MICASA: Farm Worker Family Cohort Study
Final Technical Report

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List of terms and abbreviations

MICASA	Mexican Immigration to California: Agricultural Safety and Acculturation
PM	particulate matter

Abstract

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Hired farm workers provide the majority of the workforce for California's labor-intensive agricultural sector, and they also suffer the greatest health burden. California's hired farm workers face increased risks of morbidity and mortality from respiratory disease, musculoskeletal problems, infectious diseases, stress-related mental health disorders and lifestyle-related diseases such as obesity. There has been very little research into the etiology of the poor health outcomes that occur disproportionately in this population. The overall goal of this project was to continue with a longitudinal follow-up of a cohort of hired farm worker families in California that was established through supplemental funding from NIOSH. This research characterizes the demographic picture and a wide range of health behaviors and outcomes in a representative sample of immigrant farmworkers in California. The population is young and of Latin American origin. Overall income is low, as is educational level. Agricultural work was common among adolescents in the population and was associated with lower level of acculturation. Overall cigarette smoking frequency was low, but the frequency increased among women with increased level of acculturation. Low-level smoking (less than 5 cigarettes per day) was common in this population. Low-level smokers were more likely to be single and to experience frequent mental distress. Self-reported mental symptoms (depression, nervios) were common in the population and were associated with workplace injuries. Higher acculturation level was associated with higher level of dietary fat intake and being born in Latin America was associated with more fruit and vegetable intake. Dental care levels were poor, with the majority not having dental insurance and almost half having untreated caries. The study evaluated many illness and injury outcomes from agricultural work. For example, the use of personal protective equipment was uncommon except for work with pesticides. Chronic hip pain was associated with frequent stooping/bending at work, and with long hours of tractor driving. Most subjects had received training about heat illness at work, but knowledge about acclimatization was low and reported water intake was below recommendations for all subjects. Women were noted to drink less water at work than were men. Measurements of dust exposure showed high levels of inhalable particles, with levels varying by different crops. Pesticide residues were measured inside the houses of the study subjects. Permethrins, a type of pesticide, were detected in over half the households, which is similar to what has been found in other rural farmworker communities, but other pesticides were detected.

Section 1: Final Progress Report

Significant Key Findings

This study establishes a population-based, longitudinal approach to provide estimates of disease incidence and changes in health-related behaviors over time in a cohort of farm worker families. Through follow-up interviews, we will be able to obtain incident data for a variety of outcomes, including respiratory symptoms, injuries, and musculoskeletal problems.

Agricultural work and characteristics of work behaviors were identified that increase the risk of workplace illness and injury. These include repetitive postures associated with chronic hip pain, excessive dust exposure and respiratory health and inadequate water intake to prevent heat illness. The causes of these increased risk behaviors include lack of education, poverty, failure to use personal protective equipment at work, and the physical demands of agricultural work. Additionally, lifestyle behaviors were identified that are associated with adverse health outcomes. These include cigarette smoking, poor dietary intake and lack of dental hygiene.

Translation of Findings

There are several interventions possible to prevent workplace disease and injury based on these findings. Engineering changes to reduce the ergonomic stresses of agricultural work will help reduce incidence of chronic pain and other adverse musculoskeletal outcomes. These engineering changes can specifically look at the stresses of heavy equipment operation as well as harvesting and other farmwork tasks. With regard to heat stress, the first approach is educational. Beyond this, engineering and workplace changes to increase the acceptability and use of water will help reduce risk of heat illness.

Outcomes / Impact

Several of the outcomes described above are being addressed in current research. This includes a greater understanding on how to increase the methods to prevent heat illness. Educational programs have been developed and are being tested to improve dietary knowledge and intake among farmworkers.

1) Potential outcomes –

- New heat stress prevention programs have been developed.
- New clothing for field use to prevent heat stress are being created and tested.
- Programs for reduction of diabetes/obesity among farmworkers have been developed and are being tested among farmworker populations.
- Educational programs and interventions have been developed to improve dental health in this population.

2) Intermediate outcomes –

- New regulations to reduce heat stress have been proposed in California.
- Interventions are being developed to reduce cigarette smoking in the population.

3) Impacts –

- Provided direct education to farm worker families through 30 monthly community meetings since 2008 on wide variety of topics including pesticides, air quality, heat-related illness, injuries, alcoholism, gangs and violence, cancer, tobacco education and mental health.
- In 2011, provided 12 educational sessions on heat stress to over 130 farm workers.
- Conducted spirometry testing, anthropometry measures and provided education and handouts explaining to test results to over 450 participants.
- Conducted testing for pesticide residue in 110 farm family homes and provided education and test results back to families.
- Held annual health and information fair with participation from over 15 local and county public health and social services vendors with attendance by over 200 community members.
- Developed collaborations with other organizations including UCSF School of Dentistry's Center to Address Disparities in Children's Oral Health (The CAN DO Center), which provided dental exams to participant families evaluating dental caries and tooth loss, oral hygiene, gingivitis, periodontitis, and treatment urgency.
- MICASA Newsletter: *El Melon Rondero*, published from 2006-2011, was mailed to all participating families to provide information on project activities, such as the dental exams and breathing tests, and tips on improving health.

Section 2: Final Progress Report

Scientific Report

Hired farm workers provide the majority of the workforce for California's labor-intensive agricultural sector and increasing for agriculture across the country. They also suffer a large health burden, facing increased risks of morbidity and mortality from respiratory disease, injuries, infectious diseases, stress-related mental health disorders and lifestyle-related diseases. There has been little research into the etiology of poor health outcomes that occur disproportionately in this population. The overall goal of this project was to continue with a longitudinal follow-up of a cohort of hired farm worker families in California. This was done to improve our understanding of the causes of disease in this population, develop strategies to prevent complications from acute and chronic diseases, and provide a basis for effective public health and clinical interventions. The activities included in this project address National Occupational Research Agenda (NORA) priority areas by focusing on improving the health of a special population at risk—hired farm workers and their families.

The Farm Worker Family Cohort study developed from The Mexican Immigration to California: Agricultural Safety and Acculturation (MICASA) Study, a population-based sample of 400 hired farm worker families from Mendota, in California's Central Valley. The cohort was established in 2004-2006, and this study (2008-2013) provided longitudinal data to assess the incidence and prevalence of disease. Mendota was chosen because of its large proportion of immigrants from Mexico and Central America and high proportion of agricultural workers. Information on demographics, occupational and environmental risk factors, diet, food handling practices, food security, acculturation, smoking status, and health outcomes (respiratory health, injuries, mental health, and reproductive health) was collected. The findings were disseminated to participants, the larger farm worker community, policy makers and researchers to increase awareness of factors affecting health among hired farm worker families and to suggest approaches to improve health in the population.

Specific Aim 1: Measure the incidence of respiratory symptoms and agricultural injuries and assess the independent association of agricultural exposures and lifestyle factors to disorders such as respiratory symptoms, agricultural injuries, and musculoskeletal conditions.

Specific Aim 1a: Assess the relationship of exposure to dusts from agricultural activities to respiratory health. Outcomes will include respiratory symptoms and impaired pulmonary function measured through spirometry. Our hypotheses are that (1) total dust exposure is independently associated with an increased prevalence of respiratory symptoms; (2) total dust exposure is associated with lung function (FEV1, FEV6, FVC, FEV1/FVC, FEF25%-75%); (3) age, sex, and BMI modify the relationship between dust exposure with respiratory symptoms and pulmonary function.

