

# Occupational Exposures and Migration Factors Associated With Respiratory Health in California Latino Farm Workers

## *The MICASA Study*

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**Objective:** To evaluate associations of agricultural work and migration on self-reported respiratory symptoms in a Latino farm worker sample. **Methods:** Work history and respiratory symptoms were assessed in 702 workers through interviews in a community-based cohort. **Results:** Prevalence was 6% for asthma, 5% for chronic cough, 3% for chronic bronchitis, and 7% for persistent wheeze. The total number of years in agriculture was associated with asthma; however, time-weighted average dust exposure, use of protective equipment, and pesticide use in the past 12 months were not associated with respiratory outcomes. Living 15 years or more in the United States (adjusted odds ratio = 3.60; 95% confidence interval = 1.16 to 11.16) and medium/high acculturation (adjusted odds ratio = 6.06; 95% confidence interval = 1.40 to 26.29) were associated with increased odds of asthma in women. **Conclusions:** Analysis of this community-based Latino farm worker cohort identified associations with asthma, particularly with migration factors in women.

Hired farm workers provide the majority of the workforce for California's labor-intensive agricultural sector. In California, estimates suggest that more than 450,000 people are employed in agriculture, with more than two thirds being of Latino ethnicity.<sup>1</sup> More than 400 commodities are produced in California, with gross revenue reaching \$37.5 billion in 2010, accounting for 11.9% of the US total.<sup>2</sup> Farm workers suffer a large health burden, facing increased risks of morbidity and mortality, and of particular concerns are respiratory symptoms and diseases associated with exposure to pollutants in the agricultural work environment.<sup>3</sup> The type, concentration, and duration of exposure to airborne pollutants depend on the type of work environment, the nature of the work being performed and the type of agricultural operation.<sup>4-7</sup> These airborne pollutants have been linked to adverse respiratory outcomes, including chronic bronchitis, rhinitis, hypersensitivity pneumonitis, asthma, organic dust toxic syndrome, respiratory zoonoses, and silo-filler disease.<sup>4,8</sup>

Asthma is a specific focus because many exposures in the agricultural work environment can aggravate asthma and may even cause it. Among agricultural workers with asthma, the percentage of asthma cases attributable to certain agricultural work exposures, such as dust, is still unknown. Nevertheless, agents identified in

the manufacturing and agricultural workplaces capable of causing asthma include<sup>9,10</sup> arthropod-derived materials such as grain and barn mites,<sup>11,12</sup> plant-derived materials including grain dust,<sup>13</sup> and animal-derived proteins such as animal epithelia.<sup>14</sup> The degree to which exposure to these agents causes or exacerbates asthma depends on the composition and intensity of these agents as well as the duration of exposure,<sup>15</sup> factors that vary by task and crop and/or work with livestock.<sup>2,16</sup>

Aligned with potential increases in asthma from these occupational exposures, observed increases in asthma among Latino immigrants necessitate the examination of possible explanations.<sup>17</sup> Although research has increased our understanding of the nature of these exposures, there has been scarce examination of respiratory health in Latino hired farm workers. Therefore, the Mexican Immigration to California: Agricultural Safety and Acculturation (MICASA) study recruited farm workers families and assessed respiratory symptoms using baseline survey data. The purpose of this analysis is to assess associations of agricultural work, specifically time and intensity spent in a dusty environment, recent ( $\leq 1$  year) dust exposure in the agricultural workplace, and migration (age at immigration, years in the United States, and acculturation level) on self-reported symptoms.

## METHODS

### Overall Design and Rationale

The MICASA study is a population-based sample of 467 hired farm worker households from Mendota, in California's Central Valley. Mendota was chosen because of its large proportion of immigrants from Mexico and Central America and high proportion of agricultural workers.

