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Agricultural work and chronic musculoskeletal pain among Latino farm workers: the MICASA Study

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Abstract

Background—Agriculture poses varied dangers to hired farm workers in the U.S., but little information exists on occupational risks for chronic musculoskeletal pain. We examined common work positions, such as kneeling, carrying heavy loads, and repetitive motion that may increase the risk for chronic musculoskeletal pain.

Methods—MICASA is a population-based study of occupational exposures and health in hired farm workers in California. This analysis includes 759 participants, 18–55 years old, engaged in farm work and residing in Mendota, CA. Chronic pain was defined as pain lasting six weeks or longer at specific body sites (back, knee, hip, etc.) over the entire farm work career.

Results—Mean age was 37.9 years. 65% participants were born in Mexico, 27.7% were born in El Salvador, and 4.2% were U.S.-born. Chronic pain was associated with older age and female sex. After adjustment for age, years working in agriculture, and smoking, stooping/bending >30hrs/week among both men (OR=2.49, 95%CI:1.03–5.99) and women (OR=2.15, 95%CI:1.04–4.46) was associated with chronic hip pain. Driving tractors or other heavy farm equipment >60 hrs/week was associated with increased odds of chronic hip pain (OR=2.16 95%CI: 1.02–4.54) among men. We also observed significant associations with kneeling or crawling >35 hrs/week among women for both chronic back pain (OR=2.96 95%CI: 1.27–6.93) and knee pain (OR=3.02 95%CI: 1.07–8.50), respectively.

Conclusions—Chronic musculoskeletal pain is prevalent among farm workers and is associated with common work positions. Further research should focus on developing preventive interventions for tasks associated with increased pain risk. These interventions should be targeted to specific types of agricultural tasks.

Keywords

agriculture; hired farm workers; chronic musculoskeletal pain; working posture; MICASA

Background

Farming is an arduous occupation with several adverse health impacts on farm workers that increase their risk for chronic musculoskeletal pain. Although there are many epidemiologic studies reporting on acute injuries in agricultural populations [Lewis, et al. 1998; Lyman, et al. 1999; Meyers 1998], few studies have investigated the relationships between chronic musculoskeletal pain and cumulative exposure to physical stress, in particular, stress

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associated with working posture. In California, 24% of farm workers reported at least one musculoskeletal problem in 2003–2004, and the number of cases has increased each year since 1999 [Carroll, et al. 2005]. In the California Agricultural Workers Health Study (CAWHS), the most commonly reported musculoskeletal problems were back pain (22%), knee pain (15%), foot pain (15%), and hand pain (14%) [Villarejo, et al. 2000]. Among Kansas farm workers, the 12-month period prevalence of musculoskeletal pain was 37.5% for low back pain, 25.6% for shoulder pain, 23.6% for knee pain, and 22.4% for neck pain [Rosecrance, et al. 2006]. Park and colleagues reported a significantly higher prevalence of low back pain compared to the general working population [Park, et al. 2001]. Holmberg and colleagues reported similar results as well among farmer and rural non-farmers [Holmberg, et al. 2003]. Osborne and colleagues pointed out that musculoskeletal disorders were more common in farmers working longer hours among Irish farmers and noted the relative paucity of published work addressing the anatomical regional distribution of musculoskeletal disorders [Osborne, et al. 2010].

Musculoskeletal pain develops from repeated exposures to a stressor among farm workers [Davis and Kotowski 2007]. Cumulative forces may cause soft tissue damage, leading to inflammatory response and pain [Fathallah 2004; Rempel, et al. 1992]. Long-term exposure to heavy physical work, heavy lifting and carrying, whole-body vibration, and work in awkward postures with trunk flexion may be risk factors for low back pain [Davis and Kotowski 2007; Holmberg, et al. 2003; Meyers, et al. 2004; Rosecrance, et al. 2006]. Kneeling, bending, heavy lifting and carrying, vibrations from tractor driving and work in uncomfortable postures were found to be associated with hip pain and knee pain [Davis and Kotowski 2007; Holmberg, et al. 2003; Osborne, et al. 2010]. Risk factors for upper extremity pain include poor wrist postures, repetitive gripping, and high hand forces [Davis and Kotowski 2007]. Neck pain may occur when farm workers pick fruit, prune grapes, or perform other tasks above their head [Davis and Kotowski 2007]. Stooping is a major factor for low back pain among crop farm workers [Kirkhorn, et al. 2010].

