MARC B. SCHENKER, MD, MPH
Principal Investigator, Center Director
University of California, Davis

NIOSH Agricultural Center/AFF

CLOSE-OUT REPORT - January 2012

NGA: 5 U50 OH007550-06-10
9/30/2006 – 9/29/2010

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Center History

Funded by the National Institute for Occupational Safety & Health (NIOSH), the Western Center for Agricultural Health & Safety (WCAHS) is situated on the University of California, Davis campus. The WCAHS is in its 21st year of multidisciplinary efforts to improve health and safety in Western agriculture (California, Arizona, Hawaii and Nevada) under the direction of its Founder and Director, Marc B. Schenker, MD, MPH. The WCAHS is the oldest, and one of nine, NIOSH *Agriculture, Forestry and Fishing (AFF)* Centers across the United States.

The overall goal of the WCAHS is to improve the health and safety of farmers, farmworkers and their families and communities, with particular consideration of those issues unique to western agriculture, partnering with diverse stakeholders, conducting innovative multidisciplinary research, providing education that links into established health education networks, and demonstrating effective outreach and translation of all Center activities.

2006-2011 Grant Overview

The WCAHS "Western Ag Center" CDC/NIOSH Grant # 5 U50 OH007550, administered by the Center's "Administration Core", includes its Outreach & Education, and Pilot Project programs. Additionally the Administrative Core, Director and Manager, provide guidance and oversight of the Grant's (four) 4 Research Projects

Administration/Administrative Core

Marc B. Schenker, MD, MPH - Center Director
Kent Pinkerton, PhD - Center Assistant Director
Sandra Freeland - Center Manager
Stephen McCurdy. MD, MPH - Outreach & Education
Frank Mitloehner, PhD - Director of Research/Pilot Grants

Research Projects 1-4

Project 1 – MICASA (*One year only*) - PI: Marc B. Schenker, MD, MPH

Project 2 – Respiratory Health on Large California Dairies - PI: Frank Mitloehner, PhD

Project 3 – Health Effects of Ambient Airborne Particles from the Sacramento/San Joaquin Valley - PI: Kent Pinkerton, PhD

Project 4 – Rapid Assays for Human and Environmental Exposure Assessment - PI: Bruce Hammock, PhD

The WCAHS staff, Campus and Community partners have developed and continue to refine innovative and effective means of communication, including conferences, focused talks and workshops, electronic media and newsletters, as well as investigator meetings, advisory panels and interactions among the agricultural community.

On June 8, 2010, the WCAHS celebrated its 20th Anniversary at the Annual WCAHS strategic planning meeting and presented a 10-minute Center video, which included appearances from past and current researchers, as well as graduate students. The video (located at: http://agcenter.ucdavis.edu/) captures historic WCAHS agricultural health and safety achievement milestones.

WCAHS 2006-2010 Administrative, Outreach, Trainings & Research Projects - Production Summaries

OUTREACH & EDUCATION

- **240,000+** Individual Visits to the WCAHS Website/http://agcenter.ucdavis.edu/) (over half from within the USA, balance includes India, Canada, Iran, Indonesia, Spain, Switzerland, Mexico, Germany and Turkey)
- **45** WCAHS Core sponsored Monthly Seminar Series Presentations
- **35** Outreach Presentations – Heat Illness Prevention w/CalOSHA
- **12** Worker Occupational Safety & Health Training & Education Program (3-day Workshops in partnership with ..... CA State Workers Compensation & UC Berkeley
- **9** Radio bilingual interviews
- **67** Community partnership public presentations
- **8** UC Davis Campus Department Partnerships
- **3** UC System-wide Partnerships
- **10** Industry partnerships/associations –public presentation materials
- **10** Government agency partnerships/subcontracts
- **18** Non-government and Community partners
- **4** Heat Illness Focus Groups in partnership with CalOSHA
- **12** 4-Hour Heat Illness Prevention Train-the-Trainer (presented in Hmong, Punjabi, Spanish & English speaking communities)
- **2** Dairy-worker Safety Training Guides (English & Spanish); 1000 copies distributed nationally and internationally
- **4** Dairy-worker Safety Training Videos (Spanish & English); 1000 copies
- **6** On-site Dairy Safety Guide Workshops

SCIENTIFIC RESEARCH Deliverables/Output

- **4** Project 4/Hammock Generated Resources (antigens for fipronil; reagents; midacloprid metabolite assays) available gratis to universities for research
- **24** Video/Podcast Agricultural Health & Safety Productions
- **81** Peer Reviewed Publications; 3 In-Press
- **41** Research Project Generated Professional Presentations
- **7** Book Chapters

Research Project Summaries:

PROJECT **1**/MICASA **PI: Marc Schenker, MD, MPH** (Funded 1 year only)

The purpose of this study was to examine occupational and environmental exposures and health in 400 hired farm worker families in Mendota, California. The specific aims of the project were to: 1) develop protocols and methods for assessing occupational and environmental health risks from agricultural-related exposures, such as dust, toxic chemicals and gases, and conduct a health needs assessment in a sample of 400 farm workers and their families in Mendota, California; 2) develop methods for home exposure assessment, including food preparation, food storage and sanitation in this population; and 3) develop priorities for education and training programs to reduce newly identified and quantified occupational and environmental hazards among farm workers.

Collaborators were Jane Weintraub and Judith Barker, University of California, San Francisco, School of Dentistry, and the Firebaugh-Mendota Rotary Club

Study finds are listed in the MICASA Final Report starting on Page 9 of this report and MICASA 2006 also resulted in the need for further study which evolved into the CDC/NIOSH Grant #5 R01 OH009292, Project Title: *The Farm Worker Family Health Cohort Study*.

PROJECT **2**/ CAL-DEHRI STUDY **PI: Frank Mitloehner, PhD**

Project 2 monitored 13 larger dairies and one vegetable processing plant (a control facility) in the California Central Valley. The aim was to define the concentrations of airborne pollutants highly associated with respiratory problems and study the respiratory health of the dairy workers compared to a control group. A total of 275 male workers wore backpacks containing personal air samplers over the course of a workshift, including 49 control workers, and stationary samplers co-collected air samples. The workers' pulmonary function was tested before and after their shift, and respiratory symptoms and other information was collected by interviewers. We found that California dairies generated lower concentrations of airborne particles than conventional eastern USA dairies. This is likely due to the open, well ventilated structure of these facilities. Over the course of a work shift, dairy workers were more likely than controls to experience a reduced ability to forcefully expel air (the Forced Expiratory Volume in 1 second – FEV1 $p=0.02$) or to fill their lungs (the Forced Vital Capacity - FVC was decreased $p= 0.002$). With all workers combined a decrement in FVC was significantly associated with exposure to endotoxin (fragments of Gram negative bacterial cell walls). No significant long-term effect on breathing was found. Occupational exposure from time spent re-bedding

(removing soiled bedding where lactating cows rest in the freestalls, and replacing with fresh material) was found to be significantly higher for smaller airborne particles ($PM_{2.5}$), total suspended particles (TSP) and endotoxin, compared to time spent milking or conducting other tasks. Time spent feeding was associated with higher concentrations for $PM_{2.5}$ and TSP, with lower concentrations for endotoxin. Using human macrophages in cell culture, we found the most critical component of dairy farm dust was endotoxin, which may trigger local and systemic inflammatory reactions upon inhalation. In conclusion the results suggest dairy laborers should not exclusively work at tasks such as rebedding, but be rotated out after a couple of hours, and they should be encouraged to wear an effective dust mask, for example a N95, in tasks where exposed to any visible dust.

PROJECT **3/** CA Central Valley Ambient Air**/ PI: Kent Pinkerton, PhD**

The primary goals for Project 3 have been to determine how variation in atmospheric particle concentration, size, and composition in agricultural settings affect health outcomes in the cardiopulmonary system. Laboratory rodents were used as we identified specific sources of fine and ultrafine particulate matter in farming and dairy settings in the Sacramento and San Joaquin Valleys. Mice and rats were examined for health effects of direct exposure to these particles in real time at agricultural sites. An important objective of our studies was to examine the importance of season in each agricultural setting where particle size and composition are likely to be different due to level of activity and weather. The overarching hypothesis was both concentration and composition of inhaled fine/ultrafine particles (< 2.5 µm in diameter) as well as coarse particles (2.5 to 10 µm in diameter) comprised of metals, organics, nitrates, and carbonaceous compounds and generated by agricultural activities (crop production, field preparation) determine the health outcomes associated with airborne particulate matter.

Our studies over the past 5 years examined a wide variety of conditions which included the impact of the 2008 California wildfires for coarse and fine particulate matter toxicity in the Central Valley. This study was the key in demonstrating clear impacts of vegetative burning to produce acute lung inflammation published in Environmental Health Perspectives (2009). A second study also published in Environmental Health Perspectives (2009) demonstrated that combustion particle inhalation in mice produced significant alterations in the central nervous system (neuroplasticity) to decrease heart rate variability, a highly relevant measure of altered heart function due to particulate matter exposure. A follow-up study in mice exposed to concentrated ambient particulate matter in the agricultural setting of rural Westside, CA resulted in platelet and systemic cytokine activation, demonstrating effects of inhaled particles that extend beyond the respiratory

system. A study in humans conducted in the Central Valley also demonstrated pneumoconiosis from agricultural dust exposure among young California farmworkers was associated with significant structural remodeling of the lungs associated with inflammation, cellular changes and fibrosis. (published in Environmental Health Perspectives 2009)

Further research publications arising from Project 3 reported the health effects of inhaled engineered and incidental nanoparticles published in 2009 and presented as a seminar of nanotechnology in agriculture. A report was published in 2010 in California Agriculture on airborne particles in the San Joaquin Valley and how they may affect human health. This work served as an outreach effort to the agricultural community. Other key publications arising from Project 3 were studies to examine age-related impacts of particle exposure. Oxidative injury was found in the lungs of neonatal rats following short-term exposure to ultrafine iron and soot particles, while susceptibility of the aging lung to environmental injury was reported in Seminars in Respiratory and Critical Care Medicine (2010)

PROJECT **4**/Rapid Assays for Human Assessments/ **PI: Bruce Hammock**, PhD

During the project period we made and used rapid analytical methods for environmental contaminants such as pyrethroid insecticides, herbicides, personal care products and other materials. We utilized these assays to monitor for these materials in the environment and in human body fluids as indicators of exposure. In addition we also have advanced immunochemical technologies along several fronts. These advances can be applied to immunoassays for human and animal health as well as for environmental analysis. One dramatic advance is the use of heat stable recombinant nanobodies cloned from alpaca. These new binding reagents promise to revolutionize immunoassay development. We immunize alpaca with multiple antigens, collect cDNA from white blood cells, PCR the nanobody single chain genes and place into phage, then pan the phage for the desired antibodies. These antibodies can be produced in large amounts in *E. coli* and used for a variety of immunoassays and biosensors. During the last year we developed the most sensitive nanobody based assays ever reported for small molecules. In addition we continue to develop phage amplified immunoassays to improve sensitivity and specificity of immunoassays. This technology can be applied to any immunoassay by using phage to bind to the antigen antibody complex. This results in a 5-50x improvement in sensitivity. Finally, we are using novel fluorescent lanthanide nanoparticles to enhance the sensitivity of immunoassays. These materials are particularly suited to biosensor and microfluidic formats. From a basic standpoint we are increasing dramatically the sensitivity and specificity of immunoassays in general by integrating the above technological advances. We are applying these technologies to evaluate exposure of farm workers and their families to pesticides and other environmental contaminants. These targets include exposure to pyrethroids in

the central valley of California and exposure to the highly toxic and newly reregistered pesticide paraquat to field workers in Hawaii.