### Household Enumeration and Sampling Procedures

A stratified area probability sampling design was used with stratification into one of the two census tracts and the census block as the primary sampling unit. Initially, enumerators compiled a list of all dwellings (including houses, apartments, trailers, and garages) within randomly selected blocks. Then, they returned to each mapped dwelling, enumerated the individuals in the household, and ascertained the relationship of the house's occupants, age, sex, ethnicity, involvement in farm work, and years of residence in Mendota. Households with no hired farm workers were mapped, but individuals in the household were not enumerated. Further details of the enumeration procedures are provided elsewhere.<sup>18</sup>

### Eligibility and Recruitment

Trained, Spanish-speaking interviewers visited eligible households and explained the purpose and procedures of the project and attempted to recruit the head of household and spouse. Study recruitment and baseline interviews were conducted between January 2006 and April 2007. Eligible participants included men and women between the ages of 18 to 55 years who self-identified as Mexican or Central American, resided in Mendota at the time of the baseline interview, with at least one household member who worked in

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farm labor for at least 45 days in the previous year. Spanish is the primary language of participants, and few spoke much English, so all explanations and informed consent were provided in Spanish. Written consent was obtained from each eligible respondent who agreed to participate in the study. All study procedures were approved by the University of California, Davis, Institutional Review Board.

A total of 1069 households were included in the enumeration process. Of these, 467 households participated in the study, 203 declined, 351 were ineligible, and 48 were classified as “unable to contact.”<sup>18</sup> Among the 467 participating households, 843 adults completed a baseline interview. Both the head of household and the spouse were interviewed in 376 households, only one household member was interviewed in 21 households, and 29 households consisted of single heads of households. Among participants who declined, the primary reasons given included *desconfiado* (distrusted), no time, not interested, or did not want to share personal information. For the purposes of this study, analyses were restricted to 702 participants who reported at least 1 day of farm work in the previous year. An alternate subset who had worked at least 45 days in the year before interview was also considered ( $n = 691$ ). Nevertheless, restricting analyses to these individuals did not significantly alter the distribution of the demographic variables or logistic regression results, so this subset was not considered further.

## Measures

The survey instrument collected information on demographics, occupational and environmental risk factors, home environment, acculturation, smoking status, and health outcomes (respiratory health, injuries, mental health, and reproductive health). Questionnaires were completed through in-person interviews in the participant’s home or at the project office, and required approximately 1 hour to administer. The survey instrument was developed in both Spanish and English, with back translation to ensure its accuracy. Survey questions relied on relevant existing survey instruments, were developed by consensus among the investigators, and revised after review and pilot testing in the community. Standardized questions from the ATS-DLD-78 questionnaire were used to assess respiratory health and symptoms.<sup>19</sup> A classification scheme on the basis of American Thoracic Society criteria was used to classify participants with asthma, chronic cough, chronic bronchitis, and persistent wheeze.

The abbreviated version of the original Acculturation Rating Scale for Mexican-Americans II (ARSMA-II) was used to assess acculturation, a composite measure calculated from responses regarding an individual’s language preference/use, ethnic identity, and ethnic interaction.<sup>20</sup> Responses to each question are scored on a Likert-type scale, ranging from “not at all” (score = 1) to “extremely often or almost always” (score = 5). Two separate total scores, a Mexican Orientation Score and an Anglo Orientation Score, are then calculated by adding up the respondent’s score from each question in the respective category. The Mexican Orientation Score is subtracted from the Anglo Orientation Score to arrive at an overall acculturation score. ARSMA-II scores can then be classified into five levels of acculturation. Because few participants scored in levels II through V, level I was categorized as low acculturation, and levels II through V were collapsed to form the medium/high acculturated category for the study population.<sup>12,20</sup> Age at immigration was evaluated as a continuous variable, and the mean number of years in the United States was categorized with a cut-point at the mean creating two levels: less than 15 years and 15 years or more.

Work exposure was assessed in several ways—exposure to dust, length of employment in agriculture, use of protective equipment in dusty environments, and pesticide use at work. Several measures of dust exposure in the past 12 months were assessed. The first measure examined the frequency of work in dusty environments,

and was based on the question, “During the past year, approximately how often did you work where a lot of dust was generated?” with responses ranging from 0 (never) to 4 (always). The second measure was a time-weighted average of dust exposure on the basis of self-reported dust rating for each job held in the past year (scale of 0 to 10, with 0 being no dust and 10 being very dusty) and days worked at each agricultural job. Workers could report up to eight different jobs from the past year. The dust exposure rating for each job was multiplied by the duration of the job (in days); these values were then summed. The total value across all jobs was then divided by the total days worked in agriculture to create a time-weighted summary measure of dust intensity during the most recent 12 months of agricultural work.