Latino workers in the U.S. industry numbered 30.3 million in 2010 according to the Bureau of Labor Statistics. In 2004, 30.2% of U.S. agriculture workers were Mexican, and 90% of California farm workers were immigrants [DHHS 2004; Schenker 2010]. California agriculture is heavily dependent on hired Latino farm workers, who provide approximately 85% of farm labor [Schenker 1996]. These farm workers come predominantly from Mexico or Central/South America [Schenker 1996; Schenker 2010]. Despite the increased importance of hired Latino labor in California agriculture, there are few reports in the literature on the health status, including occupational health, of this population [NAWS 2005; Schenker 1996; Schenker 2010; Villarejo 2003; Villarejo and Baron 1999; Villarejo and McCurdy 2008]. Understanding the magnitude of musculoskeletal problems and associated risk factors (particularly working postures) in this population is critical for educating farmers and farm workers, informing policy makers, and implementing effective public health interventions to reduce musculoskeletal pain.

The purpose of the present study is to characterize the association between agricultural work and chronic musculoskeletal pain among a community-based sample of both male and female Latino farm workers in California. This analysis examines common work positions, such as kneeling, stooping, carrying heavy loads, driving tractors and other heavy equipment and repetitive motion, which may increase the risk for chronic musculoskeletal pain.

Methods

Sample description and eligibility

This study is an analysis of baseline (cross-sectional) data from a population-based prospective cohort study of occupational exposures and health in California Latino farm workers. Participants in this study were 420 men and 339 women, 18–55 years old, who identified themselves as Mexican, Central or South American, Hispanic or Latino, with at least one member of the household engaged in farm work for at least 45 days in the last year and residing in Mendota, CA at the time of the interview. Mendota was chosen as the research site since it is located in Fresno County, which leads agricultural production in California, and has a large proportion of immigrants and hired farm workers [CDFA 2011]. The primary commodities produced in the area include melon, tomatoes, nuts, grapes and cotton. We examined common work positions, such as stooping or bending, kneeling, carrying heavy loads, and repetitive motion that may increase the risk for chronic musculoskeletal pain.

Sampling and recruitment

To obtain a representative sample of farm worker families in Mendota, we employed a two-stage household enumeration process. Initially, 62 census blocks in Mendota were randomly selected to provide the sampling frame. In the first step of the enumeration, all dwellings within the selected blocks were mapped, and in the second stage, residents within each mapped household were enumerated. The enumerator obtained information on age, gender, nationality, farm work, and years living in Mendota for each adult member of the household. Further details of the enumeration procedure are documented elsewhere [Stoecklin-Marois, et al. 2011]. A random list of these eligible, enumerated households was created, and households were approached and asked to participate in the study. In total, 467 households, comprising 843 adults out of a pool of 1039 (196 people declined) were recruited and completed a baseline interview, yielding a response rate of 81%. Of these, 759 individuals answered “yes” to the question “have you ever worked in agriculture?” and were included in this analysis.

Data collection

All data collection was done by a local field team in Mendota. The interviewer-administered questionnaire assessed demographic characteristics; occupational and environmental risk factors, including common work postures; smoking status; acculturation; and a variety of health outcomes, including musculoskeletal problems. Interviews were conducted from January 2006 to April 2007 by trained interviewers in Spanish. Written consent was obtained from each participant. Subjects received a \$15 gift card for completing the interview. All study procedures were approved by the University of California, Davis, Institutional Review Board.

Outcome measurement

Musculoskeletal pain was assessed at six sites: low back, hip, knee, neck, hand and finger. Participants were first asked if they ever experienced pain at these sites. Those who responded affirmatively were then asked if the pain lasted for six weeks or more, was due to a specific injury, and whether they were unable to perform normal tasks in the past year due to pain. For analysis, chronic pain at each site was defined as pain lasting six weeks or longer reported over the farm work career.

Exposure measurement

The primary exposure measurements were self-reported assessments of postures and activities over the entire farm work career. Participants reported the frequency of engaging in these postures/activities as number of hours per week. These included engaging in repeated use of manual tools or making repetitive motions; driving tractors or other heavy farm equipment; stooping over or bending down; kneeling or crawling; walking while carrying more than 25 pounds; and standing at a counter or at a machine. Other postures assessed at interview but not included in analysis were working while lying down, operating vibrating tools and jumping from one level to another. These postures were not included since there was little variability and at least 90% of individuals reported “0” hours/week working in these positions.

Exposure variables were not normally distributed; therefore, for analysis, exposures were categorized as low, medium, and high exposure levels according to the distribution of each variable. We chose this method because biological information on which to base category cut points was not available. As the data were skewed towards zero, for each variable, 0 hours /week was classified as the low exposure level, and the remaining data were divided into approximate halves, yielding three ordinal categories for each variable.

Confounding factors

Age, gender, smoking status, years working in agriculture, country of birth, years living in the U.S., education level and family income were considered as potential confounding factors or effect modifiers. There were differences in reporting of both musculoskeletal pain and work posture exposures by gender, so all multivariable analyses were stratified on gender. Age at time of baseline interview and years working in agriculture were included as continuous variables in logistic regression models. Smoking was treated as a confounder and entered into the model as current vs. never/former smokers. Years living in the U.S. was highly correlated with years working in agriculture and therefore was dropped from the model. Education level and family income were not confounders and were not retained in final models.

