian or Alaska Native				
Asian				
Native Hawaiian or Other Pacific Islander				
Black or African American				
White				
More Than One Race				
Unknown or Not Reported				
Racial Categories: Total of Hispanics or Latinos**				**

* These totals must agree.
** These totals must agree.

Materials Available for Other Investigators

This project has produced no materials available for other investigators.