## Statistical Analysis

Statistical analyses centered on exploring the relationship of dust exposure and acculturation/immigration-related factors to respiratory outcomes, as well as comparing demographic and agricultural work history variables by sex. *t* tests were used to compare continuous variables. Chi-square tests were used to compare categorical variables.

Preliminary analyses explored the bivariate relationship between selected independent variables and the four dependent variables of interest: asthma, chronic cough, chronic bronchitis, and persistent wheeze. On the basis of those results and a priori hypotheses of interest, multivariate logistic regression models, using SAS Procedure SURVEYLOGISTIC, were constructed. For models with acculturation and migration-related factors as the independent variables, the decision was made to include an interaction term of the main effect with sex. This was based on a priori knowledge of differential effects on men and women.<sup>21–23</sup> Logistic regression models for survey data with census tract and block specified as strata and cluster variables, respectively, were used to account for design effects from our stratified clustered survey design. All models were adjusted for age, sex, and smoking status (never, former, and current). All statistical analyses were done using SAS version 9.2 (SAS Institute, Inc, Cary, NC).

## RESULTS

### Demographic Characteristics

The 702 farm worker participants were composed of 403 (57.4%) men and 299 (42.6%) women, with a mean age of 38 years (standard deviation [SD] = 10 years) (Table 1). Most were born in Mexico (64.3%), with almost one third born in Central America—primarily El Salvador and Honduras. The overall prevalence of current smoking was 11.4%, and the difference between smoking prevalence by sex was significant ( $P < 0.0001$ ), with 16% male current smokers compared with 5.0% female current smokers. Sixty-three percent of participants had spent more than 10 years in the United States, with men reporting significantly longer residencies than women (17 years vs 13 years;  $P < 0.0001$ ). Ninety-five percent were classified as low acculturated, and there were no differences in acculturation by sex.

The prevalence of respiratory symptoms was low: asthma (6.0%), chronic cough (5.0%), chronic bronchitis (3.1%), and persistent wheeze (6.7%) (Table 2). Overall, 12.9% of participants reported having at least one of these respiratory symptoms. For all reported respiratory symptoms, prevalence did not significantly differ between men and women. In bivariate analyses with smoking status, current smokers reported higher prevalence of chronic cough (8.8%) compared with never- and ex-smokers (3%) ( $P = 0.01$ ). There was no difference by smoking status for asthma, chronic bronchitis, or persistent wheeze. In addition, participants born in the United States and those classified as medium/high acculturation reported higher prevalence of asthma and persistent wheeze.

**TABLE 1.** Demographic Characteristics and Agricultural Work History and Exposures of MICASA Participants Engaged in Farm Work at Least 1 Day in Previous Year, 2006 to 2007\*

	Mean (SD)
Age, yrs	37.7 (10.0)
Living in the United States, yrs	15.5 (9.8)
Working in agriculture, yrs	13.6 (9.3)
Worked in agriculture in past year, d	211.6 (87.3)
Time-weighted average—dust	6.5 (2.4)
	<i>n</i> (%)
Sex	
Male	403 (57.4)
Female	299 (42.6)
Marital status	
Married/living together	656 (93.6)
Single/divorced/widowed/separated	45 (6.4)
Country of birth	
United States	25 (3.6)
Mexico	451 (64.3)
Central America†	226 (32.2)
Education	
No schooling	42 (6.5)
Primary	368 (56.8)
More than primary	238 (36.7)
Smoking status	
Never-smoker	550 (78.5)
Ex-smoker	71 (10.1)
Current smoker	80 (11.4)
Acculturation level	
Low	653 (95.2)
Medium/high	33 (4.8)
Frequency of work in a high-dust environment	
Never	19 (2.7)
Sometimes	106 (15.3)
Half the time	239 (34.5)
Most of the time	216 (31.2)
Always	113 (16.3)
Use of protective equipment in dusty environments	
Scarf over mouth and nose	
Never/sometimes	466 (66.9)
Half/most time/always	231 (33.1)
Disposable dust mask	
Never/sometimes	569 (81.6)
Half/most time/always	128 (18.4)
Cartridge respirator	
Never/sometimes	673 (96.6)
Half/most time/always	24 (3.4)
Used pesticides—past 12 mos	73 (10.5)

\*Overall *n* = 702.