Statistical analysis

Initial descriptive statistics were conducted for the outcome and exposure measures and important covariates (age, gender, smoking, and years working in agriculture). T-tests compared continuous variables, and chi-square tests were used for categorical variable comparisons. Logistic regression was subsequently employed to calculate odds ratios and 95% confidence intervals for assessing the association between work activities and postures with chronic pain at each body site. Analyses were stratified by gender to account for effect modification. Final models were stratified by gender and adjusted for age, years working in agriculture, and smoking. All analyses were conducted using SAS 9.1.3 (Cary, NC, USA).

Results

Demographic characteristics

Of the 759 participants, 55.3% were men and 44.7% were women (Table I). Median age was 37.9 years, and most were born in Mexico (65.0%) or El Salvador (27.7%). The prevalence of current smoking among men (12.4%) was more than double the prevalence reported by women (5.9%). Men had worked in agriculture for an average of 16 years compared to 10 years for women ($p<0.001$).

Twelve-month work histories were obtained at baseline interview, with 92.5% reporting agricultural work in the past year (Table II). Participants could report more than one task in

the previous year, and the most frequently reported tasks included packing/sorting (38.5%), hoeing/weeding (33.3%), picking/harvesting (24.0%), pruning/cutting (15.6%), and machine operation (13.4%). There were also gender differences by task with women more frequently reporting packing/sorting tasks ($p<0.0001$) while men were more likely to report picking/harvesting ($p<0.0001$), machine operation ($p<0.0001$), pruning/cutting ($p<0.0001$), hoeing/weeding ($p<0.0001$) and supervision ($p=0.009$).

Chronic musculoskeletal pain

The 12-month period prevalence of chronic pain for men and women was the highest for back pain (24.5%), followed by knee pain (13.7%), hip pain (12.1%), neck pain (8.9%), hand pain (7.4%), and finger pain (7.1%) (Figure 1). Women reported a higher prevalence of chronic pain at all sites except for the knee. These differences between men and women were statistically significant only for hip ($p=0.008$) and hand pain ($p=0.005$). Increasing age showed a statistically significant positive association with chronic pain at all body sites (Figure 2). Men and women over 40 years of age had pain prevalence more than twice that of the youngest age group (18–30 years) for all sites.

Years working in agriculture was directly associated with chronic pain in all anatomic sites except the back (data not shown). Nearly one-third of participants reported changing their jobs due to chronic pain, and this was consistent across all body sites assessed for pain. Additionally, among those reporting chronic pain, for each anatomic site nearly 50% reported that this pain affected their normal activities in 12 months prior to interview.

Work postures, activities and chronic musculoskeletal pain

The most frequently reported work postures at the highest exposure level were done by male and female workers engaging in repeated use of manual tools, working stooped or bent over, and standing at a counter or machine (Table III). Additionally, the highest exposure level exceeded 40 hours per week for repeated use of manual tools, driving tractors or other heavy equipment, and standing at a counter or machine.

The reported time spent in various work postures and activities varied by gender. Women reported more hours per week standing at a counter or at a machine, particularly at the highest exposure level, compared to men.

Work postures were examined as associated with specific body sites based upon *a priori* knowledge and biological plausibility. For example, repeated use of manual tools was assessed with hand and finger pain, and stooping or bending was assessed with hip, back, knee and neck pain. Repeatedly using manual tools or making repetitive motions was not associated with hand or finger pain in either men (Table IV) or women (Table V). Men showed elevated odds of hip, back and neck pain with walking while carrying more than 25 pounds, although none were statistically significant. Similarly, women showed elevated odds for hip and back pain, but again these were not significant.

Significant differences in chronic pain were found at the highest exposure levels. Driving tractors or other heavy farm equipment > 60 hrs/week was associated with chronic hip pain (OR=2.16 95% CI: 1.02–4.54) among men (Table IV). After adjusting for age, years working in agriculture, and smoking, stooping/bending >30 hrs/week was significantly associated with chronic hip pain among both men (OR=2.49, 95% CI: 1.03–5.99) (Table IV) and women (OR=2.15, 95% CI: 1.04–4.46) (Table V). However, no associations between stooping/bending were observed for chronic back, knee or neck pain for either men or women. Kneeling or crawling >25 hrs/week increased the odds of chronic back pain (OR=2.96 95% CI: 1.27, 6.93) and chronic knee pain (OR=3.02 95% CI: 1.07, 8.50) only among women (Table V).