Local Scientific Conferences

Multi Campus Graduate Student Research Colloquia

WCAHS hosts biennial conferences to highlight the achievements of our graduate students. Graduate Student colloguia provide a synergistic environment to discuss potential areas of collaboration, and familiarized attendees with new each other's projects and research within the WCAHS region.

Green Acres/Blue Skies Conferences: UC Davis Campus

For the last three years, WCAHS co-sponsored a conference, in conjunction with the UC Davis Agricultural Air Quality Research Center (led by WCAHS Investigator Frank Mitloehner) and the Air Quality Research Center, focusing on air quality and agriculture. The conference drew together agricultural producers and industry leaders, researchers, policymakers, legal experts, regulators, environmental groups and green-technology providers with the purpose of creating a cleaner and more sustainable agricultural industry in California. Each year the conference has a different focus, including "Agriculture and Air Quality – Issues and Solutions – A Stakeholders Conference" (2008); "Agriculture and Air Quality – Working Towards Common Solutions" (2009); and "Agricultural Sustainability – The Air Quality Connection" (2010).

Regional and National Scientific Conferences

Western States Agricultural Health and Safety Conferences hosted and/or co-hosted annually by the WCAHS are committed to sponsoring scientific conferences to broaden the distribution of research results and expand on potential collaborations locally, regionally, nationally and internationally. Along with the Pacific Northwest Agricultural Safety and Health Center (PNASH) in Seattle, WCAHS expanded the conference to engage the Colorado and Texas Agricultural Health Centers.

Pacific Grove, CA (2006) - WCAHS hosted the biennial meeting in September: "Health and Safety in Western Agriculture: Research to Practice (R2P)." The highly successful conference culminated in a Special Issue publication of the Journal of Agricultural Safety & Health (JASH): April 2008, Vol. 14, No. 2. WCAHS also leveraged sponsorship from the UC Davis Schools of Medicine and Veterinary Medicine, Colleges of Agricultural & Environmental Sciences and Engineering, the California Departments of Pesticide Regulations and Occupational Safety and Health, Kaiser On-the-Job, Foster's Americas, Pedrick Produce, Mariani Nut Company, and the UC Berkeley Labor Occupational Health Program.

Cle Elum, WA (2008) – WCAHS co-sponsored with PNASH: "Health and Safety in Western Agriculture – New Paths." WCAHS sent five graduate students, four investigators, and five key research staff.

Aging Farmer Conference – *March 6-8, 2008, Indianapolis Airport*
WCAHS participated in conference planning and sponsored attendance of several Center investigators and affiliates in the conference sponsored by Chip Petrea, University of Illinois, Chicago, Institute for Health Research and Policy. WCAHS presentations included "Physiological Aging and Chronic Exposure to Agricultural Environments: Implications for Farm Tasks and Subsequent Risk of Injury," "National Injury and Fatality Data for Aging Farmer," and "Older Farmers in Western United States."

International Conferences

Saskatoon International Occupational Health and Safety Symposiums
WCAHS staff and investigators participated in program planning and attended the 4-day symposium, which addressed the health consequences for people working and living in agricultural settings. The interdisciplinary teams of researchers and stakeholders support access to other research funds for the development of integrated programs of research and knowledge translation for the prevention of agriculture-related health and safety issues.

Binational Health Week Conferences
Dr. Schenker serves on the program planning committee, presents research findings, and conducts workshops for the Binational Health Week Conferences, which is one of the largest mobilization efforts of government agencies, community-based organizations, and volunteers in the Americas to serve Latino populations living in the U.S. and Canada.

Creation of the Annual Outstanding Achievement in Farm Health & Safety Award

2008, the Sacramento County Farm Bureau received the award for their annual no-cost Farmworker Safety Training Day and their free Farm Family Health Fair attended annually by 250.

2009, Reiter Affiliated Companies (RAC), Garland Reiter, President, Oxnard, CA, received the award. RAC is the largest supplier of fresh berries in North America and its success is based on its values, honesty, fairness and respect; their internal employee training and on-site health plans are outstanding.

Annual External Advisory Board and Steering Committee Strategic Advancement Planning Retreats

WCAHS hosts annual Strategic Advancement Planning all-day retreats for the members of the External Advisory Board and Steering Committee. The retreats serve as a means for re-evaluating agricultural health and safety practices, developing new areas of study, and showcasing current research outcomes by Center investigators and their graduate students.

2006 Health and Safety in Western Agriculture: *R2P*
2007 Health and Safety in Western Agriculture: NEW PATHS
2008 Strategic & Advancement Planning in Western Agriculture Health and Safety. One goal was to explore the interface between farmworker health and food safety, and discuss potential areas of new collaboration with Dr. Michele Jay-Russell from the Western Institute for Food Safety and Security.

2009 Changing Demographics: Strategic & Advancement Planning in Western Agriculture Health and Safety
2010 Partnering for Impact: Strategic & Advancement Planning in Western Agriculture Health and Safety

NIOSH Ag Centers and NORA AgFF Program Meetings

WCAHS was responsible for organizing the NIOSH Ag Center Directors meetings, alternating between Washington D.C. and other sites. Meetings coincided with regional & national meetings supported by NIOSH & others, i.g., Sixth International Symposium: Public Health & the Agricultural Rural Ecosystem in Saskatoon, Canada. WCAHS maintains ongoing quarterly conference calls for Ag Center Directors.

WCAHS hosted in August 2010, the NORA AgFF Council meeting on the UC Davis campus.

WCAHS participates in the NIOSH Agricultural Evaluation Center (ACE) initiative, a collaboration between the 9 NIOSH Ag Center managers formalizing the collection and recording of data to measure outcomes of similar projects across multiple Centers.

Other Collaborations and Memberships

WCAHS hosted U.S. Congressman Mike Thompson, 1st District, in September 2007. Representative Thompson's discussions focused on farmworker and dairyman safety issues, ergonomics, air quality, and infectious diseases in agriculture.

WCAHS joined The Agricultural Safety and Health Council of America (ASHCA), which is working to close the farm work safety gap. The new Council, driven by farmer/rancher and agribusiness leaders, is the first of its kind in the U.S. to pursue a national strategy to reduce disease, injuries and fatalities in American agriculture.

WCAHS annually supports the AgSafe Annual Conferences, the National AgrAbility Project Conferences, the Migrant Clinicians Network, Farm Safety 4 Just Kids, Small Farm Conferences, the UC Sustainable Agriculture Research and Education Program workshops, and the Childhood Agricultural Safety Network, to name a few.

WCAHS actively participates in the creation of worker safety and health initiatives with local Farm Bureaus, Agricultural Safety Resource Alliance, Zenith Worker's Compensation Fund, Western Dairymen Association, California Institute for Rural Studies, California Rural Legal Assistance, Inc., and Cal/OSHA through the California Department of Industrial Relations.

WCAHS was a major participant in the 2009-2010 Cal/OSHA Heat Illness Prevention Media Campaign.

- **50 Presented Monthly Educational Seminars**

WCAHS hosts free informative and educational seminars monthly during the academic year on Campus, attendance since 2006 was close to 1200 participants, in addition to special guests speaker presentation. Video footage and podcasts from each are made available via the Center's website.

- **20 AgHealth Newsletters; 3 El Melon Rondero; and AgHealth Listserv**

The Center is strongly committed to publicizing new progress via several means of communication, including *AgHealth News*, a quarterly publication with 2300 subscribers (now distributed electronically); a WCAHS subscribers-only listserv w/300 national & Int'l members; WCAHS Wiki, Western Ag Facebook, Tweet accounts & interactive website.

Research Projects 1 (Year 1 Only, Close-out Report); and for Research Projects 2, 3, & 4 -- Year 5, Final Reports

PROJECT 1: (2006 Final Close-out Report)
Farm Worker Family Cohort Study / Agricultural and Environmental Health for Latino and Indigenous Farmworkers

PROJECT OFFICER(s)
Marc B. Schenker, MD, MPH
Western Center for Agricultural Health and Safety
Center for Health and the Environment
Bldg 3792, Room 129
Old Davis Road
Davis, CA 95616
Telephone: (530) 752-5676
mbschenker@ucdavis.edu

PROJECT DESCRIPTION
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 evolving demography of Mexican immigrants and differences between urban and rural immigrant populations requires that information be obtained for rural Hispanic immigrants to understand the association between occupational and environmental health risks, poor dietary factors and lifestyle with associated illnesses, including respiratory disease, infectious disease, and mental health.

The purpose of this study was to examine occupational and environmental exposures and health in 400 hired farm workers (300 men and 100 women) in Mendota, California. With additional funding from The California Endowment, the study was expanded to collect information on the head of household and spouse in 400 farm worker families.

The specific aims of the project were:
Develop protocols and methods for assessing occupational and environmental health risks from agricultural-related exposures, such as dust, toxic chemicals and gases and conduct a health needs assessment in a sample of 400 farm workers and their families in Mendota, California.

Develop methods for home exposure assessment, including food preparation, food storage and sanitation in this population.

Develop priorities for education and training programs to reduce newly identified and quantified occupational and environmental hazards among farm workers.

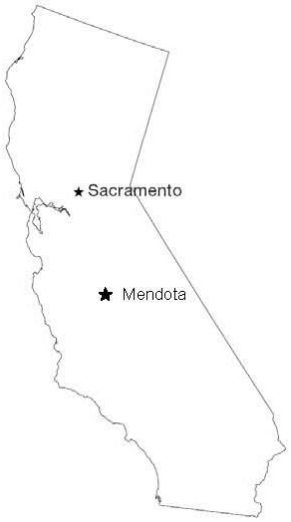
PROJECT START AND END DATES: October 1, 2004 - September 30, 2007

STATES THE PROJECT WAS ACTIVE IN: California

COLLABORATIONS FOR FY 2007

Jane Weintraub and Judith Barker, University of California, San Francisco, School of Dentistry
Firebaugh-Mendota Rotary Club

PROJECT ACTIVITIES / ACCOMPLISHMENTS



This study began work in Mendota, California in Spring 2005. In the community, the project is known as "Proyecto MICASA," and is referred to as MICASA study here. Mendota is located in Fresno County in the heart of California's San Joaquin Valley. The county encompasses 3,816,130 acres, mostly devoted to agricultural production. Fresno County is the most productive agricultural county in the U.S. and it ranks first in agricultural worker population estimates in California due to high numbers of hired farm workers employed in the agricultural sector. The city of 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. The original proposal focused on recruiting and interviewing 400 hired farm workers, but with additional funding from The California Endowment (TCE), we expanded the scope of work to include interviews with both the head of household and spouse in 400 participant households. These households also included some single female heads of household and a small number of solo males (men who are in the U.S. for work while their families remain in their country of origin).