Specific Aim 1b: Assess the contribution of agricultural work factors to acute injuries. A primary goal is to understand the relationship between specific work patterns and risk factors

for acute injury. These factors have not been well characterized, particularly in hired farm workers. Our hypotheses are that (1) job characteristics, type of employer, type of payment and number of farm jobs during the year are associated with acute injury incidence; (2) previous injury and musculoskeletal symptoms are independent risk factors for subsequent acute injury and (3) previous injury is a risk factor for loss to follow-up and change in employment out of farm work.

Specific Aim 1c: Assess the contribution of agricultural work factors to chronic musculoskeletal conditions. Our hypotheses are that (1) exposure to physical hazards and engaging in repetitive tasks are associated with musculoskeletal symptoms, and (2) previous injury and musculoskeletal symptoms are independent risk factors for subsequent musculoskeletal disability.

Specific Aim 1d: Assess the relationship between lifestyle factors, agricultural work factors and respiratory symptoms, agricultural injuries, and musculoskeletal conditions. Specifically, we are interested in characterizing lifestyle factors that are known to change with acculturation, such as dietary factors, obesity, and smoking habits and how these factors vary by characteristics related to farm work and their effect on health outcomes such as respiratory health, acute injury, and musculoskeletal conditions. Our hypotheses include: (1) lower intake of fruits and vegetables, regardless of smoking status, is associated with increased respiratory symptoms and poor pulmonary function; and (2) obesity, poor nutrition and smoking are associated with acute injury as well as more frequent and severe musculoskeletal symptoms.

Specific Aim 2: Conduct a nested case-control study to examine the prevalence and determinants of atopy, asthma and asthma symptoms. Atopy will be defined as a positive response to RAST testing with a panel of common allergens. Our hypotheses are that (1) workers with early childhood exposures to farms and livestock will have lower rates of atopy and asthma than those who did not have childhood exposures and (2) long-term exposure to farm work and livestock is associated with decreased atopy and atopic asthma.

Specific Aim 3: Determine levels of particulate matter exposure for crops and tasks commonly conducted by agricultural workers in our population. We plan to determine the validity of self-reported measures of dust exposure for hired farm workers (1) for same day self-reported exposure and (2) for self-reported exposure in a recall evaluation.

Specific Aim 4: Examine incident respiratory symptoms and changes in pulmonary function over time and assess the relationship between predictors such as occupational factors and acculturation with incident symptoms and changes in pulmonary function. Our hypotheses are that (1) respiratory symptom progression is associated with increased loss of lung function (FEV1, FEV6, FVC, FEV1/FVC, FEF25%-75%) and (2) occupational exposures and acculturation-related changes are independently associated with incident respiratory symptoms.

Methods

Mendota is located in Fresno County in the heart of California's Central Valley. The county encompasses 3,816,130 acres with much of this land devoted to agricultural production. Fresno County is the most productive agricultural county in the U.S. In 2007, the county produced over $5 billion in gross agricultural products, with grapes, almonds, milk, poultry, tomatoes, cotton, cattle, peaches, oranges and garlic as the leading commodities. Fresno County ranks first in agricultural worker population estimates in California due to the high numbers of hired farm workers employed in the agricultural sector. According to the U.S. Census Bureau, at the time of the household enumeration in 2005, the US Census Bureau estimated Mendota's population at 9,791 persons, of whom over 97% were of Hispanic/Latino ethnicity. Median household income was $25,422, and nearly one-third of the population reported income below the federal poverty level Mendota has traditionally been almost entirely dependent on agriculture for its economic well-being, with 44.1% of the city's population employed in this sector. Mendota's economy primarily depends on tomatoes, broccoli, corn, onions, cantaloupe and lettuce.

Enumeration and sampling

The goal of the sampling strategy was to select a random, community-based sample of Mexican and Central American immigrants residing in Mendota, California. A two-stage sampling process was employed, including the identification of eligible census tracts in Mendota and a door-to-door enumeration to identify eligible participants. In the first stage, we compiled a list of blocks within the two census tracts. A random sample of 67 blocks was selected. Enumerators then created a universal list of all dwellings (including houses, apartments, trailers, and garages) within these selected blocks using a door-to-door enumeration procedure. Once dwellings were mapped, enumerators returned to the each dwelling and enumerated the people living in the household. Through this enumeration procedure, we obtained the relationship of the house's occupants to the head of household (spouse, adult child, parent sibling, other), age, gender, ethnicity, involvement in farm work, years of residence in Mendota, and, for each head of

household, the number of children under the age of 18 years. A random sample of households was then selected to be invited to participate in the study.

Inclusion/exclusion criteria

Eligible participants included men and women, ages 18-55 years, self-identification as Mexican or Central American, head of household or spouse engaged in farm work at least 45 days in the last year, and residing in Mendota at the time of the interview.

Study components

The cohort was established and baseline health assessments were administered through supplemental funding from NIOSH (2004-2006) and The California Endowment (TCE). The Farm Worker Family Cohort (2008-2013) study included follow-up health assessments on the families comprising the cohort to provide longitudinal data to assess the incidence and prevalence of disease. Follow-up interviews were conducted with study participants twice during the study period, 2008-2009 and 2011-2012. Pulmonary function testing, measurement of vital signs and anthropometry were also done at these two time periods. An exposure measurement field campaign was done to assess exposure to particulate matter for the most common commodities and agricultural tasks (2009). Finally, a nested case-control sub-study was conducted that included anthropometry, nitric oxide testing, and blood collection for ascertainment of atopy status (2010).

Participation rates

Table 1. Summary of enumeration of 62 census blocks in Mendota, California, July 2005.

Disposition	Number	Percent (%)
Total dwellings mapped	1257	--
Farm worker households enumerated	729	58.0
Households with no farm workers	442	35.2
Vacant	40	3.2
Refused (did not want to provide information)	14	1.1
Business or other non-resident dwelling	6	0.5
Mapped but not enumerated	26	2.1

From the numeration, 467 households were recruited and participated in the MICASA study, and baseline interviews (2006-2007) were completed with 843 adults (Table 2).

Table 2. Participation and interview completion by household and individual.

	Households (1st enumeration)	Households (2nd enumeration)	Total Households	Total Individuals
Both head of household and spouse completed questionnaire	305	71	376	752
One household member completed questionnaire	15	6	21	21
Single head of household completed questionnaire	20	9	29	29
Unaccompanied male household completed questionnaire	41	0	41	41
Total	381	86	467	843
Declined participation	121	82	203	--
Ineligible	179	172	351	--
Unable to contact	48	--	--	--

Mendota lies within the geographical boundaries of Fresno County, but it is much less diverse economically, demographically, and occupationally than the county as a whole. Therefore, the characteristics of the MICASA enumerated population were compared to other California survey data: Fresno County Latinos interviewed in the 2005 CHIS and US Census 2000 data. The results are in Table 3.

Table 3. Population comparison with the 2005 CHIS and U.S. Census 2000 data.