†Central America category includes El Salvador, Honduras, Nicaragua, and Guatemala.

SD, standard deviation.

## Agricultural Work History and Exposures

The number of years worked in agriculture was greater for men (mean = 16 years; SD = 9.8 years) than for women (mean = 10.4 years; SD = 7.6 years) ( $P < 0.0001$ ) (Table 1). Time-weighted average of self-reported agricultural dust exposure in the past year was similar for men (mean = 6.6; SD = 2.2) and women (mean = 6.4; SD = 2.4). Nevertheless, the frequency of work in a high-dust environment differed significantly by sex, with 59% of men and 32% of women reporting working in an environment where a lot of dust was generated most or all of the time.

Assessments of protective equipment in dusty environments found significant differences between men and women for wearing a scarf, using a disposable dust mask, and wearing a cartridge respirator. Although women reported wearing a scarf over the mouth and nose more frequently than men when working in a dusty environment, men were more likely to use disposable dust masks half the time or more under dusty conditions. Only 3.4% of the sample reported using a cartridge respirator half the time or more, but men were more likely than women to use one. Use of pesticides in the last 12 months was low; however, men were significantly more likely to have worked with pesticides (17.6%) than women (0.7%) ( $P < 0.0001$ ).

## Agricultural Work Exposures and Respiratory Symptoms

For each agricultural work exposure, corresponding logistic regression coefficients were similar across the range of respiratory symptoms assessed in separate multivariable models (Table 3). Time-weighted average of agricultural dust exposure in the past year did not significantly increase the odds of any respiratory symptom. The total number of years worked in agriculture was associated with asthma (adjusted odds ratio = 1.04; 95% confidence interval [CI] = 1.00 to 1.09). Nevertheless, the time-weighted average dust exposure, use of protective equipment, and pesticide use in the past 12 months were not associated with respiratory outcomes.

## Migration Factors and Respiratory Symptoms

Models assessing associations between acculturation and immigration-related factors with respiratory symptoms were reported separately for women and men (Table 4). Age at immigration was modeled continuously for all outcomes and was not significantly associated with respiratory symptoms in either women or men. Among men, acculturation was not associated with respiratory symptoms. After adjustment for age and smoking, medium/high acculturated women were six times more likely to report having asthma (95% CI = 1.40 to 26.29) and almost seven times more likely to report chronic bronchitis (95% CI = 1.27 to 33.92). Similarly, spending 15 years or more in the United States significantly increased the odds of asthma for women (adjusted odds ratio = 3.60; 95% CI: 1.16 to 11.16), but no association was observed in men. In addition, models including adjustment for the number of years worked in agriculture produced no change in the adjusted odds ratio estimates (data not shown).

## DISCUSSION

Examination of the relationship between dust exposure, years worked in agriculture, and migration-related factors to respiratory outcomes revealed an independent relationship between acculturation and years in the United States with asthma in women. Highly acculturated women also had increased odds of chronic bronchitis. In men and women, asthma was associated with the number of years worked in agriculture. Nevertheless, adjustment for the number of years worked in agriculture in the acculturation model and vice versa did not alter the adjusted odds ratio estimates. Furthermore, adverse effects of agricultural work and acculturation on respiratory health have both been separately observed in previous studies.<sup>17,24–26</sup>

**TABLE 2.** Prevalence of Respiratory Symptoms by Demographic Characteristics and Agricultural Work History in MICASA Participants, 2006 to 2007