Household Enumeration and Recruitment

The household enumeration was conducted in Mendota during the summer 2005. Using census information, 20 census blocks were randomly selected for enumeration. In the first stage, enumerators mapped all dwellings in these selected census blocks. Dwellings included all housing, temporary housing and informal structures where individuals were living. In the second stage, enumerators visited each enumerated dwelling and obtained information on the individuals residing there; including their relationship to the head of household (spouse, adult child, parent, or sibling), age and gender of all individuals, those who were engaged in farm work, nationality, and the number of children under age 18 living in the household. Households with no hired farm workers were mapped, but not enumerated. In all, 2441 individuals, living in 751 households were enumerated in Mendota. Of these, 85.8% were currently engaged in farm work. Sixty-six percent were men and 34% were women. Over half were Mexican born (55%), 35% were from Central America (primarily El Salvador and Honduras) and 10% were U.S. born.

In the next phase of the project, trained interviewers contacted enumerated households, explained the purpose and procedures of the project and attempted to recruit the head of household and spouse for participation. Eligible participants included men and women between the ages of 18-55 years who self-identified as Mexican or Central American,

resided in Mendota at the time of the baseline interview, and at least one member of the household was engaged in farm work for at least 45 days in the last year. A questionnaire was administered to both the head of household and spouse for all households that agreed to participate. The survey instrument collected information on demographics, occupational and environmental risk factors, home environment, diet and physical activity, food handling practices, food security, acculturation, smoking status, and health outcomes (respiratory health, injuries, mental health, and reproductive health). It also obtained basic information on all children in the household (e.g. age, schooling, farmwork).

Overall, 875 adults were interviewed. Of these, both the head of household and spouse were interviewed in 390 households, and 32 households consisted of single female heads of household. In addition, 41 solo males were interviewed. Table 1 outlines the disposition of participant households contacted for the study. Seventy percent of contacted households participated in the study. Three hundred forty households were determined to be ineligible due to age, no farm worker living in the household, or the family moved away before the interview could be completed. The primary reasons given by those who declined to participate in the study included *desconfiado* (distrusted), no time, not interested, or did not want to share personal information.

Table 1. Disposition of MICASA study households in Mendota, CA.

Disposition	*Number*	*Percent*
Completed family and solo male households	463	70.3%
Declined to participate	196	29.7%
Total households	659	

We have confidence that our household enumeration and sampling strategy produced a representative population-based sample of farm worker families based upon comparisons between the enumerated population and the sample population for this study. Table 2 shows comparisons between key demographic characteristics of the enumerated family population and the resulting MICASA sample population that was drawn from the enumerated households. No significant differences were found between these two populations in terms of age, country of birth and the number of years living in the U.S. This sample population has important benefits in conducting a wide range of cross-sectional and prospective studies. These include assessing occupational risk factors and the relationship to disease incidence and examining biologic markers for disease.

Table 2. Demographic characteristics of enumerated population and MICASA sample population.

	Enumerated family population	**MICASA sample**	χ^2	**p-value**
Age				
18 – 30 years	41.7%	27.5%	4.7	0.09
31 – 45 years	37.9%	50.3%		
46+ years	20.4%	22.2%		
Country of birth				
Mexico	59.4%	65.7%	4.4	0.11
Central America	27.5%	29.7%		
U.S. born	13.0%	4.6%		
Years lived in US				

0 – 5 yrs	28.1%	15.1%	5.1	0.08
6 – 15 yrs	33.9%	42.0%		
16+ yrs	38.0%	42.9%		

Data Results

Demographic characteristics — Results of demographic analyses are found in Table 3. Interviews were completed with 435 men and 440 women. Women were slightly younger than men, 36 years vs. 38 years, and the average age for the cohort was 37 (± 10.2) years. Almost 95% of the sample was married. The majority of participants were born in Mexico (65.7%), and about one quarter (26.6%) were born in El Salvador. Mean number of years residing in the U.S. was 15.6 (± 10.1). The average number of years in the U.S. was 14 years for women and was significantly lower than the average of 17 years reported by men. The overall prevalence of current smoking was 9%, with men significantly more likely to smoke than women (13% and 5% respectively). "Household size" refers to the number of people living in the home (average size was 4.6), which was higher than the state average of 2.87 (U.S. Census 2000 data). Sixty-four percent reported incomes of $20,000 or less for the previous year and 16% reported receiving social assistance in the last year. For comparison purposes, the 2005 HHS Poverty Guideline is $19,350 for a family of four.

Table 3. Distribution of demographic variables by gender.

	Overall (n=875)	Female (n=440)	Male (n=435)	p-value
Age category				**0.0199**
18 – 30	27.5% (241)	29.6% (130)	25.5% (111)	
31 – 40	35.8% (313)	38.2% (168)	33.3% (145)	
41 – 45	14.5% (127)	14.3% (63)	14.7% (64)	
46+	22.2% (194)	17.9% (79)	26.4% (115)	
Marital status				**0.0365**
Married	94.3% (824)	93.4% (411)	95.2% (413)	
Divorced/Separated/Widowed	2.2% (19)	3.4% (15)	0.9% (4)	
Single (never married)	3.5% (31)	3.2% (14)	3.9% (17)	
Education level				**0.0152**
No schooling	4.4% (34)	4.1% (16)	4.6% (18)	
Primary	59.4% (464)	54.6% (212)	64.2% (252)	
Greater than primary	36.2% (283)	41.2% (160)	31.3% (123)	
Country of birth				0.3978
US	4.6% (40)	5.2% (23)	3.9% (17)	
Mexico	65.7% (575)	67.3% (296)	64.1% (279)	
El Salvador	26.6% (233)	24.3% (104)	29.0% (126)	
Honduras/Nicaragua/Guatemala	3.1% (27)	3.2% (14)	3.0% (13)	
Years lived in US				**<.0001**
0 – 5 yrs	15.1% (132)	19.8% (87)	10.4% (45)	
6 – 15 yrs	42.0% (366)	45.1% (198)	38.8% (168)	
16+ yrs	42.9% (374)	35.1% (154)	50.8% (220)	
Smoking status				**<.0001**
Current smoker	9.0 (79)	5.0% (22)	13.1% (57)	
Ex-smoker	4.6% (40)	0.7% (3)	8.5% (37)	
Never smoker	86.4% (755)	94.3% (415)	78.3% (340)	
Household size (mean, SD)	4.6 (±1.7)	4.6 (±1.7)	4.5 (±1.7)	0.3086

Total family income last 12 months				0.4437
$0 – $20,000	64.0% (544)	65.3% (278)	62.7% (266)	
More than $20,000	36.0% (306)	34.7% (148)	37.3% (158)	
Received social benefits last 12 months	16.0% (133)	19.4% (79)	12.9% (51)	**0.0166**

Self-reported respiratory and allergic rhinitis symptoms — Respiratory health and allergic rhinitis among participants was assessed by self-reported symptoms. The overall prevalence for respiratory symptoms was chronic cough 3.4%, chronic bronchitis 3.3%, persistent wheeze 6.6%, shortness of breath with wheezing 7.7% and ever having asthma 6.3%. The overall prevalence for allergic rhinitis was 34.9%, allergic rhinitis accompanied by itchy, watery eyes was 88.1% and allergic rhinitis caused by contact with pollen or animals (e.g. "hay fever") was 40.5%. There were no statistically significant differences between gender and prevalence of self-reported respiratory or allergic rhinitis symptoms (Table 4).

Injury and health status — Approximately, 6% of study participants reported an injury for which treatment was sought during the previous year. Of those with an injury, 65% were off work for at least half a day as a result, with men significantly more likely to have missed work than women (Table 5). Thirty-three percent performed lighter or reduced activities as a result of the injury, with no differences by gender. Fifty-four percent reported musculoskeletal symptoms, such as having pain or stiffness in the back/lower back, hip, knee, finger, wrist/hand, or neck/shoulder. Back pain was most frequently reported at 73%, followed by knee pain at 41%. There was no difference by gender on the prevalence of ever having pain; however, there were differences by specific body parts. Women were significantly more likely than men to report ever having pain in the hip (45% vs. 28%), finger (24% vs. 16%) and hand/wrist (33% vs. 17%).

Table 4. Prevalence of respiratory and atopic symptoms.

Symptom	Overall (n=875)	Female (n=440)	Male (n=435)	p-value
Chronic Cough[1]	3.4% (30)	2.3% (10)	4.6% (20)	0.0588
Chronic Bronchitis[2]	3.3% (29)	3.4% (15)	3.2% (14)	0.8748
Persistent Wheeze[3]	6.6% (58)	6.4% (28)	6.9% (30)	0.7514
Shortness of Breath with wheeze[4]	7.7% (67)	8.5% (37)	6.9% (30)	0.3733
Ever had asthma[5]	6.3% (55)	7.3% (32)	5.3% (23)	0.2197
Allergic rhinitis[6]	34.9% (304)	35.5% (155)	34.3% (149)	0.7063
Allergic rhinitis with itchy, watery eyes	88.1% (266)	85.1% (131)	91.2% (135)	0.0991
Allergic rhinitis caused by pollen/animals	40.5% (348)	41.7% (182)	39.2% (166)	0.4387

[1]Chronic cough is defined as having a cough on most days for five consecutive months or more during the year for two or more years.
[2]Chronic bronchitis is defined as bringing up phlegm on most days for three consecutive months or more during the year for two or more years.
[3]Persistent wheeze is defined as having a chest that sounds wheezy or whistling on most days or nights OR when you have a cold AND occasionally apart from colds.
[4]Shortness of breath is determined by a yes response to the question "Have you ever had an attack of wheezing that made you feel short of breath?"
[5]Asthma was determined by a yes response to the question "Have you ever had asthma?"
[6]Allergic rhinitis was defined as having a problem with sneezing, a runny or stuffy nose apart from flu and colds in the past 12 months.

Table 5. Prevalence of injury.