	MICASA Enumerated Population[a] (n = 2441), % (n)	Fresno County Latinos, 2005 CHIS,[b] %	χ^2 and p-value Comparison, Fresno County Latinos and Enumeration	2000 U.S. Census Data,[c] %	χ^2 and p-value Comparison, 2000 U.S. Census and Enumeration
Gender					
Male	66.0 (1600)	50.4	**5.02**	60.4	0.69
Female	33.9 (822)	49.6	**(p = 0.03)**	39.6	(p = 0.41)
Age					
18-29 years	42.1 (1020)	39.0	2.62	38.6	1.49
30-44 years	37.9 (917)	34.0	(p = 0.27)	34.1	(p = 0.47)
45+ years	20.0 (485)	26.9		27.3	
Country of birth					
Mexico	54.6 (1321)	51.7	**32.64**		
Central America	35.0 (848)	0.4	**(p < 0.0001)**		
U.S.	10.0 (243)	47.1			
Other	0.3 (8)	0.8			
Years living in U.S.					
0-4 years	31.3 (746)	16.4	**16.03**	25.8	0.77
5-14 years	34.4 (820)	30.3	**(p = 0.0003)**	38.2	(p = 0.68)
15+ years	34.3 (819)	53.3		36.0	
Occupation[d]	85.8 (2088)	16.7	**135.3**	51.4	**27.3**
			(p < 0.0001)		**(p < 0.0001)**

[a] Enumerated population = all adults over 18 years residing in household in first enumeration, July 2005.

[b] Data for Latinos in Fresno County from 2005 CHIS, restricted to adults, ages 18 and older.

[c] U.S. Census 2000 data extracted for census tracts 83.01 and 83.02 defining area of Mendota, Fresno County, California.

[d] Occupation defined in the 2005 California Health Interview Survey and in the U.S. Census 2000 included agriculture, forestry, fishing, and hunting. Enumerated population answered occupation more specifically as agricultural work.

Questionnaire / Survey Instrument

An interviewer-administered questionnaire was conducted with all participants collecting information on demographics, acculturation, occupational and environmental risk factors, smoking status and health outcomes (respiratory symptoms, injuries, mental health, dental health). The survey instrument was developed in both Spanish and English, with back translation to ensure accuracy. Survey questions relied on relevant existing survey instruments and were developed by consensus among the investigators and revised after review and pilot testing in the community.

The questionnaire was completed through in-person interviews and required approximately one hour to administer. All of the interviewers were local residents, which provided the added benefit of a level of trust among community members as the interviewers were familiar with the local culture. The interviewers were extensively trained, and their interviewing techniques were monitored to optimize objective, unbiased responses and confidentiality.

After the baseline questionnaire, the entire cohort was interviewed at two follow-up time points over the course of the study. Additionally, a nested case-control study examined asthma and atopy in a subset of the cohort, and dust sampling was done at farm sites with workers, not necessarily part of the cohort, but to generate exposure estimates for types of agricultural work indicative of the area. Retention numbers and questionnaire topics can be seen in Table A and Table B, respectively. Keys to maintaining good follow-up rates included stability of the farm workers' permanent homes, predictable timing of migration, and a longstanding research program with established community contacts. The study had several mechanisms for following participants over time. Of primary importance was that the fact that the study was community-based, with a local field coordinator and field research team. For example, after completion of the baseline interview, thank you notes were sent and follow-up telephone contact was made to check in with each family.

Lastly, we followed techniques utilized in the National Agricultural Workers Study that have been highly successful in obtaining high follow-up rates. These included incentives to complete follow-up surveys and multiple contact information on participants (e.g. name of relatives) that could be used to locate participants whom may have moved.

Table A: Longitudinal completion cohort numbers for original questionnaire, follow-up questionnaire, and spirometry testing.

	Baseline* (2005-2006)	**Follow-Up #1 (2008-2009)**	**Follow-Up #2 (2011-2012)**		**Spirometry 2009**	**Spirometry 2011**
Completed questionnaire		640	505		455	460
Both HOH and spouse completed	752					
One member completed (either HOH or spouse)	21					

Single HOH	29					
Solo Males (not followed after baseline)	41	40				
Declined		75	96		137	21
Ineligible					84	120
Deceased		3	1			1
Lost to follow-up		105	38		109	38
Unable to complete					4	
Total:	**843**	**863**	**640**		**789**	**640**

*Cohort recruited and baseline interviews completed 2004-2006, prior to longitudinal study.

Table B: MICASA baseline and follow-up questionnaire topics (2005/6, 2008/9 and 2011/12).

TOPIC	BASELINE	FU 1	FU 2
Demographics Includes family and household composition	✓	Updates only	
Home environment and exposures	✓	Updates only	
Use of pesticides in home last 12 months	✓	✓	✓
Smoking, Alcohol, Drugs	✓	Smoking and alcohol	Smoking
Occupational history and farm exposures last 12 mo	✓	✓	✓ Included work conditions, and rights
Occupational pesticide use last 12 months	✓	✓	✓
Musculoskeletal exposures at work	✓	✓	
Musculoskeletal problems / symptoms and work ability	✓	✓	✓
Medical history and quality of life (HRQL)	✓ HRQL	HRQL	HRQL
Injury (general and occupational) last 12 mo	✓	✓	✓
Respiratory health (ATS) including atopy	✓	✓	✓
Female reproductive health	✓	✓	✓
Male sexual and reproductive health	✓		
Diabetes	✓	✓	
Diet last 12 mo (food	✓		✓

frequency)			
Sanitary Food prep	✓		✓
Food security	✓	✓	
Physical activity last 30 days	✓	✓	✓
Weight history	✓		
Stress / depression / mental health – history and last 2 week symptoms	✓	✓	✓
Acculturation	✓		✓
Wages and family income	✓	✓	✓
Heat Illness history and exposures		✓	✓

Statistics

In general, we begin each statistical analysis with descriptions of the marginal and joint distributions of outcome and exposure measures and important covariates. We used generalized linear models for clustered data to address our analytical goals. These models allowed us to produce covariate-adjusted relative-risk estimates for the exposures of interest, while correcting for the within-household and over-time residual correlations that are expected to be present in our sample data, which consists of repeated measures collected prospectively from members in a clustered sample of households. The multivariate regression models were built in a disciplined sequence to ensure that the model was appropriately specified.

Survey data analysis procedures were used to estimate unconditional logistic regression models, with census tract and block specified as stratum and cluster identifiers, respectively. Hence, regression-adjusted statistical contrasts accounted for sampling design effects, including correlated observations within households nested within census blocks, using the standard "ultimate cluster" approach. For exact logistic regression models, we accounted for census tract by including this term as a so-called nuisance term in the regression model.

Results

As reported by *Stoecklin-Marois et al. (2011)*, there were no significant differences between the US census data and the enumeration data on gender, age, and years living in the US. However, the enumeration data captured a greater proportion of agricultural workers than reported by the census data, as expected given the parameters of enumeration and sampling in the study. Alternatively, the 2005 CHIS data were significantly different from the enumeration data on all of these parameters, except age group. While an equal proportion of men and women were interviewed for the 2005 CHIS, two-thirds of the enumerated Mendota sample consisted of men ($p = 0.03$). The enumerated sample included more individuals born in Central America than were interviewed for the 2005 CHIS (35% vs. 0.4%). Additionally, CHIS 2005 interviews included a much larger population of US born Latinos ($p < 0.0001$) and those residing in the US for 15 or more years ($p = 0.0003$), reflecting a Latino population that is less likely to

work in agriculture. Thus, the MICASA population was more likely to be male, from Central America, work in agriculture, and have fewer years residency in the U.S. than CHIS respondents.

The household enumeration strategy also captured the breadth of dwelling types in which farm worker families reside. Approximately 9% of the enumerated dwellings were back houses or unofficial dwellings that may have been missed by the U.S. Census 2000. Demographic comparisons between the enumerated population, census data, and CHIS data highlight the differences in these sampling methods and suggest possible demographic changes in hired farm workers in California. While difficulties in accessing hired farm workers often account for the lack of population-based research, the MICASA cohort provides an opportunity to examine occupational health patterns relevant to other farm worker populations.