	<b>Asthma n = 42 Mean (SD)</b>	<b>Chronic Cough n = 35 Mean (SD)</b>	<b>Chronic Bronchitis n = 22 Mean (SD)</b>	<b>Persistent Wheeze n = 47 Mean (SD)</b>
Age, yrs	36.8 (10.4)	42.6 (10.9)	41.3 (12.2)	38.4 (11.9)
Living in the United States, yrs	17.8 (12.4)	17.0 (11.6)	17.0 (13.7)	17.5 (12.9)
Worked in agriculture, yrs	14.4 (10.4)	18.9 (13.2)	18.2 (15.2)	15.9 (13.0)
Worked in agriculture in past year, d	205.4 (87.1)	202.3 (108.0)	165.7 (99.1)	200.1 (103.9)
Time-weighted average—dust	6.4 (2.5)	6.8 (2.5)	6.6 (2.6)	6.5 (2.6)
	<b>n (%)</b>	<b>n (%)</b>	<b>n (%)</b>	<b>n (%)</b>
Sex				
Male	21 (5.2)	22 (5.5)	13 (3.2)	28 (7.0)
Female	21 (7.1)	13 (4.4)	9 (3.0)	19 (6.4)
Marital status				
Married/living together	36 (5.5)	30 (4.6)	20 (3.1)	43 (6.6)
Single/divorced/widowed/separated	6 (13.6)	5 (11.1)	2 (4.4)	4 (8.9)
Country of birth				
United States	5 (20.0)	1 (4.0)	1 (4.0)	5 (20.0)
Mexico	21 (4.7)	26 (5.8)	16 (3.6)	27 (6.0)
Central America*	16 (7.1)	8 (3.5)	5 (2.2)	02 (6.6)
Education				
No schooling	1 (2.4)	4 (9.5)	0	4 (9.5)
Primary	24 (6.6)	22 (6.0)	16 (4.4)	27 (7.3)
More than primary	15 (6.3)	8 (3.4)	5 (2.2)	12 (5.0)
Smoking status				
Never-smoker	32 (5.9)	22 (4.0)	14 (2.6)	35 (6.4)
Ex-smoker	5 (7.0)	4 (5.6)	4 (5.6)	5 (7.0)
Current smoker	5 (6.3)	9 (11.3)	1 (5.0)	7 (8.8)
Acculturation level				
Low	36 (5.5)	32 (4.9)	19 (2.9)	41 (6.3)
Medium/high	6 (18.2)	3 (9.1)	3 (9.1)	5 (15.2)
Frequency of work in a high-dust environment				
Never	2 (10.5)	1 (5.3)	1 (5.3)	3 (15.8)
Sometimes	6 (5.7)	7 (6.6)	3 (2.8)	7 (6.6)
Half the time	19 (8.0)	8 (3.4)	4 (1.7)	18 (7.5)
Most of the time	11 (5.1)	10 (4.6)	5 (2.3)	12 (5.6)
Always	4 (3.6)	9 (8.0)	9 (8.0)	7 (6.2)
Use of protective equipment in dusty environments				
Scarf over mouth and nose				
Never/sometimes	30 (6.5)	25 (5.4)	13 (2.8)	36 (7.7)
Half/most time/always	12 (5.2)	10 (4.3)	9 (3.9)	10 (4.3)
Disposable dust mask				
Never/sometimes	32 (5.6)	26 (4.6)	15 (2.6)	38 (6.7)
Half/most time/always	10 (7.9)	9 (7.0)	7 (5.5)	8 (6.3)
Cartridge respirator				
Never/sometimes	41 (6.1)	32 (4.8)	21 (3.1)	45 (6.7)
Half/most time/always	1 (4.2)	3 (12.5)	1 (4.2)	1 (4.2)
Used pesticides—past 12 mos	4 (5.5)	3 (4.1)	2 (2.7)	4 (5.5)

\*Central America category includes El Salvador, Honduras, Nicaragua, and Guatemala.  
SD, standard deviation.