Injuries sustained during past 12 months	Overall	Female	Male	p-value

	(n=875)	(n=440)	(n=435)	
Sought treatment for injury	6.1% (53)	4.6% (20)	7.6% (33)	0.0641
Missed work due to injury	65.4% (34)	42.1% (8)	78.8% (26)	**0.0074**
Performed reduced activities due to injury	32.7% (17)	42.1% (8)	24.3% (9)	0.2722
Musculoskeletal Injury				
Ever had pain/stiffness in any body part	53.7% (467)	52.7% (231)	54.6% (236)	0.3635
Back/lower back	73.4% (343)	75.3% (174)	71.6% (169)	0.4778
Hip	36.4% (170)	44.6% (103)	28.4% (67)	**0.0003**
Knee	41.3% (193)	42.4% (98)	40.2% (95)	0.6340
Finger	20.1% (94)	23.8% (55)	16.5% (39)	**0.0497**
Hand/wrist	25.3% (118)	33.3% (77)	17.4% (41)	**<.0001**
Neck/shoulder	32.1% (150)	35.9% (83)	28.4% (67)	0.0810

Occupational exposures — A majority (90.4%) of participants had done agricultural work at some time in their lives. Men reported an average of 16 years (± 9.9) working in agriculture, which was significantly longer than women (10 years ±7.7) (Table 6). With regard to specific occupational exposures related to agricultural work, men were more likely to report using pesticides and being exposed to working conditions where a lot of dust was generated. The crops most commonly reported by participants in the previous year indicated that participants worked most often with melons (54.4%), tomatoes (51.4%), cotton (27.1%) and nuts (19.4%). The most commonly reported agricultural activities include packing/sorting; picking; hoeing; water/irrigation; and tractor/truck driving.

Agricultural workers were also asked how often over the past year that they had engaged in washing and hygiene practices such as using water from a ditch or irrigation canal to wash hands; changing clothes after work and before entering the home; and washing hands or face before eating (Table 6). Workers were also asked about eating and drinking activities while on the job; such as drinking water from a ditch or irrigation canal, eating products from the field while working, or eating products from the field without washing them.

Table 6. Occupational exposures.

	Overall (n=875)	Female (n=440)	Male (n=435)	p-value
Ever done agricultural work	90.4% (791)	81.4% (358)	99.5% (433)	**<.0001**
Years worked in agriculture category				**<.0001**
0 – 5 yrs	21.7% (170)	33.5% (119)	11.9% (51)	
6 – 10 yrs	24.5% (192)	25.6% (91)	23.5% (101)	
11 – 20 yrs	35.5% (278)	32.7% (116)	37.8% (162)	
21+ yrs	18.4% (144)	8.2% (29)	26.8% (115)	
Used pesticides in last 12 months	10.0% (78)	0.8% (3)	17.7% (75)	**<.0001**
Dusty working conditions in last 12 months				**<.0001**
Never	3.8% (28)	6.4% (21)	1.7% (7)	
Up to half the time	49.8% (370)	62.1% (203)	40.1% (167)	
More than half the time	46.4% (345)	31.5% (103)	58.2% (242)	
Washing/hygiene practices				
Wash hands with ditch/irrigation canal water				**<.0001**
Never	94.8% (710)	98.5% (324)	91.8% (386)	
Up to half/more than half the time	502% (39)	1.5% (5)	8.1% (34)	

Change clothes after work, before entering home				**<.0001**
Never	83.9% (627)	92.7% (303)	77.1% (327)	
Up to half /more than half the time	16.1% (120)	7.3% (24)	22.9% (96)	
Wash hands/face before eating				**0.0069**
Never	10.3% (77)	13.7% (45)	7.7% (32)	
Up to half /more than half the time	89.7% (669)	86.3% (283)	92.3% (386)	
Eating/drinking practices				
Drink water from ditch or irrigation canal				0.2768
Never	98.9% (740)	99.4% (327)	98.6% (413)	
Up to half /more than half the time	1.1% (8)	0.6% (2)	1.4% (6)	
Eat field products while working				**0.0022**
Never	39.5% (295)	45.7% (150)	34.7% (145)	
Up to half /more than half the time	60.5% (451)	54.3% (178)	65.3% (273)	
Eat field products without washing them				**0.0328**
Never	66.0% (494)	70.2% (231)	62.8% (263)	
Up to half /more than half the time	34.0% (254)	29.8% (98)	37.2% (156)	
Protective equipment when working in excessive dust				
Wore scarf over mouth and nose				**<.0001**
Never	61.3% (457)	42.8% (140)	75.7% (317)	
Up to half /more than half the time	38.7% (289)	57.2% (187)	24.3% (102)	
Wore disposable dust mask				**0.0001**
Never	75.9% (566)	82.6% (271)	70.6% (295)	
Up to half /more than half the time	24.1% (180)	17.4% (57)	29.4% (123)	
Wore cartridge respirator				**<.0001**
Never	95.7% (714)	99.1% (325)	93.1% (389)	
Up to half /more than half the time	4.3% (19)	0.9% (3)	6.9% (29)	

When working in excessive dust, 51.5% (n=385) participants reported that they never used any type of protective equipment (Table 6). Among those who used protective equipment, wearing a scarf over the mouth and nose was reported most frequently, and women were more likely to do so; 57% of women reported wearing a scarf in dusty conditions up to half or more than half the time. Men were more likely than women to wear a dust mask and nearly 30% of the men wore a dust mask up to half the time or more when exposed to dusty working conditions. Although men were statistically more likely to wear a cartridge respirator in dusty conditions than women, the actual numbers were very small.

Our current work on the study is focused on conducting data analysis of baseline interviews to address the primary study hypotheses. Analyses and manuscripts are underway to describe the MICASA study methods; examine occupational risk factors associated with asthma and other respiratory symptoms; assess risk factors for injury among farm workers; examine occupational risks associated with musculoskeletal symptoms; and determine risks from home exposures and health.

Respiratory Health and Spirometry

Through supplemental funding from NIOSH, the field team conducted lung function tests (spirometry) among adult participants to assess asthma and other respiratory symptoms.

The specific aims for this project were:
1. Conduct pulmonary function testing on 400 hired farm workers in the Mendota cohort.
2. Provide feedback and results to workers undergoing pulmonary function testing.
3. Provide individual and community education on smoking, asthma, occupational respiratory hazards and prevention strategies.

This testing was conducted in Mendota during the summer 2006. As part of this project, two staff members who conduct the spirometry testing completed the NIOSH-Approved Spirometry Testing and Respiratory Surveillance Training Program and received certification. Spirometry was conducted using the EasyOne™ Spirometer. The EasyOne™ spirometer is designed for use with adults and measures FEV_1, FVC, FEV_1/FVC, FEV_6, and FEF_{25-75}. Disposable Spirettes™ were used for testing to minimize the need for cleaning and insure participant safety. Our efforts to conduct spirometry testing were focused on weekends and some evenings during the week to accommodate the work schedules of participants. We found that August and September are particularly busy agricultural work months due to harvesting efforts in the community. Many participants worked 6-7 days a week and often late into the evening, so it was difficult to obtain their participation in the testing.

One hundred seventy-seven participants agreed to undergo spirometry testing; five were eliminated during pre- screening (two for pregnancies, one for current tuberculosis treatment, and two for unspecified medical reasons). The three best efforts were saved and analyzed for each participant completing the spirometry testing. Spirometry was conducted on 172 participants, and analyzable results were obtained from 152 (84 males, 68 females). The most common reason for elimination for analysis was a lack of reproducibility (defined as a difference of more than 10% or 200mL in FEV1 or FVC among the two best efforts). An additional five participants had fewer than three acceptable efforts; for these subjects only the efforts meeting QC criteria were analyzed. In a sixth participant, all efforts showed late second breaths and so FEV6 was used to estimate FVC.

Table 7. Selected characteristics of included/excluded spirometry participants.

	Tested (n=172)	Excluded (n=20)	Analyzable results (n=152)
Mean age	40.1 years (± 10.7)	42.1 years (± 11.3)	39.8 years (± 10.7)
Female	45.9%	55.0%	44.7%
Asthma	5.2%	5.0%	5.3%
Smoking status			
Current	15.7%	40.0%	12.5%
Former	1.2%	0.0	1.3%

Table 7 describes key characteristics of participants excluded from analyses with those from whom we obtained analyzable results. Participants did not differ on age or gender. Participants were also asked if they possibly or definitely had asthma. Five percent of excluded individuals and 5.3% of participants with analyzable results reported possibly or definitely having asthma. Forty percent of those with excluded spirometry tests and 12.5% of those with analyzable spirometry results reported current smoking. There were no differences between excluded and included participants on asthma, but excluded participants were significantly more likely to be smokers (OR 4.67, 95% CI 1.69-12.89). Table 8 shows the distribution of key spirometric measures for males and females from whom we were able to obtain analyzable results.

Table 8. Spirometry results.

	Overall (n=152)	Females (n=68)	Males (n=84)
FEV1	2.872	2.390	3.262
FVC	3.621	2.929	4.181
FEV1/FVC percent of predicted	97.8%	97.9%	95.8%

At the time of the spirometry testing, we also obtained height, weight, and waist circumference for all participants. Overall, 14% of participants were underweight/normal weight (BMI $\leq$ 24.9), 40% were overweight (BMI 25-29.9) and 45.8% were classified as obese based upon BMI (BMI measuring 30+). Among women, 42.2% were overweight and 44.4% were obese. For men, 37.9% were overweight and 47.1% were obese.

For those who participated in the spirometry testing, the results of the spirometry test were given to each participant in the form of a brief report and these results were explained. The report provided information on the participant's height and weight, blood pressure and two measures of lung function (FEV_1 and FVC). Participants who reported that they were smokers during the test session were given a "*Rompa con el hábito de fumar*" pamphlet to encourage smoking cessation. Follow-up letters were sent to participants who scored less than 80% on their pulmonary function measures and/or who have blood pressure measurements in excess of 140/90. The letters provided the participants with referral information about local medical providers in the event that the participant did not have a regular physician. Two members of our advisory committee are physicians serving the community of Mendota, and we were able to refer any participants requiring additional medical attention to these physicians.

Oral Health Ancillary Study

The Center to Address Disparities in Children's Oral Health (CAN DO) is a research center at the University of California, San Francisco School of Dentistry. CAN DO is collaborating with us and conducting an ancillary study in the Mendota population. Funding for this ancillary study is provided by the CAN DO Center. The UCSF team is assessing oral health and providing dental exams for families and all children of our MICASA participant households. The UCSF team includes a dentist, dental examiner and interviewer based in Mendota for the interviews and examinations. The MICASA field office was used for the dental examinations, and both field teams coordinated efforts to insure that families are aware of project activities taking place in the community. Three hundred forty-three families with eligible children completed the baseline MICASA questionnaire and were contacted by the UCSF dental team for recruitment into their project. The dental research component included an adult interview, a parent interview about children in the household, interviews with children old enough to complete it, and dental examinations for adults and children in the household. The dental team completed 323 adult interviews with 213 families, 485 parent interviews with 214 families, and 692 dental exams with 199 families. The collaboration with UCSF benefited the community both in terms of the service they provided to participants and to further inform our knowledge about oral health attitudes and practices and suggest interventions to address this important health concern.