Standing at a counter or at a machine more than 60 hrs/week showed a protective association with back pain (OR=0.33, 95% CI: 0.14–0.82) among men (Table IV) and was not associated with hip pain. There were no associations between standing at a counter or at a machine with hip or back pain observed for women. Similarly, repeated use of manual tools or making repetitive motions more than 60 hrs/week showed a protective association with finger pain (OR=0.36, 95% CI: 0.13–0.97) among women. No clear dose-response relationship was observed in this analysis.

Discussion

The goal of this study was to assess whether agriculture work is associated with chronic musculoskeletal pain among Latino farm workers. The sample of both men and women was substantial enough to support stratified analysis to assess differences by gender in both work postures and reported musculoskeletal pain. We found that chronic musculoskeletal pain, especially involving the back, knee, and hip, was common among farm workers, increased for women and with age, and was associated with common work positions and years working in agriculture. The strongest associations were found between stooping/bending with hip pain among both men and women and between kneeling and both knee and back pain in women. Women reported a higher prevalence than did men for chronic musculoskeletal pain at all sites except for the knee. These differences were statistically significant for hip and hand pain.

Our results are consistent with those reported among other populations of agricultural workers. Among Swedish pig farmers, women had significantly greater risk than men for aching fingers and wrists [Stal and Englund 2005]. Women were consistently more likely to report chronic pain compared to men, which was also observed in a study of Swedish dairy workers [Gustafsson, et al. 1994]. This may reflect an actual increased risk for injury, possibly related to smaller body size and muscle mass compared with men. In addition, women may have a lower pain threshold, perhaps due to hormonal differences [Arendt-Nielsen, et al. 2004]. Social and psychological factors also may play a role [Myers, et al. 2003]. Men and women maintain different postures according to their different jobs, and these results are consistent with our knowledge of the types of work tasks in which male and female farm workers engage.

In men, driving tractors or other heavy farm equipment for more than 60 hours/week was associated with chronic hip pain. We did not observe a similar result among women, but power to detect any association was limited since only nine women drove tractors in this sample. Other researchers have noted that tractor driving is associated with hip osteoarthritis in farmers, and chronic hip pain can result from hip osteoarthritis. [Croft, et al. 1992; Kirkhorn, et al. 2003; Thelin 1990; Thelin, et al. 1997].

Stooping/bending more than 30 hours/week increased the risk of chronic hip pain among both men and women. Allen et al. reported that bending/twisting/reaching was associated with symptomatic hip osteoarthritis, of which the major symptom is pain, among a community-based sample in rural North Carolina [Allen, et al. 2010]. Kirkhorn et al. also reported that bending was a risk factor for hip osteoarthritis [Kirkhorn, et al. 2003; Walker-Bone and Palmer 2002]. Thelin et al. reported that farmers with swine confinement operations had an increased risk of developing osteoarthritis of the hip, and those who milked more than 40 cows daily had an increased risk compared to those who did not work in dairy production [Thelin, et al. 2004]. This is consistent with our study results because swine handling and milking requires frequent stooping or bending, which was associated with hip pain in our participants.

We observed a strong and biologically plausible association between kneeling and chronic knee pain among women. Allen et al. reported that crawling was associated with increased odds of symptomatic knee osteoarthritis [Allen, et al. 2010]. This supports our findings as crawling includes kneeling, and pain is the major symptom of osteoarthritis. Thus, we would expect that avoiding prolonged kneeling should reduce the risk of chronic knee pain. Knee pads can also be used to protect against knee pain [Coggon, et al. 2000].

Back pain was the most frequently reported chronic pain in this sample, which is consistent with results from other studies [Rautiainen and Reynolds 2002]. The prevalence of back pain has been reported to range from 26.2% to 41% in other agricultural worker populations [Gomez, et al. 2003; Rosecrance, et al. 2006; Xiang, et al. 1999]. Agricultural work often requires a static forward-bent posture while working at or near ground level (e.g., pruning, weeding, and harvesting crops) and puts a significant physical load and strain on the lower body, which may explain the high prevalence of low back pain [Fathallah 2004; Pinzke 2003].

In this study, kneeling or crawling was strongly associated with back pain among women but not men. This is consistent with findings from other studies showing an association between awkward postures and back pain [Wickstrom and Pentti 1998]. Surprisingly, we did not observe significant associations between back pain and stooping/bending or walking while carrying more than 25 pounds, factors commonly reported by other studies to cause back pain.

Standing at a counter or at a machine was associated with reduced odds of chronic back pain. This was similar to the association between repetitive use of manual tools and reduced odds of finger pain. The underlying mechanism for protective associations is unclear. The questionnaire did not address whether subjects engaged in the posture or other work postures prior to onset of pain or if they changed to the current job and postures as a result of pain. Moreover, it is possible that those without pain were more likely to remain in a job associated with uncomfortable posture, leading to an artificially low prevalence of pain in that group consistent with the “healthy worker effect” [Hartvigsen, et al. 2001].