To further understand migration-related public health issues of the MICASA cohort and the sampling methods, MICASA was compared to the Immigration, Work and Health (ITSAL) study conducted in Spain. While international migration is a growing global phenomenon, it has yet to be generally accepted as an exposure in and of itself, yet it encompasses a wide range of experiences and health effects. *Sousa et al. (2014)* compared self-rated health between MICASA and ITSAL. Sousa observed a greater gender balance in the MICASA sample than the ITSAL sample, where there was a substantial male majority. Mexican-born workers in the MICASA sample tended to be older, less educated, and more likely to work in agriculture than their Moroccan-born counterparts in the ITSAL study. The MICASA sample also had a higher prevalence of poor self-rated health compared to the ITSAL sample. Differences may be due to sampling and data collection issues, cultural issues and the subjectivity of self-rated health as an outcome, as well as actual health differences.

Specific Aim 1: Measure the incidence of respiratory symptoms and agricultural injuries and assess the independent association of agricultural exposures and lifestyle factors to disorders such as respiratory symptoms, agricultural injuries, and musculoskeletal conditions.

Specific Aim 1a: Assess the relationship of exposure to dusts from agricultural activities to respiratory health. Outcomes will include respiratory symptoms and impaired pulmonary function measured through spirometry. Our hypotheses are that (1) total dust exposure is independently associated with an increased prevalence of respiratory symptoms; (2) total dust exposure is associated with lung function (FEV1, FEV6, FVC, FEV1/FVC, FEF25%-75%); (3) age, sex, and BMI modify the relationship between dust exposure with respiratory symptoms and pulmonary function.

- **Agricultural work**

Agricultural work is hazardous, and immigrant workers perform the majority of production tasks, yet there are few data describing agricultural work and use of protective measures by demographic characteristics. McCurdy et al. (2014) examined cross-sectionally the influence of region of birth (Mexico vs. Central America) and sex on agricultural work and use of protective measures in the MICASA cohort of immigrant Latino farm workers in Mendota, California. Of 445 participants, 293 (65.8%) were born in Mexico (163 men, 130 women) and 152 (34.2%) were born in Central America (80 men, 72 women). Men worked on average 74.4 more days

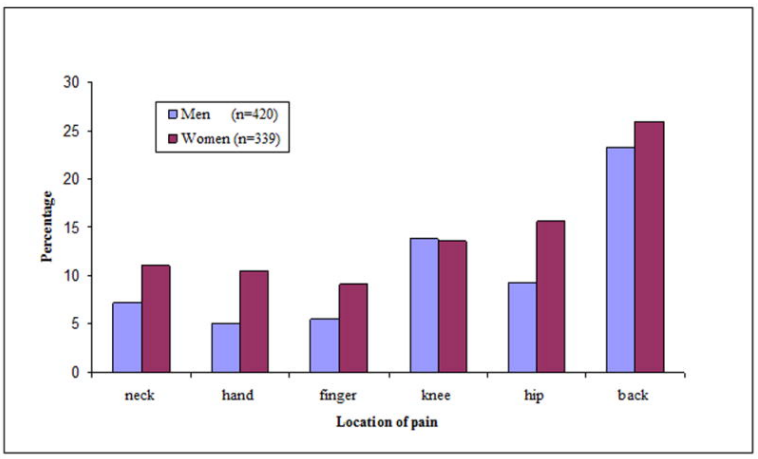
than women (95% CI 62.0, 86.9) and were more likely to perform tasks requiring high levels of training or strength, such as machine operation, pruning, picking, planting, and irrigation; more likely to work in dusty conditions; and more likely to work directly with pesticides. Women predominated in packing. Respondents from Mexico were more likely to work with tomatoes and less likely to work with melon and lettuce. Central America-born respondents were less likely to engage in planting, irrigation, and pesticide use. Use of task-appropriate personal protective measures on at least a half-time basis was rare, with the exception of persons working with pesticides (a group limited to men) and for facial scarves among Central American women. The authors determined that work should focus on identifying barriers to use of preventive measures and programs to further their use. Educational models accounting for cultural factors and driving social norm change, employer engagement, and use of community health workers (promotores) may be helpful in promoting use of preventive measures.

Specific Aim 1b: Assess the contribution of agricultural work factors to acute injuries. A primary goal is to understand the relationship between specific work patterns and risk factors for acute injury. These factors have not been well characterized, particularly in hired farm workers. Our hypotheses are that (1) job characteristics, type of employer, type of payment and number of farm jobs during the year are associated with acute injury incidence; (2) previous injury and musculoskeletal symptoms are independent risk factors for subsequent acute injury and (3) previous injury is a risk factor for loss to follow-up and change in employment out of farm work.

Specific Aim 1c: Assess the contribution of agricultural work factors to chronic musculoskeletal conditions. Our hypotheses are that (1) exposure to physical hazards and engaging in repetitive tasks are associated with musculoskeletal symptoms, and (2) previous injury and musculoskeletal symptoms are independent risk factors for subsequent musculoskeletal disability.

- **Injury**

Agriculture poses varied dangers to hired farm workers in the U.S., but little information exists on occupational risks for chronic musculoskeletal pain. Therefore, *Xiao et al. (2013)* examined common work positions, such as kneeling, carrying heavy loads, and repetitive motion in the MICASA population that may increase the risk for chronic musculoskeletal pain. Chronic pain was defined as pain lasting 6 weeks or longer at specific body sites (back, knee, hip, etc.) over the entire farm work career. Chronic pain was associated with older age and female sex.



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

After adjustment for age, years working in agriculture, and smoking, stooping/bending >30 hr/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 hr/week was associated with increased odds of chronic hip pain (OR = 2.16, 95% CI: 1.02-4.54) among men. There were also significant associations with kneeling or crawling >35 hr/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. Thus, chronic musculoskeletal pain was found prevalent among the farm workers and was associated with common work positions. The authors felt that 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.

McCurdy et al. (2013) conducted a follow-up survey of the MICASA cohort for injury. Among 560 participants, the authors observed a cumulative 1-year injury incidence of 6.6% (all injuries) and 4.3% (agricultural injuries). Increased prospective injury risk was associated with males, US birth, years lived in the United States, family income, and poor self-rated health. Agricultural injuries were associated most frequently with being struck by an object, falls, and cutting instruments, whereas over two thirds of nonagricultural injuries involved motor vehicles. Prevention should focus on safe handling of tools and materials, falls, and motor vehicle safety.

Specific Aim 1d: Assess the relationship between lifestyle factors, agricultural work factors and respiratory symptoms, agricultural injuries, and musculoskeletal conditions. Specifically, we are interested in characterizing lifestyle factors that are known to change with acculturation, such as dietary factors, obesity, and smoking habits and how these factors vary by characteristics related to farm work and their effect on health outcomes such as respiratory health, acute injury, and musculoskeletal conditions. Our hypotheses include: (1) lower intake of fruits and vegetables, regardless of smoking status, is associated with increased respiratory symptoms and poor pulmonary function; and (2) obesity, poor nutrition and smoking are associated with acute injury as well as more frequent and severe musculoskeletal symptoms.

- **Smoking**

Cigarette smoking is the most preventable cause of death in the U.S. Research regarding the phenomenon of low-level smoking, defined as smoking one to five cigarettes per day (CPD) on average, is increasing as its high prevalence is better recognized. *Rodriquez et al. (2014)* analyzed the MICASA cohort for patterns and behaviors of cigarette smoking, establishing demographic, migration-related, and psychosocial characteristics and risk factors for low-level smoking. The investigators found that 7% of participants were current smokers, 61% of them being low-level smokers. Low-level smokers did not smoke as many days during the past month as those who smoked 6+ CPD (p=0.04).