The dental study examined oral health in both children and adults. Preliminary results from the dental study on the children show a very high prevalence of tooth decay. More than half of the 2-5 year olds examined already had tooth decay, which is twice the national average. 80% of children 6-11 years old had tooth decay in their permanent teeth which is two times higher than national data.

Among adult participants, 13% reported never having been to a dentist, 31% of men and 5% of women. National data report that 1.8% of men and 0.6% of women have never been to a dentist. The California Agricultural Workers Health Study (CAWHS) found 50% of male and 44% of female farm workers reported never having been to a dentist. Early findings also show that participants in Mendota appear to have even worse perceived and clinically-determined oral health than other cohorts of farm workers and their families.

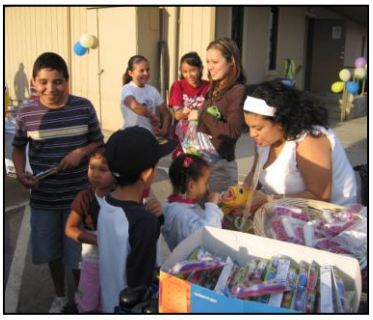
RESEARCH TO PRACTICE

The study benefits from a Community Advisory Committee comprised of community representatives, county health department officials, local health professionals and farm worker advocates. The advisory committee provides an avenue for advice and feedback to the UC Davis investigators and the local research team about the community and any concerns that might arise during the course of the study. It also affords the opportunity to share progress, study results and develop appropriate strategies for disseminating information within the community. The committee meets 2-3 times a year in Mendota and interim communication is maintained through email and other correspondence with committee members.

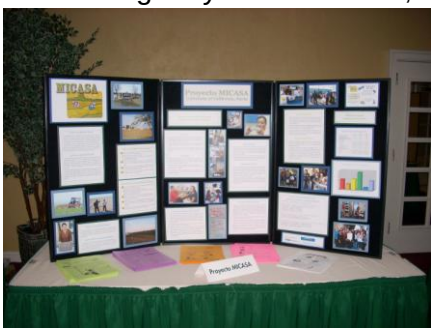
Committee members have provided suggestions on how the study can serve the community and have a lasting impact. Specifically, they suggested disseminating study information and results to the community through open community meetings, health fairs, and town hall meetings. Advisory members also discussed other issues facing the community that the MICASA project could address such as increasing availability of fresh fruits/vegetables, making the community more walkable, increasing access to transportation, improving opportunities for outdoor activities for children as well as health issues such as alcoholism, vision care and mental health. Additional discussion included the role of UC Davis in providing technical assistance and grant writing assistance in order to increase the ability of local agencies to obtain grant funds.

The community-based focus of the MICASA project continues to be an important aspect of the work we are doing in the community. Dr. O'Connor, the UC Davis field coordinator, is an active participant in the community through attendance at City Council meetings to keep members informed about the study and its progress. She is also a member of the Firebaugh-Mendota Rotary Club, which provides the opportunity for interaction with local community leaders and further understanding of community priorities and needs. Second, our research assistants are residents of Mendota, and are either former farm workers or from farmworking families themselves. We have trained these staff members in interviewing and recruiting techniques, and they recently completed the NIOSH-Approved Spirometry Testing and Respiratory Surveillance Training Program and received certification. As members of the community, they have been invaluable to the project as we are working with a hard-to-reach population known for its suspicion of outsiders. They have also been critical to our ability to cultivate and maintain long-term relationships with our participants, and establish trust and rapport. Our local staff has also provided essential help with preparation of survey instruments and outreach materials, as they are able to quickly provide locally-appropriate Spanish-language translations.

As a way to outreach to our participants and the advisory committee, the field team puts together a newsletter, *El Melón Rondero* (Appendix). Three issues of the newsletter have been sent to all participant families. The first issue contained information about the purpose of the MICASA project, introduced the members of the field team, provided information about heat stress and how to stay cool, and briefly described some of our future plans in the community. The second issue included information about lung health, the spirometry component of the project, the benefits of quitting smoking and the UCSF dental study. A third issue was recently mailed to participants with updates on study progress, information on ergonomics and announcements for seminars sponsored by the MICASA study. Thank you notes and follow-up telephone calls are also made to participants to maintain communication.



We held an open house on November 12, 2006 to celebrate the opening of the field study office in Mendota. Invitations were mailed to all participants, the advisory committee, and community groups. Investigators from UC Davis and UCSF, as well as the local field team, hosted the event. Over 200 participants and their families attended the open house event. While adults mingled with investigators and MICASA field staff members, children played with piñatas, were taught proper tooth-brushing techniques by UCSF dental study staff members and played with jump ropes and balls given out by our staff. The event received local media coverage by Univision 21, the local Fresno television broadcast affiliate.



We have also developed a MICASA Study display board in both English and Spanish that is used at educational activities. The information was exhibited at The California Endowment 2007 Agricultural Worker Health Initiative Conference, *Cultivando Cambio Para el Futuro,* held in Sacramento, CA on August 22 - 24, 2007. The MICASA display has also been used at local educational efforts in the community of Mendota. The study also maintained a booth with the display at Mendota's annual Harvest Festival in July 2007.

Dr. Marc Schenker, the study PI, presented results of the study to the Mendota City Council on November 13, 2007. A handout of some key study results was prepared in both English and Spanish (Appendix) and distributed to the City Council members and the City Manager. A community meeting was also held to disseminate information about the results of the study to community members. The meeting was advertised throughout the community, and Dr. Schenker, the local field team, and a member of the UCSF dental team were present at the meeting to discuss key study results. This meeting was conducted in Spanish to best meet the needs of our participants. The study handout was distributed to those in

attendance and other relevant educational materials on topics including pesticide use, asthma and heat stress were available.

R2P efforts for the respiratory health and spirometry component of the MICASA study centered on the development of relevant and culturally appropriate handouts for study participants. One handout, "*La prueba de la function de los pulmones*," was designed to provide a more detailed explanation of the spirometry test and the meaning of test results (Appendix). A second handout for participants titled, "*Comprendio su presion de sangre*" provides information on blood pressure and the interpretation of blood pressure measurements (Appendix). Initially, the handouts were tested for content in the community before distribution to participants. In addition, the field coordinator and survey workers are working within the community to deliver educational workshops designed to assist hired farm workers in reducing their risk to respiratory hazards and respiratory symptoms.

Finally, our current efforts in research-to-practice and educational activities include a monthly seminar series in the community of Mendota to address issues of interest to the participants and the community at large. We are partnering with the Firebaugh-Mendota Rotary Club for these monthly seminars. We have presented our findings from the MICASA project to the community and currently have scheduled lectures on breast cancer, domestic violence, arthritis, and nutrition - all subjects requested by our participants. Future lecture topics suggested by our participants include talks on appropriate pesticide use; reducing workplace hazards; cholesterol and hypertension; cancer; oral health; and mental health. We solicit speakers from a variety of agencies that provide Spanish lectures such as Centro la Familia, the American Cancer Society, the Agricultural Commission, the UCSF School of Dentistry, and the Fresno County Health Commission. The lectures have been very well-attended and the audiences have been lively and engaged.

PROJECT PRODUCTS

1. Presentations:

Schenker MB; Stoecklin-Marois MT; Hennessy-Burt TE. Associations of acculturation with asthma and atopy in Hispanic farm workers. American Thoracic Society Annual Meeting 2008. Toronto, Ontario, Canada. May 16-21, 2008.

MT Stoecklin-Marois; TE Hennessy-Burt; LM Butler; MB Schenker. Immigration and Acculturation Factors Related to Weight Perceptions and BMI in California Hired Farm Workers. American College of Epidemiology Annual Meeting 2007. Ft. Lauderdale, FL. Sept 15 – 18, 2007.

Schenker MB; Stoecklin-Marois MT; Hennessy-Burt TE; O'Connor K. Smoking Patterns in Hispanic Farmworker Families. American Thoracic Society Annual Meeting 2007. San Francisco, CA. May 18 - 23, 2007.

Hennessy-Burt TE; Stoecklin-Marois MT; Meneses-Gonzalez F; Schenker MB. Migration and asthma - a US/Mexico bi-national comparison. American Thoracic Society Annual Meeting 2007. San Francisco, CA. May 18 - 23, 2007.

Sterling, Robie. Respiratory Symptoms, Smoking Prevalence and Dust Exposure in Hired Farm Workers. UC Davis Undergraduate Research Conference 2007. Davis, CA. April 21, 2007.

Adela M. Del Valle, Tamara Hennessy-Burt MS, Maria Stoecklin-Marois MPH, PhD, and Marc B. Schenker MPH, MD. Food Insecurity and Health Issues Among California's Hired Farm

Workers. UC Davis Undergraduate Research Conference 2007. Davis, CA. April 21, 2007.

Hennessy-Burt TE; Stoecklin-Marois MT; Meneses-Gonzalez F; Schenker MB. Understanding acculturation, health risk behaviors and the Hispanic Epidemiologic Paradox in the context of a bi-national investigation. Health and Safety in Western Agriculture: Research to Practice, Asilomar, CA. September 20-22, 2006.

M. Schenker, M. Stoecklin-Marois, and K. O'Connor. Agricultural Health in a Community-Based Farm Worker Population: The MICASA Study. NORA Symposium 2006. Washington, D.C. April 18-20, 2006.

2. Publications

Peer Reviewed Journal:

Fact Sheets / Brochures / Technical Publications:
La prueba de la function de los pulmones
Comprendio su presion de sangre
Proyecto MICASA – in English and Spanish

Other Publications:

3. Education / Training / Outreach

Training Seminars:

News Letters:
El Melón Rondero, Volume 1, Issue 1
El Melón Rondero, Volume 1, Issue 2
El Melón Rondero, Volume 1, Issue 3

Other:
MICASA study Open House
MICASA study display board – presents information about the study in English and Spanish

4. Conferences / Meetings Sponsored:

Mendota Community Meeting / Proyecto MICASA Reunion Comunitario – November 13, 2007

TITLE OF PROJECT 2 IRB **PROTOCOL NUMBER** 200513524-6 through February 2011

Respiratory Health and Exposures on Large Californian Dairies

PROGRAM DIRECTOR/PRINCIPAL INVESTIGATOR

Frank Mitloehner, PhD
Associate Professor, Dept of Animal Science
University of California
One Shields Avenue
Davis, CA 95616
Email:fmmitloehner@ucdavis.edu
Tel:(530) 752-3936

Marc Schenker, MD, MPH, Co-Investigator
Professor, Department of Public Health Science
University of California, Davis
One Shields Avenue
Davis, CA 95616
(530) 752-4050

Deborah Bennett, PhD, Co-Investigator
Associate Professor, Department of Public Health Science
University of California, Davis
One Shields Avenue
Davis, CA 95616
(530) 754-8282

Daniel J. Tancredi, Ph.D, Co-Investigator
Assistant Professor in Residence
UC Davis Department of Pediatrics and
Center for Healthcare Policy and Research
2103 Stockton Blvd, Suite 2224
Sacramento, California 95817
(916) 734-3293 (voice)

Christoph Vogel Ph.D. Co-Investigator
Assistant Research Scientist
Environmental Toxicology
University of California, Davis
One Shields Avenue
Davis, CA 95618
Tel: 530 752 7775

Until the economic downturn in 2008, the dairy industry, and more specifically, milk production had grown rapidly in California's San Joaquin Valley. The size of dairies had increased, along with the potential for respiratory health hazards due to the practice of housing large concentrations of cows in open sided free stalls or open dirt-floored

corrals. This study aims to define the concentrations of airborne pollutants highly associated with respiratory problems in a group of 200 dairy workers compared to a control group of 50 workers unexposed to cows and dairy conditions. This data will be compared to exposure and health data collected on smaller Colorado dairies. Air samples collected will be assessed for inflammatory potential when applied to macrophage cultures. Personal exposures to particulate matter, endotoxins and ammonia was monitored over a work shift on dairies with over 1000 lactating cows, and at the control facility. Health data was collected by questionnaire and pre-and post-shift measures of pulmonary function.