We observed significant associations only at the highest level of exposure. These results suggest that one prevention strategy for addressing risks of chronic musculoskeletal pain might include reducing the number of hours spent in the same posture. This could be accomplished through job rotation and/or using protective equipment [Rempel, et al. 1992]. For example, a mandatory 10 minutes break every 2 hours working in the positive of kneeling or stooping. Effective interventions likely need to be targeted toward specific types of agricultural tasks. Modifications of the work process offer another possibility for preventing chronic musculoskeletal pain. For example, elevating planting beds would reduce stooping and bending over. Modifying wheelbarrow with adjustable handles and 3 wheels would reduce load on low back [Kirkhorn, et al. 2010].

This study has several important strengths. It focuses on musculoskeletal pain as a common occupational health problem responsible for significant morbidity and productivity loss in a large and relatively understudied group critical to one of California’s largest industries. Additionally the study presents data on both men and women, the latter representing a group often not sampled in sufficient numbers to support gender specific analysis. The cross-sectional design is efficient in terms of time and cost and allowed us to focus on multiple outcomes and potentially important exposures. The study used some standardized questions from NHANES for assessing outcome variables, allowing national comparisons and to other populations having used these instruments. Participation was maximized by our study team’s careful and long-standing integration into the population, and interviewers were

native-Spanish speakers drawn from and trusted by the community itself. Finally, we employed careful quality control and data monitoring to maximize validity and precision.

There were also limitations to this study. First, we could not assess causality because temporality is not clear in cross-sectional studies. Second, assessing exposure and establishing category cut points for level of exposure is challenging in the absence of biological information on which to base categorization. Moreover, the relationship between exposures and log odds of chronic pain were not linear, indicating that it was inappropriate to analyze exposures as simple continuous variables. Therefore, we decided to categorize data into three ordinal groups (low/medium/high) based on the observed distribution of exposures so that we could examine dose response without requiring an assumption of linearity. This approach limited power for detecting true differences, especially for sub-groups with smaller cell sizes. Third, we summarized exposures over the entire agriculture career rather than season-to-season data over the participant's entire career, which would have been impractical in this setting. However, it is our experience that farm workers tend to specialize in crops and associated activities over long periods. Because the duration of farm work (median 11 years) is not excessively long, it is likely that the aggregated responses reasonably reflect the experience of the population, although there will likely be some individuals with unusually varied careers for whom this method is inadequate. Fourth, study data were based on self-report [Kirkhorn, et al. 2010], which we were unable to validate, and there is the potential for recall and interview bias. Finally, this study sampled community-dwelling Latino farm workers in California, and the results may not be applicable to other types of agriculture work or other ethnic groups.

Conclusions

The results of this study show that chronic musculoskeletal pain is common among farm workers, is influenced by work positions, and prevention interventions may require gender specific approaches. The findings may be useful for guiding prevention and management of chronic musculoskeletal pain. Recommendations for engineering changes for equipment and work environment modifications to reduce physical stresses are possible prevention strategies. In particular reducing the number of hours spent in the same posture through job rotation and use of protective equipment or modification of the work process. There is also a need to establish more accurate data on underserved migrant and seasonal farm workers for appropriate public health intervention.