These results showed that the number of years lived in the United States was positively associated with both acculturation and years worked in agriculture ( $P < 0.0001$ ) and is a proxy for acculturation. We did observe independent effects of years in the United States on asthma, but it may also be a component of the number

of years worked in agriculture and acculturation, contributing to the elevated odds of asthma and respiratory symptoms.

In this study, we have focused on asthma and respiratory symptoms. Acculturation level and years living in the United States were independently associated with asthma in women, but not in men.

**TABLE 3. Odds Ratios and 95% Confidence Intervals for Occupational Exposures Associated With Respiratory Symptoms for MICASA Participants, 2006 to 2007\***

	Asthma		Chronic Cough		Chronic Bronchitis		Persistent Wheeze	
	Crude OR (95% CI)	Adjusted OR† (95% CI)	Crude OR (95% CI)	Adjusted OR† (95% CI)	Crude OR (95% CI)	Adjusted OR† (95% CI)	Crude OR (95% CI)	Adjusted OR† (95% CI)
Worked in agriculture, yrs	1.01 (0.97–1.05)	1.04 (1.00–1.09)	1.05 (1.02–1.08)	1.03 (0.97–1.10)	1.05 (1.00–1.09)	1.04 (0.97–1.11)	1.03 (0.99–1.06)	1.03 (0.98–1.08)
Worked in agriculture in past year, d	0.99 (0.99–1.00)	1.00 (0.99–1.00)	0.99 (0.99–1.00)	1.00 (0.99–1.00)	0.99 (0.98–0.99)	0.99 (0.98–1.00)	0.99 (0.99–1.00)	0.99 (0.99–1.00)
Time-weighted average dust exposure in past year	0.97 (0.87–1.09)	0.97 (0.87–1.09)	1.06 (0.90–1.24)	1.06 (0.92–1.23)	1.02 (0.84–1.23)	1.02 (0.85–1.23)	1.00 (0.87–1.15)	1.00 (0.88–1.15)
Use of protective equipment in dusty environments								
Scarf over mouth and nose‡	1.38 (0.66–2.85)	1.52 (0.71–3.28)	1.34 (0.75–2.40)	1.28 (0.69–2.39)	0.80 (0.32–2.02)	0.66 (0.25–1.71)	1.85 (0.85–4.04)	2.04 (0.89–4.69)
Disposable dust mask‡								
Never/sometimes	0.77 (0.38–1.57)	0.65 (0.32–1.34)	0.68 (0.30–1.51)	0.80 (0.36–1.74)	0.54 (0.23–1.30)	0.53 (0.22–1.27)	1.05 (0.48–2.33)	1.15 (0.51–2.61)
Cartridge respirator‡								
Never/sometimes	1.50 (0.27–8.39)	1.32 (0.28–6.24)	0.35 (0.13–0.95)	0.43 (0.13–1.45)	0.74 (0.12–4.68)	0.80 (0.10–6.42)	1.64 (0.20–13.38)	1.79 (0.21–15.68)
Used pesticides in past 12 mos	0.89 (0.34–2.36)	1.10 (0.42–2.92)	0.79 (0.27–2.29)	0.65 (0.23–1.85)	0.85 (0.20–3.63)	0.83 (0.20–3.37)	0.78 (0.31–2.01)	0.71 (0.28–1.81)

\*Odds ratios calculated from separate logistic regression models for each occupational exposure and outcome. All logistic regression models were fit using survey data analysis procedures to account for the stratified clustered sampling design.  
 †Multiple logistic models used to estimate adjusted OR, included age, sex, and smoking status as independent variables.  
 ‡Reference level: half of the time/most of the time/always.  
 CI, confidence interval; OR, odds ratio.