The hypotheses to be tested are:

- Exposure to elevated concentrations of airborne pollutants will result in increased respiratory symptoms and changes in pulmonary function over the work shift; specific dairy tasks will be associated with different pollutant concentrations.
- Long-term exposure to elevated pollutants will result in increased prevalence of respiratory symptoms, reduced lung function and more respiratory problems in dairies than in creamery workers.
- Facility environment including endotoxin composition will vary between California and Colorado dairies, resulting in different respiratory outcomes.
- Dairy air samples will activate macrophage cultures designed to assess inflammatory potency.

Information on exposure and health effects will be essential to evaluate any health consequences of modern Californian dairy practices. This information is the basis for studies on mitigation of potential risks to the dairy workers. This present project will include a strong outreach and extension component primarily toward the dairy industry in the San Joaquin Valley. Outreach will also be extended to those individuals who deal with health, safety and other regulations pertaining to the dairy industry.

A. PROJECT START AND END DATES

Started October 1, 2006. Anticipated ending date with no cost extension, 2012.

B. PROJECT ACTIVITIES / ACCOMPLISHMENTS

Previously Accomplished:

- October 2007 - Pilot study for preliminary test of protocols and equipment.
- March 2008 - Winter conditions assessment of the first study dairy. Information gained on the variability between day to day personal exposures.
- Mid June – Mid September 2008 – Field visits to 13 large San Joaquin dairies sampling 220+ workers over their work shift.
- Mid to late September 2008 – Field visit to a control facility to sample 50 workers (49 complete assessments were accomplished).
- In 2008 field data collection on large Californian dairies was completed. The field component in the San Joaquin Valley began June 23rd and finished September 21st 2008. Data collection on over 220 dairy and 49 control workers was achieved The data included cross-shift personal dust samples, pre and post-shift pulmonary function tests and interviewer conducted questionnaires. Concurrent

stationary sampling over the shifts was carried out at designated sites in each dairy to allow a comparison of dairies with respect to particulate profiles at each site. In all 13 dairies and one control (vegetable food processing factory) were monitored in the successfully completed field component of the study.

Accomplished 2008-2009:

- All sampler filters were gravimetrically weighed in compliance with study protocols and the information entered into the study data base.
- Endotoxin analysis by rFC and GC/MS was completed at the Colorado laboratory of the study collaborator – Stephen Reynolds, PhD.
- Data (double) entry of questionnaire responses were completed and field log information (air sampling data for both personal and area samplers) were entered with 10% double entry into the secure web-based data management system in the Department of Public Health Sciences
- Quality control and data cleaning of base data sets in SAS (Statistical Analysis Software) were completed.

Accomplished 2009-2010:

- Cleaned data underwent quality control checks and were incorporated into data sets stored on the department secure server.
- Personal sampling data included 226 dairy worker participants who completed the study and 49 control worker participants. 211 dairy workers and 46 control workers have a combination of sufficient exposure, questionnaire and pulmonary function test data (both pre and post-shift) for analyses. Exposures sampled included Total Suspended Particles (TSP) PM2.5 (particles with an aerodynamic diameter ≤ 2.5 µm). The TSP samples were analyzed for particle mass and endotoxin components using both rFC and GCMS techniques. With the PM 2.5 sampling, only mass was analyzed. Analyses were conducted comparing the pulmonary symptoms and pulmonary function between dairy and control workers both at baseline and cross-shift. Personal Exposures were calculated for dairy workers both general particulate matter and endotoxin, and for major classes of work / areas worked on the dairies.
- Area Exposure Sampling consisted of 410 filters. Approximately 50% of the filters were material collected from the button samplers (full particle range in size), and 50% from cyclone filters (PM 2.5). TEOM electronic data flows giving continuous real-time PM2.5 concentrations was collected from 8 dairies. A Burkard sampler was used to collect bioaerosols from 3 dairies which will be analyzed for allergens and other biological particles. At five of the dairies samples of total particulates fractionated into 4 size fractions [1.3 – 10.2 µm] from a HiVol were collected. This material has been used to assess the inflammatory potential of the dairy particulates.

FIGURE 1: Study Timeline

Key :

☒ Completed

X To be completed

YEAR	Year 1: 2006-7				Year 2: 2007-8				08-09	09-10	10-11
Season	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Year 3	Year 4	Year 5
Protocol / Methods / SOP's Instrument /development	X	X	X	X	X						
Pilot Testing / Modify protocols					X						
Choose and recruit dairies and control facilities						X	X				
Winter exposure testing, analysis and modifications						X					
Recruit and train staff for main study						X	X				
Main cross-sectional study of 200 dairy, 50 control workers							X	X			
Data collection / cleaning/ compiling						X	X	X	X	X	
Analysis						X			X	X	X
Report writing										X	X
R2P – Communicating results to the community											X

Progress Report

The study year 5 (October 2010-September 2011) was spent in data analysis, discussion with our Colorado collaborators, presenting information from the study at scientific meetings, in agricultural news updates, manuscript writing and preparing to take the results back to the dairy industry in California;

At least 8 manuscripts are being prepared from this study. A summary of the findings is given in connection to the Specific Aims listed below, and a list of the manuscripts is also provided.

Administrative and Collaboration developments:

Project meetings continue on an as needed basis, and we continue to collaborate with the Reynolds laboratory in Colorado. We have a "Smart site" - a UC Davis collaboration and Web-based management system which allows investigators to share documents, data, schedule meetings or other events. The project also has a public Web site: (http://cal-DEHRI.ucdavis.edu/). The latter will be updated in English and Spanish in 2012 to reflect the final results and conclusions from the study.

We have IRB study protocol approval through February 2013.

Projected Activities:

The activities still planned in the remainder of the no-cost extension period include completing and submitting / revising manuscripts to peer-reviewed journals for publication. At least seven papers are either at a journal or in late stages of completion in addition to the one already in print. We intend to continue to collaborate with the Reynolds lab in Colorado for our joint hypothesis. The major findings and translation into practical information / education and possible interventions (if needed), will be

presented to California dairymen and workers with a short fact sheet from the study, a poster in Spanish, and an in person presentation by the PI, Dr. Mitloehner, to take place in 2012. The Web site will also be updated with this information.

Results with respect to the Specific Aims of the project

Specific Aim 1: To quantify the association between exposure to particulate matter, endotoxin, and ammonia with respiratory health problems (respiratory symptoms and pulmonary function changes). This objective has three main hypotheses:

Hypothesis #1a: Dairy workers exposed to elevated concentrations of particulate matter, endotoxin, and/or ammonia exhibit both acute respiratory symptoms and a decrement in pulmonary function over the course of their work shift.

Hypothesis #1b: Specific tasks in different areas of the dairy expose workers to different concentrations of endotoxin, particulate matter, and ammonia.

Hypothesis #1c: Dairy workers exhibit a higher prevalence of respiratory symptoms and more airflow obstruction than a comparison group of control workers, independent of age, cigarette smoking, and other non-occupational effect modifiers.

Results:

Hypothesis #1a Analysis has been completed and the results will be reported in two papers. Symptoms of non-doctor diagnosed asthma were found to be higher than expected in dairy workers (See C Eastman et al. 2010). An association between a decrement in cross-shift FVC and increasing endotoxin concentration was found when all workers (control and dairy) were combined. The results are being incorporated into a manuscript.

Hypothesis #1b Personal concentration distributions were higher than area based concentration distributions for $PM_{2.5}$, total suspended particles (TSP) and endotoxin indicating the existence of a worker-induced personal exposure component. The difference between personal and area concentrations was greatest for TSP. Milking was usually conducted at one location for the entire work shift and, therefore, was expected to have the greatest correlation with area based concentrations. Correlations found between personal and area based concentrations were low for TSP, with better correlation for $PM_{2.5}$ and endotoxin.

Occupational exposure from time spent re-bedding (removing soiled bedding where lactating cows rest in the freestalls, and replacing with fresh material) was found to be significantly higher for $PM_{2.5}$, TSP and endotoxin, compared to time spent milking or conducting other tasks, yet only two percent of workers performed this task exclusively, while six percent performed it at some point during their shift. For those that performed this task, the average amount of time re-bedding was 5.7 hours. Time spent feeding was associated with higher concentrations for $PM_{2.5}$ and TSP, with lower concentrations for endotoxin, likely due to exposures to dust with lower concentrations of endotoxin when feeding. Future studies might be warranted regarding mitigation practices around re-bedding of freestalls, feeding, and/or effectiveness of protective gear to lower exposures while performing such tasks. Two manuscripts are submitted / in preparation that address this hypothesis. One concentrates on the exposures

(submitted), the second on differences between cross-shift pulmonary function for different job classes of workers.

Hypothesis #1c Dairy work was associated with mean baseline differences of -0.132 L (p=0.07), -0.163 L (p=0.053), and -0.131 L (p=0.13) in FEV_1, FEV_6, and FVC, respectively, compared to control employees, adjusting for age, height squared, smoking status, and days back at work. The final adjusted baseline model approached statistical significance and was suggestive of a chronic association of dairy work and FEV_1 (p=0.07) and FEV_6 (p=0.053). (However, there was not an association of dairy work and the baseline ratios FEV_1/FEV_6 or FEV_1/FVC (p=0.96 and 0.64, respectively).

Dairy work was associated with a mean cross-shift difference of -65.2 mL (p=0.02), -96.0 mL (p<0.01), and -103.1 mL (p<0.01) in FEV_1, FEV_6, and FVC, respectively, adjusting for smoking status and shift time (morning v afternoon/evening start of shift). Dairy workers experienced a greater cross-shift decrement in both markers of obstruction (FEV_1) and restriction (FEV_6 and FVC) (p=0.02, 0.002, and 0.002, respectively) after adjusting for smoking status and shift time. The difference between dairy workers and control employees was not statistically significant for FEV_1/FEV_6 or FEV_1/FVC (p=0.61 and 0.42, respectively).