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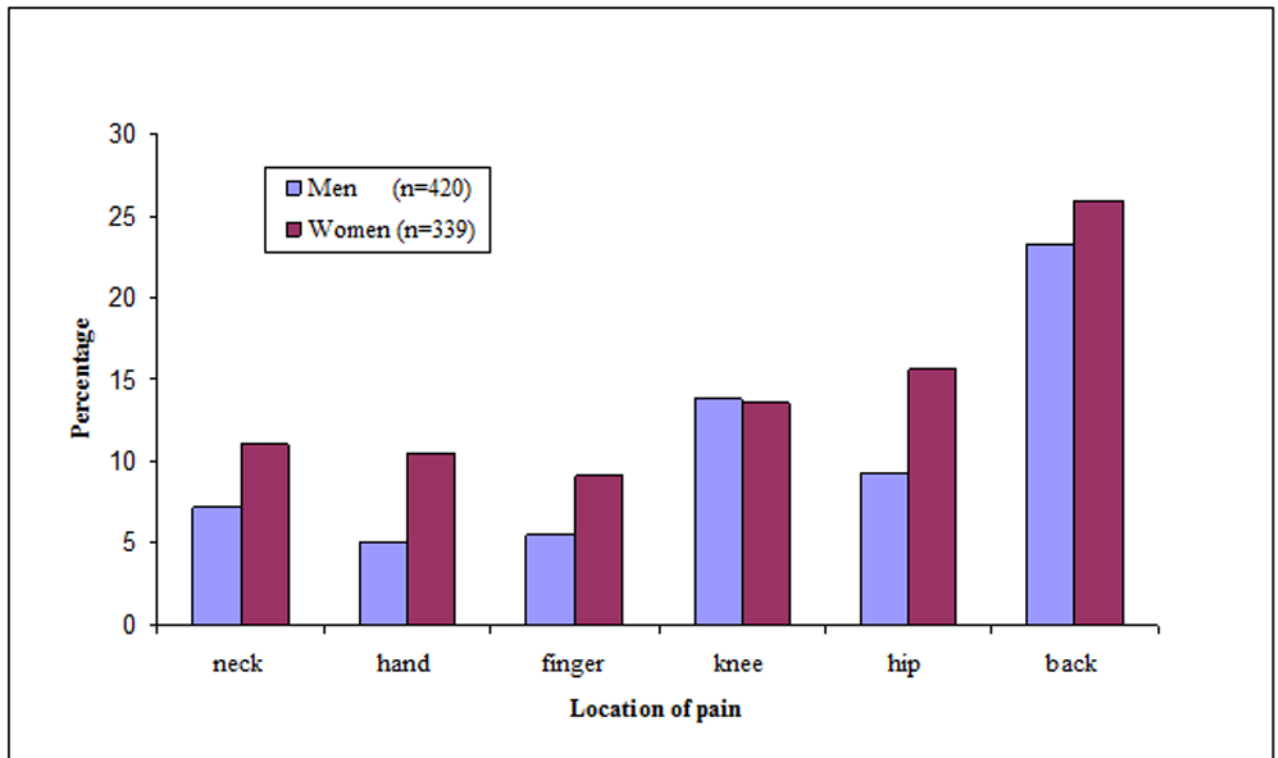


Figure 1.
Prevalence of chronic pain by gender among hired farm workers in the MICASA Study

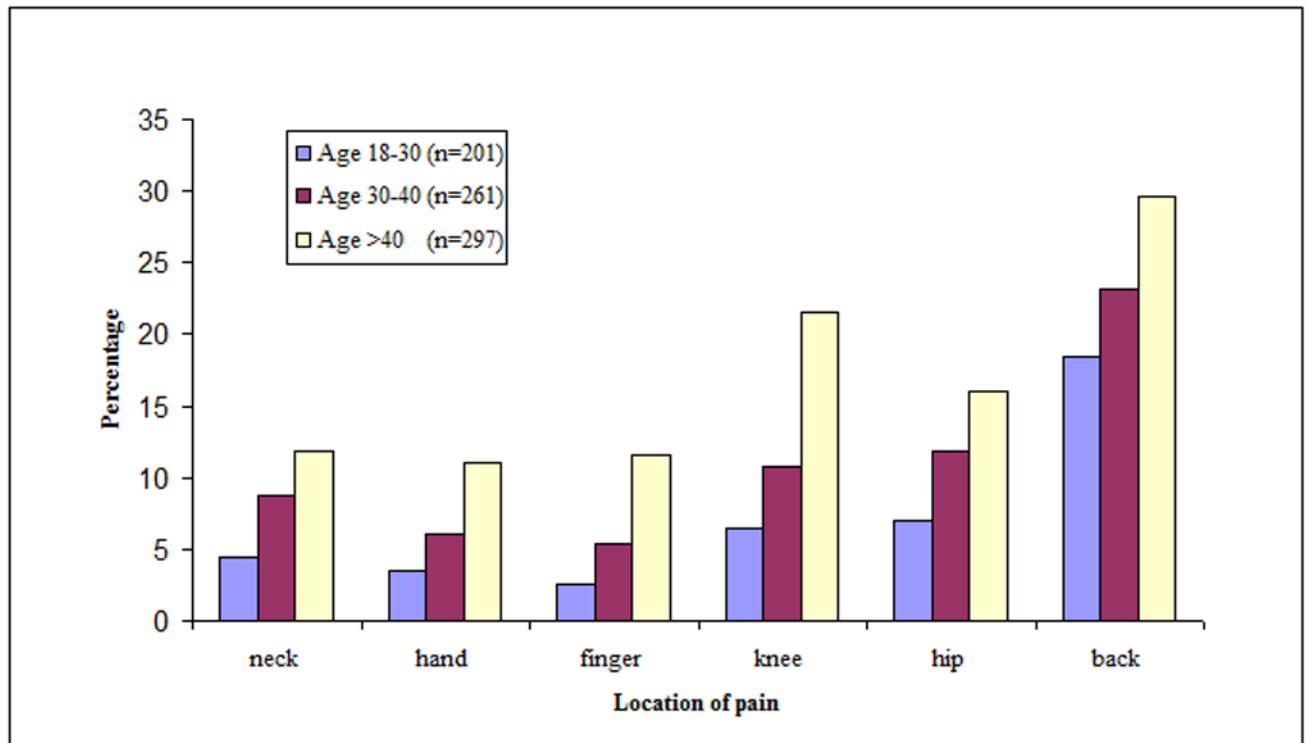


Figure 2.
Prevalence of chronic pain by age among hired farm workers in the MICASA Study