Our finding of increased odds of asthma in medium/high acculturated women is consistent with previous studies for other health outcomes, such as obesity,<sup>22,27,28</sup> diabetes,<sup>23,29</sup> and hypertension,<sup>30</sup> and health behaviors, such as alcohol consumption,<sup>31–36</sup> smoking,<sup>21,34,37,38</sup> and drug use.<sup>39,40</sup> Acculturation is associated with adverse health outcomes in men as well, but it disproportionately affects women.<sup>41</sup> Higher acculturation level and longer years living in the United States tend to be harmful to Latino health<sup>41,42</sup> in terms of both an increase in poor health outcomes and an increased engagement in adverse health behaviors. Reasons for this increase in poor health outcomes have been proposed, such as selective migration of healthier individuals<sup>43,44</sup> and erosion of protective health behaviors.<sup>32,45</sup> Becoming acculturated to any host society entails increased exposure to a different lifestyle and environment, as well as different beliefs and knowledge. At the same time, it necessitates time away from potentially protective factors found in the society of origin. Whatever the degree of change, the extent to which an immigrant's lifestyle in a new culture affects health outcomes is partially dependent on how healthy his/her lifestyle was in the country of origin.<sup>46</sup> In addition, aspects of a new society, such as the environment, are largely beyond individual control. An immigrant may have some choice in which environment to move to, but any new location will have certain environmental exposures that are present and unchangeable. A good example directly related to asthma is exposure to foreign allergens. Migration involves exposure to a new set of pollutants and allergens.<sup>47</sup> Allergens capable of affecting the respiratory system are found in the air, and the immigrant can take steps to decrease exposure, but cannot eliminate it.

Dust exposure in the past year was not independently associated with respiratory outcomes. The overall prevalence of asthma and respiratory symptoms was low, but a high proportion (82%) of subjects reported working in an environment where a lot of dust was generated more than half the time. Previous research examining agricultural dust exposure and respiratory health in Europe and the United States has confirmed high dust levels in the farming environment through objective measurement,<sup>16,48</sup> but have produced mixed results when analyzing the relationship between dust and respiratory outcomes. In a study of California farm operators, an independent association between persistent wheeze and dust exposure was found, but not for asthma.<sup>24</sup> A cross-sectional study of 877 Dutch farmers found a positive, dose-dependent association between exposure to endotoxin (a component of dust) and respiratory symptoms such as shortness of breath, wheezing, and cough.<sup>49</sup> In both the United States and European studies, occupational exposures to organic and inorganic dust in the agricultural workplace have been found to contribute to chronic bronchitis.<sup>50–52</sup>

The independent association between the accumulation of years spent in the agricultural work environment and asthma indicates that exposure to dust, pesticides, gases, fumes, and other airborne workplace affects respiratory health. This has been previously observed in a Hispanic farm working population; in a cross-sectional study of elderly Hispanic and non-Hispanic whites, those reporting farm work as their longest-held occupation had twice the odds of current asthma.<sup>53</sup>

The number of years worked in agriculture is a surrogate measure of exposures common to agricultural work through measurement of time. Observing an association between time and respiratory problems provides information on the overall effects of time on the whole population independent of the nature of the work. Nevertheless, development of respiratory problems attributable to the agricultural environment depends on more factors than just time, such as location, the nature of the work performed, and intensity and composition of the airborne pollutants. These potentially modifiable variables will be unique to each job workers engage in, and for farm workers, are complicated by the many jobs held throughout the entire agricultural work career. Determining the contribution of each

**TABLE 4.** Adjusted Odds Ratios and 95% Confidence Intervals for Migration Factors and Respiratory Symptoms for MICASA Participants by Sex

	Asthma* OR (95% CI)	Chronic Cough* OR (95% CI)	Chronic Bronchitis* OR (95% CI)	Persistent Wheeze* OR (95% CI)
Age at immigration				
Male	0.96 (0.88–1.05)	0.99 (0.91–1.07)	0.93 (0.85–1.03)	0.99 (0.92–1.06)
Female	0.99 (0.95–1.03)	1.00 (0.90–1.10)	1.02 (0.93–1.12)	1.02 (0.93–1.12)
Medium/high acculturation†				
Male	2.17 (0.56–8.41)	1.29 (0.18–9.18)	1.93 (0.23–16.00)	1.77 (.034–9.20)
Female	6.06 (1.40–26.29)	3.28 (0.43–25.31)	6.57 (1.27–33.92)	4.47 (0.98–20.52)
≥15 yrs in the United States‡				
Male	0.73 (0.30–1.76)	0.61 (0.21–1.79)	0.51 (0.18–1.44)	0.54 (0.20–1.40)
Female	3.60 (1.16–11.16)	0.75 (0.13–4.38)	0.53 (0.10–2.77)	0.58 (0.25–1.36)