Dairy work in California was associated with a mixed effect of mild acute airway obstruction and acute airway restriction, as evidenced by the significant cross-shift decline in FEV_1, FEV_6, and FVC. The chronic effect of dairy work in California is unclear and merits further investigation. One paper has been submitted in conjunction with Hypothesis 1c.

Specific Aim 2: To compare the effects of air contaminants on cross-work shift pulmonary function among workers on large California dairies with those found in a study of dairy workers in Colorado with vastly different facility sizes, climate, and management practices. We will compare the results of Specific Aim 1 with those of a NIOSH study proposal from High Plains Intermountain Center for Agricultural Health and Safety (HICAHS).

> **Hypothesis #2:** Differences in facility environment, size, and management practices will result in different exposures to air contaminants and consequently different respiratory health outcomes for dairy workers in California versus Colorado**.**

Results: Our collaborators in Colorado were still collecting data in 2011 for comparison to our California study. They have analyzed our samples for endotoxin so that we have comparable methods. We are able to share data using a Web-based study site- the Cal-DEHRI smart-site, and will use this function to share data and results. We aim to combine data over the next year to both increase power of the overall studies and examine differences in results between them.

Specific Aim 3: To investigate the composition of particles in dairies, whether they have inflammatory potency in macrophage cell cultures, and how their inflammatory potency compares to other known environmental toxicants. This will include a comparison of particulate matter from HICHAHS dairy facilities in Colorado and ambient samples collected in rural and urban areas of San Joaquin Valley

Results: Analysis from material taken from the Hi-Vol sampler indicated activation in cell culture of human macrophages, of mRNA for markers of inflammatory

reactions including cytokines IL-8, TNFα , COX-2, C-reactive protein and IL-6. In summary, the most critical component of dairy farm dust is endotoxin, which may trigger local and systemic inflammatory reactions upon inhalation. Exposure to particulate matter (PM) collected on dairy farms generates an inflammatory response in human macrophages partly mediated through activation of TLR4 and the NF-κB signaling cascade. The inflammatory response induced by urban samples of PM was significantly lower compared to PM from dairies, which has a higher level of endotoxin than the urban PM.

Staff / Other Personnel:
Diane Mitchell – Study Coordinator
Tracey Armitage – Assistant Statistician
Graduate Students:
Chelsea Eastman (health / epidemiology)
John Garcia (exposure)
Undergraduate Assistants:
Rebeca Gallo (data processing, general office duties)

F. Publications
References:

1. Mitloehner, F.M., and M. Schenker. Environmental exposure and health effects in concentrated animal feeding operations. *Epidemiology.* 2008; 18: 309-311
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In Press:
Christoph F. A. Vogel, Johnny Garcia, Dalei Wu, Diane C. Mitchell, Yanhong Zhang, Norman Y. Kado, Patrick Wong, Danitza Alvizar Trujillo, Anna Lollies, Deborah Bennet, Fumio Matsumura, Marc B. Schenker, and Frank M. Mitloehner *Activation of inflammatory responses in human U937 macrophages by particulate matter collected from dairy farms* Environmental Health (Accepted with revisions)

Johnny Garcia, Deborah H. Bennett, Daniel Tancredi, Marc B. Schenker, Diane Mitchell and Frank M. Mitloehner *Occupational exposure to particulate matter and endotoxin for California dairy workers.* International Journal Occupational Health and Hygiene (Accepted with revisions)

Submitted:
Johnny Garcia, Deborah H. Bennett, Daniel Tancredi, Marc B. Schenker, Diane Mitchell and Frank M. Mitloehner *Occupational exposure to particulate matter and endotoxin for California dairy workers.* International Journal Occupational Health and Hygiene (Accepted with revisions)

Johnny Garcia, Deborah H. Bennett, Daniel Tancredi, Marc B. Schenker, Diane Mitchell and Frank M. Mitloehner *Particulate matter levels from two size fractions collected on thirteen California dairy farms.*
Submitted to Atmospheric Environment.

Johnny Garcia, Deborah H. Bennett, Daniel Tancredi, Marc B. Schenker, Diane Mitchell Stephen J Reynolds, Rona Silva, Gregory P Dooley, John Mehaffy and Frank M. Mitloehner *Characterization of endotoxin collected on California dairies using personal and area based methods.* Submitted to Journal of Occupational and Environmental Hygiene.

Ready for submission:
Chelsea Eastman, Marc B. Schenker, Diane C. Mitchell, Daniel J. Tancredi Deborah H. Bennett, Frank M. Mitloehner *Acute pulmonary function change associated with work on large dairies in California* To be submitted to Journal of Occupational and Environmental Medicine.

Chelsea Eastman, Marc B. Schenker, Diane C. Mitchell, Daniel J. Tancredi Deborah H. Bennett, Frank M. Mitloehner *Are specific tasks on large Californian dairies associated with a decrement in lung function?*

In Preparation:
Diane Mitchell, Marc B Schenker, Tracey Armitage, Deborah H Bennett, Daniel J Tancredi, Chelsea Eastman, Johnny Garcia, and Frank M Mitloehner. *Associations between particulate matter exposures and pulmonary function in California dairy workers.*

Presentations:
J Garcia *'PM2.5, TSP and endotoxin levels found on California dairy farms through area and personal sampling'* 21st annual meeting of Northern Chapter of Society of Environmental Toxicology and Chemistry 2011
Abstract:
Presented at the American Thoracic Society meeting in May 2011 at Denver, CO.
'Acute change in FEV_1 and FVC associated with work in large-scale dairies in California'
Chelsea Eastman[1], Marc Schenker[1], Diane Mitchell[1], Daniel Tancredi[2], Deborah Bennett[1], Frank Mitloehner[3]

Presented at EPICOH meeting September 2011 in Oxford, UK.
'Are Respiratory Decrements Associated with Exposure to Particles Including Endotoxins on Large California Diaries?' Diane Mitchell, Marc Schenker, Tracey Armitage, Deborah Bennett, Daniel Tancredi, Frank Mitloehner.

G. STATES THE PROJECT WAS ACTIVE IN

California

H. COLLABORATION

Stephen J. Reynolds, Ph.D.,CIH, Professor and Director
High Plains Intermountain Ctr for Ag Health & Safety, 154B EHB
Department of Environmental and Radiological Health Sciences
Colorado State University
Ft. Collins, CO 80523-1681
Phone 970-491-3141, Fax 970-491-2940
Stephen.Reynolds@Colostate.edu

PROJECT 3: Health Effects of Ambient Airborne Particles from the Sacramento/San Joaquin Valley

Project Leader: Kent E. Pinkerton
Project Co-Leader: Michael Kleeman

A. Specific Aims

There have been no changes to the specific aims.

B. Studies and Results

The primary objectives for Project 3 have been to (1) determine how variation in particle concentration, size, and composition in agricultural settings affect health outcomes in laboratory rats, (2) identify sources of fine and ultrafine particulate matter in farming and dairy settings in the Sacramento and San Joaquin Valleys and test their health effects through direct exposure studies using laboratory animals, and (3) examine the importance of season in each agricultural setting where particle size and composition are likely to be different due to level of activity and weather. These research objectives are based on the following hypothesis:

Hypothesis: The concentration and composition of inhaled fine/ultrafine particles (< 2.5 μm in diameter) as well as coarse particles (2.5 to 10 μm in diameter) comprised of metals, organics, nitrates, and carbonaceous compounds and generated by agricultural activities (crop production, field preparation) determine the health effects associated with airborne particulate matter.

In the fifth year we continued our focus on the unique working environment of California farmers. We completed the examination of three agricultural locations in the San Joaquin Valley and compared each to Fresno, CA the largest city located in the San Joaquin Valley. The small farming community of Parlier which contains abundant stone fruits and vineyards has been an ideal location for studying fine/ultrafine and coarse particles. Our preliminary findings for this agricultural site have been published in the January-March 2010 issue of California Agriculture (Vol 64, pp 12-16). Field studies involving nearby dairy operations have been a second area of investigation which subject workers to a wide range of airborne particles. Tulare County in the San Joaquin Valley, site of the highest density of diary cows in the United States has been the site selected for these studies. The third agricultural region is a rural site at Westside, also located in the San Joaquin Valley approximately 45 miles to the southwest of Fresno, CA. This area has extensive row crop farming.

Our efforts during the past year have been to complete studies on particle effects to the respiratory and neural systems in rats exposed to concentrated ambient aerosols located in these three unique agricultural settings of Parlier, CA, Tulare County, and Westside, California. Conditions of particle exposure via short-term inhalation studies in rats have been completed for particle size, composition, and concentration and correlated to biological endpoints in both the respiratory and neural systems of rats.

C. Significance

We anticipate our research findings will begin to yield the following outcomes: A) measurement of the effects of inhaled particles in nose to brain transport and neurological outcomes, the degree and distribution of inflammatory cells present in the nasal cavity, olfactory bulb and brain and

changes in elucidation of the biological plausibility for these particles to produce health effects in the agricultural setting. Our field studies to date have demonstrated the feasibility of performing animal inhalation studies in peripheral sites away from the Davis campus, the feasibility of using the mobile unit to perform such studies, and success in partnering our research program with state agencies (Department of Pesticide Regulation and the California Air Resources Board) and the local air quality district of San Joaquin Valley to contribute unique and novel data. Although not a primary objective, we have found our work might contribute to environmental justice projects for the state of California and agricultural communities such as Parlier, Tulare and Westside, CA. We are also delighted these efforts represent the first steps to create public outreach and educational programs to agricultural practices where our studies are conducted.

D. Plans

Through the renewal project for the Western Center for Agricultural Health and Safety we will continue to investigate the biological effects of agricultural dusts and extend our studies into allergic conditions. It is anticipated our research findings will yield the following outcomes: 1) measurement of the respiratory health effects of inhaled particles, 2) elucidation of the biological plausibility for these particles to produce health effects in the agricultural setting; 4) sharing of findings with partner state agencies and local air quality districts of the Sacramento and San Joaquin Valleys; and (5) contributions to public outreach and educational programs to agricultural practices and dairy operations where studies will be conducted.

E. Publications

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2009 Madl, A.K., and Pinkerton, K.E. Health effects of inhaled engineered and incidental nanoparticles. Critical Reviews in Toxicology 39:629-658.