Table I

Demographic characteristics of hired farm workers in the MICASA Study (2006–2007)

Characteristics	Total n=759 n (%)	Female n=339 n (%)	Male n=420 n (%)	p-value*
Age				0.4
18–30	201 (26.5)	95 (28.0)	106 (25.2)	
31–40	261 (34.4)	120 (35.4)	141 (33.6)	
41+	297 (39.1)	124 (36.6)	173 (41.2)	
Marital status				0.01
Married/live w/someone	711 (93.8)	313 (92.3)	398 (95.0)	
Divorce/Separated/Widow	18 (2.4)	14 (4.1)	4 (1.0)	
Single (never married)	29 (3.8)	12 (3.5)	17 (4.1)	
Country of Birth				0.29
US	32 (4.2)	17 (5.0)	15 (3.6)	
México	493 (65.0)	223 (65.8)	270 (64.3)	
El Salvador	210 (27.7)	87 (25.7)	123 (29.3)	
Other	24 (3.2)	12 (3.5)	12 (2.8)	
Smoking status				<0.0001
Current smoker	72 (9.5)	20 (5.9)	52 (12.4)	
Ex-smoker	37 (4.9)	2 (0.6)	35 (8.4)	
Never smoker	649 (85.6)	317 (93.5)	332 (79.2)	
Years working in agriculture				<0.0001
0–5 years	164 (21.8)	115 (34.2)	49 (11.8)	
6–10 years	183 (24.3)	85 (25.3)	98 (23.6)	
11+ years	405 (43.9)	136 (40.5)	269 (64.7)	
Years of living in the US				0.001
0–5 years	109 (14.4)	64 (18.9)	45 (10.8)	
6–10 years	162 (21.4)	83 (24.6)	79 (18.9)	
11–20years	152 (20.1)	70 (20.7)	82 (19.6)	
21+years	333 (44.1)	121 (35.8)	212 (50.7)	
Education level				0.15
No school	43 (6.2)	18 (5.8)	25 (6.4)	
Primary education or less	393 (56.4)	163 (52.8)	230 (59.3)	
> primary education	261 (37.5)	128 (41.2)	133 (34.3)	
Family income				0.49
\$0–10,000	144 (19.5)	61(21.5)	73 (17.9)	
>\$10,000	323 (43.7)	142 (43.0)	181 (44.3)	
>\$20,000	174 (23.6)	73 (22.1)	101 (24.7)	
>\$30,000	98 (13.3)	44 (13.3)	54 (13.2)	

* p-value for chi-square comparison by gender

Table II

Twelve-Month Work History Data Assessed at MICASA Baseline Interview (2006–2007)

	% (n)	Men % (n)	Women % (n)	p-value
Worked in last 12 months	92.5 (702)	96.0 (403)	88.2 (299)	<0.0001
Tasks Worked in last 12 months				
Packing/Sorting*	38.5 (292)	9.8 (41)	74.0 (251)	<0.0001
Picking/Harvesting	24.0 (182)	38.1 (160)	6.5 (22)	<0.0001
Hoeing/Weeding	33.3 (253)	31.0 (130)	36.3 (123)	0.12
Irrigation ⁺⁺	8.2 (62)	14.5 (61)	0.3 (1)	<0.0001
Planting	7.6 (58)	7.6 (32)	7.7 (26)	0.97
Pruning/Cutting	15.6 (118)	22.1 (93)	7.4 (25)	<0.0001
Machine Operation [#]	13.4 (102)	23.3 (98)	1.2 (4)	<0.0001
Cleaning [^]	10.9 (83)	9.5 (40)	12.7 (43)	0.17
Supervision	2.1 (16)	3.3 (14)	0.6 (2)	0.009

* Packing/sorting tasks may be done at the field or in processing plant depending on crop; involves sorting commodity by size and placing in boxes for transport

⁺⁺ Irrigation tasks include setting up irrigation systems, laying pipe, monitoring watering in field

[#] Machine operation includes tractor driving, operating other farm equipment, driving trucks

[^] Cleaning tasks vary by the crop. In crops such as grapes, melons and tomatoes, it includes removing dead leaves from around the fruit; in almonds, cleaning involves retrieving nuts left on the ground by sweeping them into a pile to be picked up by a machine.