	Total		Never & former		Low-level		6+ CPD	
	% (n) (n= 620)		% (n) (n= 574)		% (n) (n= 28)		% (n) (n= 18)	
Sex**								
Male	45	(277)	43	(245)	71	(20)	67	(12)
Female	55	(343)	57	(329)	29	(8)	33	(6)
Foreign birtha*	97	(600)	97	(558)	93	(26)	89	(16)
Married/living with someone*	95	(586)	95	(546)	86	(24)	89	(16)
Lived >15 years in the U.S.a**	43	(267)	41	(236)	64	(18)	72	(13)
Low acculturation levela	97	(581)	97	(540)	93	(26)	88	(15)
aData assessed at the baseline interview.								

*p<0.05 for the comparison between all groups.

**p<0.01 for the comparison between all groups.

Low-level smokers were more likely than never and former smokers combined not to be married and to experience frequent mental distress. Those who smoke 6+ CPD were also more likely than never and former smokers combined to experience frequent mental distress and to be more acculturated. Low-level smokers have characteristics and risk factors that set them apart from other types of smokers. The increased understanding of low-level smokers can enhance public health education and smoking cessation programs targeted at Latinos.

Rodriquez et al. (2013) also investigated light smoking in Latino smokers as reported in the 2007-2008 National Health and Nutrition Examination Survey (NHANES) or the 2009 California Health Interview Survey (CHIS). Logistic regression assessed factors associated with very light smoking. Among NHANES smokers, those born in Mexico or who lived fewer years in the US were more likely to be very light smokers than 6+ CPD smokers. Among CHIS smokers, those born in Mexico, in another Spanish speaking country, or who spent smaller percentages of their life in the US were more likely to be very light smokers.

- **<u>Mental Health</u>**

While many studies report on the risks of agricultural injury, few have examined psychosocial factors associated with injury, especially among Latino farm workers. *Xiao et al. (2014)* examined psychological factors, including depression, perceived stress, social support and nervios that may be associated with an increased risk of injury based on the MICASA questionaire. A qualifying injury was defined as one with the need for medical care, going to a medical setting, loss of consciousness, >½ day lost work time or restricted from normal activities. The mean age of the

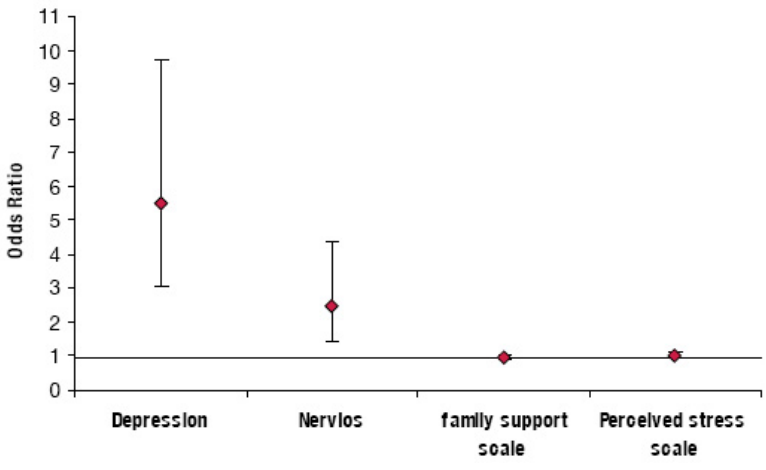


Figure 1. Adjusted ORs and 95% CI for psychosocial factors associated with injury in California farm workers

participants was 37.9 years, and 65.0% were born in Mexico and 27.7% were born in El Salvador. The past-year cumulative incidence of injury was 9.0%. A higher cumulative incidence of past-year injury was observed among participants older than 40 years (55.9% vs. 37.1 %), current smokers (17.7% vs. 10.7%), working in agriculture more than 11 years (65.7% vs. 52.7%), and long-term U.S. residents (more than 21 years) (58.8% vs. 42.6%). After adjusting for age, sex, and current smoking, depression (OR=5.4, 95% CI: 3.1-9.4) and nervios (OR=2.2, 95% CI: 1.3-3.8), a culturally defined condition of psychological stress, were significantly associated with injury. The investigators concluded that the results have the potential to for guide prevention and management of injury.

O'Conner et al. (2013) examined the prevalence of nervios and associated risk factors, including drug and alcohol use, acculturation, and housing conditions in the MICASA cohort. Data from 422 men, 381 accompanied (family) males and 41 unaccompanied males, was studied. They found the prevalence of nervios was 22 %, with no difference in prevalence by household status. Low family incomes, drug use, medium/high acculturation, and poor housing conditions were associated with increased odds of nervios. Self-reported poor/fair health, depressive symptoms, and high perceived stress were also associated with nervios. Since nervios has been shown to be a clinical indicator of psychiatric vulnerability among Latinos, this analysis furthers public health goals of reducing health disparities.

- **Diet**

Matias et al. (2013) examined adherence to dietary recommendations on fruit/vegetable and fat intake and identified correlates with acculturation indicators as well as with family, lifestyle, and occupational factors in the MICASA study. Fruit/vegetable consumption and fat intake was assessed using the Block Fruit/Vegetable/Fiber Screener and the Block Dietary Fat Screener, respectively. Survey data analysis methods for contingency tables and logistic regression were used for assessing associations. The sample included 802 participants, reporting mean fruit and vegetable intake (± SD) of 5.0 ± 1.5 daily servings, and 47% reporting < 5 daily servings. Being born in Mexico or Central America and longer United States residency were associated with higher odds of consuming ≥ 5 daily fruit/vegetable servings and more frequent consumption of field products while working was associated with lower adherence to this recommendation.

Adherence to Dietary Recommendations Is Associated with Acculturation among Latino Farm Workers

TABLE 2

Unadjusted ORs and AORs and 95% CIs for consumption of ≥ 5 fruit/vegetable servings per day among MICASA study participants[1]

Variable	n[2]	≥ 5 fruit/vegetable servings/d	
OR (95% CI)	AOR[3] (95% CI)		
Acculturation			
Country of birth (ref: United States)	697		
Mexico		2.0 (1.0–3.8)	2.1 (1.0–4.2)
Central America		2.6 (1.2–5.7)	2.7 (1.2–6.2)
≥ 14 y living in United States (ref: < 14)	694	1.3 (0.9–1.8)	1.5 (1.0–2.3)
≤ 21 y old at immigration to United States (ref: > 21)	666	1.1 (0.7–1.6)	1.1 (0.8–1.7)
Attended school in United States (ref: no)	667	0.7 (0.4–1.0)	0.6 (0.4–1.0)
Medium/high acculturation level (ref: low)	679	0.8 (0.4–1.4)	0.7 (0.4–1.6)
Family characteristics			
Family ate together ≥ 4 times/wk (ref: no)	691	1.6 (1.1–2.4)	1.5 (1.0–2.4)
Child at home (ref: no)	697	1.1 (0.8–1.6)	1.1 (0.7–1.7)
Lifestyle factors			
Current smoker (ref: no)	696	0.8 (0.5–1.4)	0.8 (0.5–1.3)
Moderate/heavy alcohol drinker (ref: light drinker)	689	1.0 (0.7–1.5)	1.0 (0.7–1.4)
Consumed fast food ≥ 1 time/wk (ref: no)	695	1.1 (0.8–1.6)	1.1 (0.8–1.6)
Occupational factors[4]			
≥ 12 y working in agriculture (ref: < 12 y)	621	1.2 (0.8–1.8)	1.5 (1.0–2.5)
Worked in a fruit or vegetable crop (ref: no)	575	0.5 (0.3–1.0)	0.5 (0.3–1.1)
Ate field products while working (ref: never)	588		
Sometimes/half time		0.9 (0.6–1.3)	0.9 (0.6–1.3)
Most times/always		0.5 (0.3–0.7)	0.5 (0.3–0.7)

- ↵1 AOR, adjusted OR; MICASA, Mexican Immigration to California: Agricultural Safety and Acculturation; ref, reference.
- ↵2 Sample sizes vary due to intermittent nonresponse.
- ↵3 Separate multiple logistic regression models were fit for each reported independent variable to statistically adjust for age, gender, income, education, and season at baseline interview.
- ↵4 Sample limited to those who ever worked in agriculture.