\*Adjusted odds ratios calculated from separate logistic regression models for each migration factor and outcome. All logistic regression models were fit using survey data analysis procedures to account for the stratified clustered sampling design. Models were specified with age, current smoking, sex, and the migration factor as main effects and with an interaction term of sex with age at immigration, medium/high acculturation, and 15 and more years in the United States to facilitate the estimation of sex-specific adjusted odds ratios.

†Reference level: low acculturation level.

‡Reference level: less than 15 years in the United States.

CI, confidence interval; OR, odds ratio.

agricultural work-related exposure to the increase seen in respiratory symptoms in this population would inform farm workers and owners as to what part of agricultural work carries the greatest risk and suggest strategies to reduce these risks.

Despite clear differences between Latino subgroups, most research in the United States has focused on persons of Mexican origin when researching acculturation in Latinos.<sup>41</sup> Latinos are a heterogeneous group, and our analyses were not restricted to those of Mexican origin. In fact, just over 30% of study participants were from Central America, thus our findings have relevance for immigrants of both Central American and Mexican origin.

Studies often rely on place of birth, age at immigration, and length of time living in the United States as proxies of acculturation, but these measures assume that the acculturation level can be measured by the amount of time spent in the host society. Using proxies can result in a high percentage of misclassification. For example, Kasirye et al<sup>54</sup> found 31% of Latinas categorized as moderate-to-high acculturated with the ARSMA-II-SV would have been misclassified into the low-accultured category using place of birth alone. Use of an acculturation measure allowed for estimation of the acculturation level independent of exposure time. Despite a small proportion of highly acculturated women in the sample, a high level of acculturation was significantly associated with asthma and chronic bronchitis.

Limiting recall to the past 12 months allowed subjects to focus on details of their recent work history, improving the quality of information obtained on current exposure. Workers were asked to detail their most recent jobs first, followed by previous jobs. The questionnaire captured a detailed account of each job: start/end dates, type of work (ie, farm work vs non-farm work), crop, task, number of days worked per week, place of work, and dust rating.

The sample included farm workers engaged in a variety of commodities and in different capacities. There are many crops grown in California, and the sample reflected this. Although certain crops, such as melon, were more frequently reported than others, the sample allowed us to examine a wide range of California agriculture.

The lack of an observed association between dust and asthma, despite biological evidence of an adverse effect of dust on development of asthma and a higher risk among farmers and farm workers to develop asthma compared with other occupations,<sup>55</sup> may be due to misclassification of dust exposure. The reliability of the dust rating scale and ability of the summary dust measure to accurately assess

farm workers' dust exposure have not yet been validated. In general, however, there are very few standardized and validated questionnaires for exposure assessment.<sup>56</sup> An underestimation of the prevalence of asthma and respiratory symptoms could have occurred if individuals sensitive to respiratory irritants found in the agricultural environment self-selected themselves out of farm work. Underestimation could also occur from misclassification of asthmatic status. Previous research has found self-reporting of asthma to be biased in disease severity. Subjects with mild asthma were more prone to denial of their disease status, and thus mild asthmatic individuals were underrepresented in asthma prevalence and rate measures.<sup>57</sup> Nevertheless, the self-reported prevalence of asthma (6.12%) falls in the middle of the 4.5% to 8.1% asthma prevalence range reported by four other studies done in Hispanic populations,<sup>58</sup> suggesting that this type of underestimation is unlikely.

## CONCLUSIONS

It is likely that both agricultural exposures and immigration/acculturation factors are associated with increases in the prevalence of asthma in Latino farm workers. Furthermore, it seems that agricultural exposures do not explain the entirety of the increase among immigrants. Nevertheless, the specific risk factors for the increase in asthma among Latino immigrants are as yet unknown and may include the absence of factors present in the country of origin or the presence of new factors in the United States.

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