Table III
Work posture exposure variables reported by hired farm workers in the MICASA Study by gender

Work activity or posture	Mean	Median	Range	Strata hours/wk	Women n (%)	Men n (%)
Repeatedly use manual tools or make repetitive motions	28.3	0	0–98	0	149 (46.4)	232 (57.4)
				1-<60	66 (20.6)	66 (16.3)
Drive tractors or other heavy farm equipment	11.1	0	0–126	0	102 (33.0)	106 (26.2)
				1-<60	315 (97.2)	250 (61.6)
Stooped over or bent down	17.9	6	0–91	0	5 (1.5)	74 (18.2)
				60	4 (1.2)	82 (20.2)
Walking while carrying more than 25 pounds	11.9	0	0–84	0	198 (61.3)	121 (29.8)
				1-<30	46 (14.2)	144 (35.5)
Standing at a counter or at a machine	37.4	0	0–114	0	79 (24.5)	141 (34.7)
				30	253 (78.1)	209 (51.5)
Kneeling or crawling	6.0	0	0–70	0	23 (7.1)	105 (25.9)
				1-<35	48 (14.8)	92 (22.7)
				35	27 (8.4)	193 (47.8)
				0	115 (35.8)	113 (28.0)
				1-<60	179 (55.8)	98 (24.3)
				60	285 (88.2)	296 (72.9)
				0	11 (3.4)	62 (15.3)
				1-<25	27 (8.4)	48 (11.8)
			25			

Note: Chi-square p-value <0.01 for all variables

Adjusted odds ratios* and 95% confidence intervals for the association of work postures and agricultural tasks with chronic musculoskeletal pain for men

Table IV

Work posture (hours/week)	Strata (hrs/w k)	Anatomic Site of Chronic Pain						
		Neck	Hand	Finger	Knee	Hip	Back	
Repeatedly use manual tools or make repetitive motions	0							
	1<60		2.86 [0.69,11.78]	1.57 [0.32, 7.73]				
Drive tractors or other heavy farm equipment	0							
	1<60		1.99 [0.73,5.42]	1.63 [0.62, 4.26]				
Stooped over or bent down	0							
	1<30	0.89 [0.35,2.24]			0.94 [0.45,1.93]	1.02 [0.40,2.63]	0.77 [0.44,1.36]	
Kneeling or crawling	0							
	1<25	0.62 [0.21,1.83]			1.37 [0.65,2.90]	2.49 [1.03,5.99]	1.02 [0.56,1.86]	
Walking while carrying more than 25 pounds	0							
	25				1.78 [0.88,3.62]		1.06 [0.58,1.95]	
Standing at a counter or machine	0				1.74 [0.69,4.42]		0.63 [0.25,1.58]	
	1<35	2.12 [0.79,5.66]					1.36 [0.57,3.23]	1.18 [0.66,2.11]
	35	1.88 [0.71,5.00]					1.65 [0.74,3.67]	1.10 [0.62,1.96]
	1<60						0.78 [0.32,1.86]	0.65 [0.35,1.20]
	60						0.27 [0.06,1.18]	0.33 [0.14,0.82]

* Logistic regression models adjusted for age, years working in agriculture and smoking (current vs. never/ex) The significant results are shown in bold

Table V

Adjusted odds ratios* and 95% confidence intervals for the association of work postures and agricultural tasks with chronic musculoskeletal pain for women

Work posture (hours/week)	Strata (hrs/wk)	Anatomic Site of Chronic Pain						
		Neck	Hand	Finger	Knee	Hip	Back	
Repeatedly use manual tools or make repetitive motions	0							
	1<60		0.42 [0.09, 1.94]	0.64 [0.17, 2.45]				
	60		0.60 [0.26, 1.36]	0.36 [0.13, 0.97]				
Drive tractors or other heavy farm equipment	0							
	1<60					1.57 [0.16, 15.81]		
	60					3.39 [0.52, 21.13]		
Stooped over or bent down	0							
	1<30	1.37 [0.51, 3.67]			0.58 [0.31, 2.30]	1.51 [0.62, 3.65]	0.74 [0.34, 1.63]	
	30	1.57 [0.67, 3.69]			1.32 [0.60, 2.90]	2.15 [1.04, 4.46]	1.38 [0.75, 2.51]	
Kneeling or crawling	0							
	1<25				1.47 [0.31, 7.13]		1.53 [0.46, 5.21]	
	25				3.02 [1.07, 8.50]		2.96 [1.27, 6.93]	
Walking while carrying more than 25 pounds	0							
	1<30	0.49 [0.10, 2.35]				0.18 [0.02, 1.47]	0.60 [0.20, 1.79]	
	30	0.67 [0.23, 1.95]				1.71 [0.79, 3.73]	1.25 [0.62, 2.49]	
Standing at a counter or machine	0							
	1<60					0.89 [0.32, 2.47]	1.10 [0.45, 2.69]	
	60					1.33 [0.47, 3.78]	1.86 [0.75, 4.66]	

* Logistic regression models adjusted for age, years working in agriculture and smoking (current vs. never/ex) The significant results are shown in bold