The average daily percent of calories from fat was 35.0 ± 4.1% and 53% of participants consumed > 35% of daily calories from fat. Men born in Mexico, women born in Central America, and participants who worked in fruit or vegetable crops had higher odds of consuming ≤ 35% of calories from fat. Higher acculturation level, United States school attendance, and having a child at home were associated with lower adherence to this recommendation. Acculturation, family, and occupational correlates of diet quality were identified in this underserved, immigrant population. Our findings may assist nutrition program targeting and intervention efforts.

- **Dental**

Finlayson et al. (2010) examined past-year dental visits among the MICASA families using the Andersen Behavioral Model of Health Services Utilization, which posits that predisposing, enabling, and need factors influence care-seeking behavior. Oral health survey and clinical data were collected in 2006-2007 from the families as part of a larger, population-based study. Generalized estimating equation logit regression assessed effects of factors on having a dental visit among adults (N = 326). Predisposing variables included sociodemographic characteristics, days worked in agriculture, self-rated health status, and dental beliefs. Enabling factors included resources to obtain services (dental insurance, income, acculturation level, regular dental care source). Need measures included perceived need for care and reported symptoms, along with clinically determined untreated caries and bleeding on probing.

			GEE logit model
	OR	95% CI	p-value
Predisposing factors			
Age	1.05	1.03-1.09	<0.0001
Male	0.76	0.49-1.18	0.2160
Married	1.96	1.13-3.39	0.0171
Days work farming	1.00	0.99-1.01	0.4818
Ask dentist advice	3.73	2.24-6.20	<0.0001
Fair/Poor general health	0.75	0.45-1.26	0.2835
Enabling factors			
ARSMA-II Acculturation scale	1.09	0.87-1.38	0.4408
Education	0.98	0.92-1.05	0.5329
Income $10,000-$19,999	1.26	0.77-2.06	0.3524
Income $20,000+	1.76	1.00-3.12	0.0514
Household size	1.17	1.01-1.35	0.0332
No dental insurance	0.25	0.15-0.41	<0.0001
Regular source dental care	4.45	2.73-7.23	<0.0001
Need factors			
Untreated decay	0.61	0.38-0.99	0.0462
Any gum bleeding on probing	0.55	0.35-0.89	0.0138
Self-reported symptoms	0.81	0.74-0.88	<0.0001
Subjective need	0.52	0.28-0.95	0.0329

Table: GEE Logit regression analyses with a prior year dental visit (N=326)

Only 34% of adults had a past-year dental visit, despite 44% reporting a regular dental care source. Most (66%) lacked dental insurance, and nearly half (46%) had untreated caries. Most (86%) perceived having current needs, and on average, reported a mean of 4.2 dental symptoms (of 12 queried). Regression analyses indicated those with more symptoms were less likely to have a past-year dental visit. Those who would ask a dentist for advice and had a regular dental care source were more likely to have a past-year dental visit. The final model included predisposing, enabling, and need factors. Despite low utilization and prevalent symptoms, having a regular source of care helps break this pattern and should be facilitated.

- **<u>Adolescence</u>**

While studies have looked at the relationship of adolescent employment with health outcomes and risk behaviors, few have focused on children of hired farm workers. These children face unique challenges affecting their health and work environment. Exploring the frequency and nature of agricultural work characteristics among adolescent children of Hispanic hired farm workers is important for assessing the potential risks they face. *Hennessy-Burt et al. (2013)* selected a cross-sectional random sample of adolescents (ages 11 to 18) from the MICASA study. The adolescents were interviewed to assess work history, place of birth, and acculturation. Of this cohort, 38% of participants were female and 62% were male; 55% were born in the U.S., 38% in Mexico, and 7% in El Salvador; and 49% worked for pay during the last year. Among those who worked, farm work was most frequently reported (73.5%). Among those who had done farm work, the mean age at initiation was 14 years, and they worked a mean of 4.3 weeks during the previous year. Hoeing, picking, and packing/sorting were the most common tasks. In models adjusted for age and sex, low-acculturated adolescents were more likely than moderately acculturated to have worked in the past 12 months, to start work younger than age 14 years, and to do farm work. It was concluded that farm work is common among adolescents in this Hispanic agricultural community and is strongly associated with foreign birth and low acculturation.

- **Heat-related Illness**

Global climate change has great potential for escalating the number and duration of extreme heat events in California. California accounts for 16% of U.S. crop production, and over 450,000 people are employed in agriculture, with more than two-thirds being of Latino ethnicity. Despite Cal/OSHA regulations, which specify that potable water, toilets, shade and rest be provided to agricultural workers, heat related illnesses and deaths still occur. In a follow-up interview of the MICASA study population, *Stoecklin-Marois et al. (2013)* found that of the 474 study participants, men reported an average of 222 d (SD=69.7) of agricultural work compared to 148 d (SD=67.3) for women (p<0.0001).

Table 2. Assessment of heat-related knowledge and practices

Characteristic	Total (n=474) Percent (n)	Male (n=263) Percent (n)	Female (n=211) Percent (n)	*p*-value*
Received training about the dangers of working in the heat	91.6 (434)	87.5 (230)	96.7 (204)	0.0003
Heat knowledge score*				
High (score = 4 or 5)	70.0 (332)	76.1 (200)	62.6 (132)	0.0014
Low (score < 4)	30.0 (142)	23.9 (63)	37.4 (79)	
^Which of the following are most likely to put you at risk for a heat disorder?				
Wearing dark colored clothing while working outdoors (correct answer)	98.9 (486)	98.5 (258)	99.5 (210)	0.2144
^Amount of time for body to acclimatize to working in heat				
< 2 h	44.3 (210)	44.5 (117)	44.1 (93)	0.1529
2–14 h	29.1 (138)	31.6 (83)	26.1 55)	
2–14 d (correct answer)	24.3 (115)	20.9 (55)	28.4 (60)	
2–14 wk	2.3 (11)	3.0 (8)	1.4 (3)	
^Which of the following factors can lead to an increased risk of heat stress?				
Age	92.0 (436)	90.5 (238)	93.8 (198)	0.1826
Prior history of heat-related illness	64.8 (307)	75.3 (198)	51.7 (109)	<0.0001
Overweight	95.6 (453)	95.1 (250)	96.2 (203)	0.5448
Employer provides beverages at work site	87.8 (416)	79.5 (209)	98.1 (207)	<0.0001
Times/day drink employer-provided beverages (mean; SD)	10.7 ± 5.7	11.1 ± 6.1	10.3 ± 5.3	0.1151
Employee brings his/her own beverages to work site	29.7 (140)	44.9 (118)	10.5 (22)	<0.0001
Comfort level with taking break to drink water				
Very comfortable	79.0 (372)	87.0 (228)	68.9 (144)	<0.0001
Somewhat comfortable	18.5 (87)	11.8 (31)	26.8 (56)	
Neither comfortable nor uncomfortable	0.9 (4)	0 (0)	1.9 (4)	
A little uncomfortable	0.9 (4)	1.2 (3)	0.5 (1)	
Very uncomfortable	0.9 (4)	0 (0)	1.9 (4)	
Level of concern related to risk of heat illness at work				
Not at all concerned	47.1 (222)	64.6 (170)	25.0 (52)	<0.0001
A little concerned	44.2 (208)	30.0 (79)	62.0 (129)	
Very concerned	8.7 (41)	5.3 (14)	13.0 (27)	
Able to take a 5 min break every hour if experiencing symptoms of heat stress	89.7 (425)	83.7 (220)	97.2 (205)	<0.0001
Shaded area available for to take breaks out of the sun	93.0 (440)	88.9 (233)	98.1 (207)	<0.0001

Percent=percentage of participants reporting, n=number of participants reporting.

*χ^2 tests comparisons to examine differences by gender.

^ Specific questions used in calculating Heat knowledge score.

Over 91% of participants reported receiving training on heat-related illness, but the level of heat illness knowledge was moderate, with 70% responding correctly to 4-5 questions.

Knowledge about acclimatization was low, with 44% severely underestimating the time required, and water consumption was low at an average of 10.7 drinks per day. The results highlight important areas to target for heat illness prevention in farm worker populations and that gender specific approaches may be needed for effective heat illness prevention.

- **Pesticide exposure**

Indoor pesticide exposure is a growing concern, particularly for pyrethroids, a commonly used class of pesticides. Pyrethroid concentrations may be especially high in homes of immigrant farm worker families, who often live in close proximity to agricultural fields and are faced with poor housing conditions, potentially causing high pest infestation and pesticide use. *Trunnelle and colleagues (2013)* investigated levels of pyrethroids in the house dust of family homes of MICASA mothers and children. Pesticide use data and levels of pyrethroid pesticides in indoor dust collected in 2009 were determined by questionnaires and a GC/MS analysis of the pyrethroids cis- and trans-permethrin, cypermethrin, deltamethrin, esfenvalerate and resmethrin in single dust samples collected from 55 households.

Table 2.

Detection frequencies, select percentiles and maximum pyrethroid concentrations reported per mass dust (ng/g) and per surface area (ng/m^2) from the MICASA Home Pesticide Study, 2009 (n = 55).

	Pyrethroid	%D	50th	75th	90th	95th	Max
ng/g dust	Cis-permethrin	67	244	568	670	755	1410
	Trans-permethrin	67	172	207	274	421	1737
	Cypermethrin	52	186	590	3223	7036	15,059
	Esfenvalerate	44	< LOD	246	426	454	585
	Resmethrin	29	< LOD	161	208	261	964
	Deltamethrin	20	< LOD	< LOD	250	385	701
ng/m^2	Cis-permethrin	67	16	22	36	56	80
	Trans-permethrin	67	5.7	6.7	9.3	14	98
	Cypermethrin	52	18	63	175	334	516
	Esfenvalerate	44	< LOD	12	15	16	19
	Resmethrin	29	< LOD	5.2	6.1	6.6	54
	Deltamethrin	20	< LOD	< LOD	13	15	16

Cis- and trans-permethrin had the highest detection frequencies at 67%, with median concentrations of 244 and 172ng/g dust, respectively. Cypermethrin was detected in 52% of the homes and had a median concentration of 186ng/g dust. Esfenvalerate, resmethrin and deltamethrin were detected in less than half the samples. Pyrethroid concentrations found in the study were compared to other studies looking at both rural and urban homes and daycares. Lower detection frequencies and/or lower median concentrations of cis- and trans-permethrin and cypermethrin were observed in the MICASA study as compared to those studies. However, deltamethrin, esfenvalerate and resmethrin were detected more frequently in the house dust from the MICASA study than in the other studies. Because households whose children had

higher urinary pyrethroid metabolite levels were more likely to be analyzed in this study, a positive bias in the estimates of household pyrethroid levels may be expected. A positive association was observed with reported outdoor pesticide use and cypermethrin levels found in the indoor dust samples (rs=0.28, p=0.0450). There was also a positive association seen with summed pyrethroid levels in house dust and the results of a pesticide inventory conducted by field staff (rs=0.32, p=0.018), a potentially useful predictor of pesticide exposure in farm worker family homes.

To further study indoor pesticide exposure, *Trunnelle et al. (2014)* did an ELISA based analysis of metabolite 3-phenoxybenzoic acid (3PBA), a metabolite of pyrethroid, levels among 105 women and 103 children in the MICASA study. The median urinary 3PBA levels (children=2.56ug/g creatinine, mothers=1.46ug/g creatinine) were higher than those reported in population based studies for the United States general population, but similar to or lower than studies with known high levels of pyrethroid exposure. A positive association was evident between poor housing conditions and the urinary metabolite levels, showing that poor housing conditions are a contributing factor to the higher levels of 3PBA seen in the urine of these farm worker families.

Specific Aim 2: Conduct a nested case-control study to examine the prevalence and determinants of atopy, asthma and asthma symptoms. Atopy will be defined as a positive response to RAST testing with a panel of common allergens. Our hypotheses are that (1) workers with early childhood exposures to farms and livestock will have lower rates of atopy and asthma than those who did not have childhood exposures and (2) long-term exposure to farm work and livestock is associated with decreased atopy and atopic asthma.

Protocol and procedures development began May 2010 with staff training for conducting testing during the summer. Office visits to collect blood samples were done October-December 2010. This component of the study included collaboration with the UC Davis Clinical and Translational Science Center (CTSC) funded through Grant Number UL1 RR024146 from the National Center for Research Resources (NCRR), a component of the National Institutes of Health (NIH), and NIH Roadmap for Medical Research. Through this collaboration, the CTSC provided in-kind nursing support. Two nurses from UC Davis traveled to Mendota to collect blood samples from participants, processed the samples in the field, and transported all samples back to the laboratory in Davis for analysis. Data on asthma status to determine eligibility were obtained from baseline and follow-up interview data. In total, 93 participants reported asthma or wheeze at either baseline or follow-up interview and were classified as cases and were eligible for recruitment for this study component. An equal number of controls without asthma/wheeze were also randomly selected for recruitment. Blood samples were obtained on 120 participants (57 cases, 63 controls).

Specific Aim 3: Determine levels of particulate matter exposure for crops and tasks commonly conducted by agricultural workers in our population. We plan to determine the

validity of self-reported measures of dust exposure for hired farm workers (1) for same day self-reported exposure and (2) for self-reported exposure in a recall evaluation.

- **Airborne pollution**

Agricultural work can have numerous risks, such as exposure to elevated levels of particulate matter (PM) and other airborne pollutants with potential adverse health effects. To determine the magnitude of occupational exposures, *Moran et al. (2014)* assessed PM levels for 89 workers from three major crops in California; almonds, melons and tomatoes. Personal samples were collected for PM2.5 and inhalable PM using personal sampling equipment. Geometric mean concentrations from personal exposure for workers in almonds (inhalable PM=4368 µg/m^3, PM2.5=122 µg/m^3, N=5), tomatoes (inhalable PM=1410 µg/m^3, PM2.5=12 µg/m^3, N=33), and melons (inhalable PM=1118 µg/m^3, PM2.5=19 µg/m^3, N=51) showed high PM exposure when working with these three crops. Large exposure differences by crop were more common than by task (i.e., harvesting, packing and weeding) among the three crops studied. This is one of the largest studies of agricultural workers engaged in hand harvesting, a significant employer of farm labor, and relatively high levels of exposure to PM were measured.

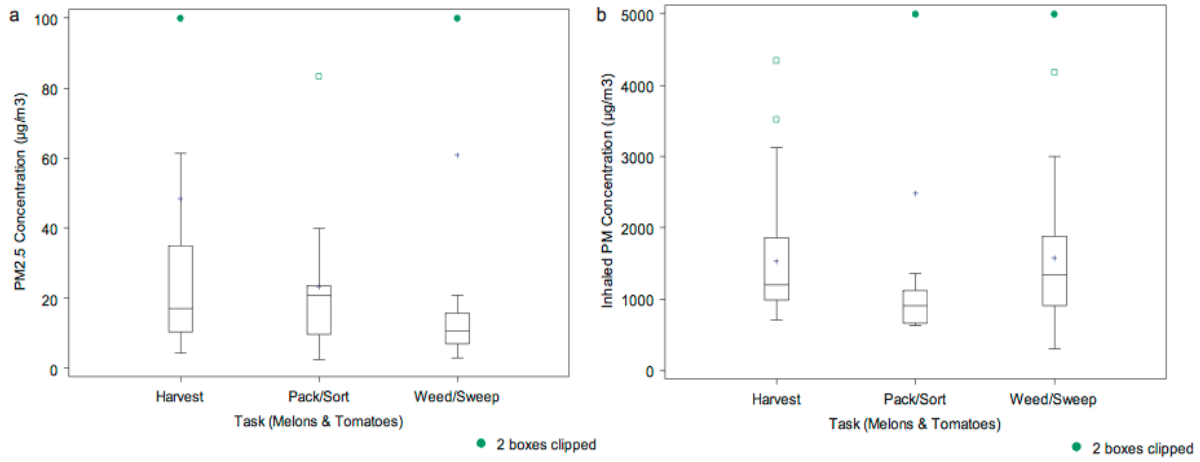
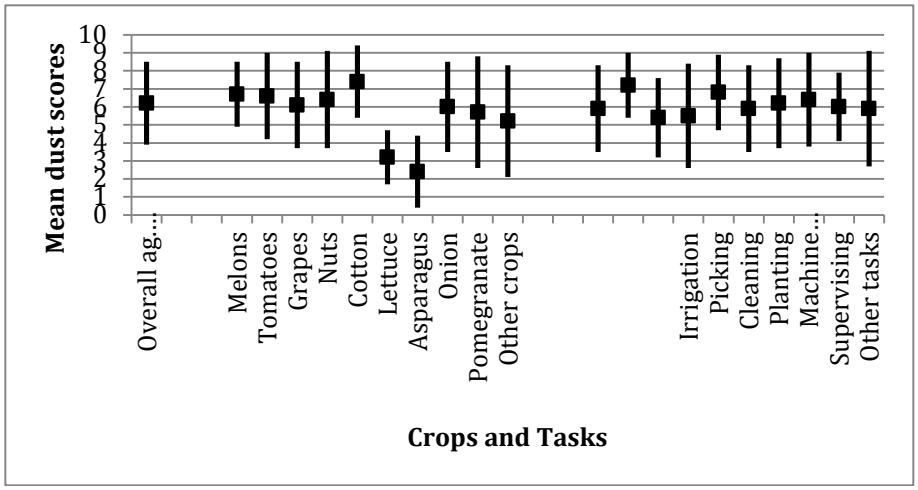


Fig. 2. (a) Personal occupational exposure $PM_{2.5}$ concentration distributions for workers performing a single task in melon and tomato crops. Harvest = harvesting of fruit (N = 32), pack/sort = packing and sorting of fruit (N = 12), weed/sweep = weeding and sweeping (N = 29) and (b) personal occupational exposure concentration distributions of inhalable PM by task for melons and tomatoes.

Specific Aim 4: Examine incident respiratory symptoms and changes in pulmonary function over time and assess the relationship between predictors such as occupational factors and acculturation with incident symptoms and changes in pulmonary function. Our hypotheses are that (1) respiratory symptom progression is associated with increased loss of lung function (FEV1, FEV6, FVC, FEV1/FVC, FEF25%-75%) and (2) occupational exposures and acculturation-related changes are independently associated with incident respiratory symptoms.

Rodriquez et al. (In press) examined associations between agricultural work exposures and pulmonary function among 450 California farm workers in the MICASA study. Time-weighted self-reported average (TWSRA) dust scores were calculated from assessments of past twelve-month agricultural work history.



Mean (± SD) self-reported dust scores by crop and task (n=450)[a]

[a] Self-reported scores of participants in a given crop type or job task were time-weighted then averaged.

[1] ag. = agricultural. Dust score across all crop types and job tasks.

Other dust exposure indicator variables included months worked in agriculture in the past twelve months and years worked in agriculture. Multiple linear regression modeled FEV1, FEF25-75%, FVC, FEV6, FEV1/FVC, and FEV1/FEV6 separately. Seventy-six percent of participants had worked in agriculture in the past year. In models conducted for crops and tasks separately, high TWSRA dust score was associated with better FEV6. Crop and task models showed associations between greater months worked in agriculture in the past year and better FEV1, FEF25-75%, and FEV6. Both models also found greater years worked in agriculture to be associated with worse FEV1/FEV6. Results were generally in the opposite direction as expected given past research but not uncommon. Future research should investigate relationships between pulmonary function and agricultural dust exposure over a lifetime and changes in pulmonary function over time.

Special Acknowledgment: The project benefited greatly from a Community Advisory Board, which consisted of community representatives, county officials, local health professionals, and farm worker advocates to help with all community-based aspects of the study. Members included:

- Fresno Unified School District
- Mendota Youth Recreation
- Current and former members of Mendota City Council
- Fresno County Department of Community Health
- Sablan Medical Clinic
- Farm Labor Contractors
- Local Farmers
- Mayor of Mendota
- Mendota City Manager

The advisory board shared study progress and results and provided feedback to the researchers. The overall goal was to work with the Advisory Board to enable a longitudinal follow-up of MICASA population to improve understanding of the causes of disease and provide basis for effective public health and clinical interventions. Through the Board's support, MICASA was able to achieve longitudinal follow-up (see Methods: Tables A and B) and include concerns of the MICASA community, such as included respiratory disease from dust exposure and pesticide exposure, in the research. In addition, a variety of community activities were sponsored, such as a fiesta for participants, with one goal being to increase follow-up rates.

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Inclusion Enrollment Report

Study Title: MICASA: Farm Worker Family Cohort Study

Total Enrollment: 1095 **Protocol Number:** 224644 (200513483)

Grant Number: RO1OH009293

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race				
	Sex/Gender			
Ethnic Category	**Females**	**Males**	**Unknown or Not**	**Total**
Hispanic or Latino	493	602		1,095 **
Not Hispanic or Latino				
Unknown (individuals not reporting ethnicity)				
Ethnic Category: Total of All Subjects*	493	602		1,095 *
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	493	602		1,095
Racial Categories: Total of All Subjects*	493	602		1,095 *

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)				
Racial Categories	**Females**	**Males**	**Unknown or Not**	**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	493	602		1,095
Racial Categories: Total of Hispanics or	493	602		1,095 **

Materials available for other investigators

The questionnaire to assess occupational and environmental risk factors, acculturation, diet, lifestyle, and associated outcomes among participants and their children is available for other investigators.