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Kodavanti, U.P., Meharg, E., Plummer, L.E., Recendez, J.J., Schenker, M.B., Sioutas, C., Smiley-Jewell, S.,
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2008 Plopper, C.G., Smiley-Jewell, S., Miller, L.A., Fanucchi, M.V., Evans, M.J., Buckpitt, A.R., Avdalovic, M., Gershwin, L.J., Joad, J.P., Kajekar, R., Larson, S., Pinkerton, K.E., Van Winkle, L.S., Schelegle, E.S., Pieczarka, E.M., Wu, R., Hyde, D.M. Primate Models of Allergic Asthma. In: A.B. Kay, J. Bousquet, P.G. Holt and A.P. Kaplan (Eds) Allergy and Allergic Diseases, 2nd Edition, pp. 1231-1245. Blackwell Publishing, London.

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F. Project generated presentations

2009 Airborne Particles: Laboratory Applications. Health Effects Task Force, Breathe California of Sacramento-Emigrant Trails. Sacramento, CA, March 27.

2009 Effects of Air Pollution on Lungs of Individuals With Different Age Groups (Experimental Animal Models). Turkish Thoracic Society, 12th Annual Congress. Antalya-Kemer, Turkey, April 11.

2009 What are the Combined Effects of Multiple Pollutants, e.g. Synergistic, Additive, Antagonistic? US Environmental Protection Agency. BOSC, Research Triangle Park, NC, June 9.

2009 Health Effects of Inhaled Engineered and Incidental Nanoparticles. Genetic and Environmental Toxicology Association of North California. Oakland, CA, June 24.

2009 Pediatric Grand Rounds, UC Davis Medical Center, "Environmental tobacco smoke and children: Clinical implications in an experimental setting". Sacramento, CA, September 4.

2010 The Safety of Nanomaterials from a Human Exposure Perspective. Nanotechnology and the Allergist, American Academy of Allergy, Asthma and Immunology. New Orlean, LA, February 27.

2010 Comparative Biology of the Lung, Continuing Education Course, Society of Toxicology. Salt Lake City, UT, March 7.

2011 The influence of environmental air contaiminants on perintal lung development. California Department of Public Health, Richmond, CA Sept 7.

2011 Health Effects of inhaled nanoparticles on human health. Kyoto Sangyo University, Kyoto, Japan, October 5.

2011 Health implications of inhaled nanoparticles. University of Bern, Bern, Switzerland, November 7.

2011 Implications of inhaled nanoparticles on health. University of Basel, Basel, Switzerland, November 8.

TITLE OF PROJECT 4

Rapid Assays for Human and Environmental Exposure Assessment

PROGRAM DIRECTOR/PRINCIPAL INVESTIGATOR

Bruce Hammock, PhD
University of California, Davis
One Shields Avenue
Dept of Entomology
Davis, CA 95616
Email: bdhammock@ucdavis.edu
Tel: (530) 752-7519

APPLICANT ORGANIZATION

WESTERN CENTER FOR AGRICULTURAL HEALTH & SAFETY (WCAHS)

PROGRESS REPORT Summary

A. Specific Aims

There have been no changes to the specific aims.

B. Studies and Results

Aim I. Assess new technologies to improve speed, sensitivity, and robustness of immunoassays for biomarkers.

We have developed novel phage displayed peptides and utilized them to obtain sandwich type immunoassays for small molecules that we term phage anti-immunocomplex assays (PHAIA). PHAIA for small molecules have all the advantages of sandwich assays typically conducted for larger molecules such as proteins. In this year, we have extended the PHAIA technology utilizing polymerase chain reaction (PCR) as the detection system instead of enzyme labels. This technology, adapted to magnetic beads instead of a microtiter plate, is 10-fold more sensitive than the conventional PHAIA and significantly faster to perform. The assay was developed for 3-phenoxybenzoic acid (3-PBA) an indicator of pyrethroid insecticide exposure and molinate a rice herbicide and validated in agricultural drain water and human urine samples (Kim, H-J. et al., 2011). An overview of the new technologies mentioned in this report was published by Ahn et al., (2011). An immunoassay for chlorpyrifos was adapted to an immunochromatographic method. This lateral flow assay, similar to a dipstick with the same ease of use, was used to screen spiked sample of rice and lettuce. The detection limit for chlorpyrifos in agricultural samples was 50 ng/mL (Kim, Y.A. et al., 2011).

Impact:

The methodologies described are more sensitive, rapid and simpler to conduct than classical instrumental methods such as liquid chromatography/mass spectrometry. The improved sensitivity translates to less sample preparation and thus improved throughput

and lower cost. The assays are field portable and can be converted to point of need use such as occupational exposure or food safety monitoring.

Aim II. Develop and implement immunoassays for new target compounds.

As assay for the rice herbicide clomazone was developed and used in a rice water management study to optimize productivity while minimizing release of chemical into the environment. The assay had a detection range of 2 – 20 ng/mL in field samples and was validated in rice water field samples against a liquid chromatography method (Carlomagno et al., 2010). In addition, an assay for the insecticide fipronil has been completed and validated in water samples. The manuscript is in progress. Triclocarban, an antibacterial compound used in soaps and hand washes is widely dispersed in the environment and has prompted review by regulatory agencies. We have conducted two studies to identify appropriate biomarkers of exposure to triclocarban (Schebb et al., 2011; Ye et al., 2011)

Impact:

These assays are easy to use and can rapidly provide data for water management and environmental fate studies leading to improved environmental health and subsequently improved human health due to decreased exposures.

Aim III. Provide analytical support for other WCAHS studies

The classical immunoassay for 3-PBA was validated for use in human urine samples and applied to a study about exposure of Southern pinecone harvesters to the pyrethroid insecticide esfenvalerate. Over 300 urine samples were analyzed for 73 study participants classified by work task as high, low or no exposure. There was no effect of orchard or day. A significant effect between high and no exposure could be seen, but was not significant after correction for creatinine concentration (Ahn, K.C., Gee, S.J., et al., 2011)

In a study of pyrethroid pesticide exposure in farmworker families, end of day urine samples were collected from 105 woman and 103 children (age 7 or under) recruited from the Mexican Immigration to California: Agricultural Safety and Acculturation (MICASA) study population. The MICASA population is a population based sample of 467 households of hired farm worker families from Mendota, CA recruited for a study to evaluate occupational and environmental exposures of significance for a farm working population. Urinary 3-PBA concentrations (as an indicator of pyrethroid exposure) in our study were detected in 80% of all samples with a range of 0.2–13 ng/mL. There was no significant difference in the detection frequencies between mothers and children. However, adjustment for urinary creatinine resulted in a significantly higher concentration of urinary metabolites in children than in mothers (p=0.0054). Urinary 3-PBA concentrations from mothers and children in the same household were positively correlated for both volume based (R^2=0.39, $p < 0.0001$) and creatinine adjusted (R^2=0.37, $p < 0.0001$). These concentrations are higher than measured in population based samples. Questionnaire data on housing quality, home pesticide use, and foods eaten over the last 24 hours were also collected. Over the last year, multivariate statistical analysis was completed and a paper has been prepared and is ready for submission. Variables included in the multivariate analysis were based upon the results of the univariate analysis. The Home Disrepair Score, derived from the combination of multiple questionnaire items, was significant in the univariate analysis only for mothers and the Inside Housing Conditions Score, derived from the staff evaluation during the

MICASA follow-up interview, was significant only for the children. As these two scores are designed to measure similar housing characteristics, both scores along with the Outdoor Spray Pesticide Use variable from the MICASA baseline questionnaire and the log-transformed creatinine concentrations were included in all three multivariate models described below.

Multivariate models assessed factors associated with 3-BPA concentrations in the combined sample (both mothers and children), children only and mothers only. Both the Home Disrepair Score ($p = 0.05$) and Outdoor Spray ($p = 0.03$) were positive significant estimates of urinary 3-PBA levels in the combined sample model, which included log-transformed creatinine, the Home Disrepair Score, Outdoor Spray, Inside Housing Conditions and a Mother/Child variable. The model restricted to children included food diary variables significant in the univariate model: Apple (categorical), Milk (continuous), All Meat (continuous) and Cereal (continuous) as well as the log-transformed creatinine, the Home Disrepair Score, Outdoor Spray and Inside Housing Conditions. In this model Outdoor Spray ($p = 0.07$) and Inside Housing Conditions ($p = 0.08$) were marginally significant positive estimators of urinary 3-PBA concentration. Cereal Total, while marginally significant in the children only data, was negatively associated with urinary 3-PBA. The mothers only model included the food diary variables Eggs (categorical), Beans (categorical), Grapes (categorical), Chicken (categorical), and Cereal (continuous) as well as log-transformed creatinine, the Home Disrepair Score, Outdoor Spray and Inside Housing Conditions. The Home Disrepair Score ($p = 0.03$), Outdoor Spray ($p = 0.03$), and Cereal Total ($p = 0.04$) were all significant positive estimators of urinary 3-PBA levels in the mothers. These results indicate that poor housing conditions for farmworker families are contributing to increased levels of pesticide exposure.

Impact:

Results from this study provided the first biomonitoring work on pine cone harvesters and represented a large, industry-wide cooperative effort to improve worker health. Results from the farmworker family study are part of a larger health education effort that will be communicated through the outreach core to the community.

C. Significance

One of the goals of the WCAHS is to detect, assess and evaluate the effects of environmental and occupational factors as well as toxic substances on human health. To meet such a goal, many types of studies are needed, varying from establishing the presence of the stress factor or toxin in the environment to developing a suitable marker of exposure or effect, and subsequent use of this marker to establish information that can be used to protect the population from exposure. In addition, information needed for occupational health models, predictions, and risk assessments is usually obtained through a large number of costly chemical analyses. This project develops and uses sensitive, selective, rapid and cost-effective immunochemical methods to address the issue of high analysis costs for human exposure and effect monitoring, as well as environmental monitoring and the need for markers of exposure and effect and their analysis. The assays and technologies developed and utilized in this reporting period are a step toward this overall goal.

D. Publications

Ahn, K.C., H-J. Kim, M.R. McCoy, S.J. Gee and B.D. Hammock. 2011. Immunoassays and biosensors for monitoring environmental and human exposure to pyrethroid insecticides. J. Agric. Food Chem. 59(7):2792-2802. PMCID: PMC3070843

Ahn, K.C., S.J. Gee, H.J. Kim, P. Aronov, H. Vega, R.I. Krieger, B.D. Hammock. 2011. Immunochemical analysis of 3-phenoxybenzoic acid, a biomarker of forestry worker exposure to pyrethroid insecticides. Anal. Bioanal. Chem. 401 (4):1285-93. PMID:21717113.

Carlomagno, M., C. Mathó, G. Cantou, J.R. Sanborn, J.A. Last, B.D. Hammock, A. Roel, D. González and G. González-Sapienza. 2010. A clomazone immunoassay to study the environmental fate of the herbicide in rice (Oryza sativa) agriculture. J. Agric. Food Chem. 58(7):4367-4371. NIHMS189902

Kim, H-J., M. McCoy, S.J. Gee, G.G. Gonzalez-Sapienza and B.D. Hammock. 2011. Noncompetitive phage anti-immunocomplex real-time polymerase chain reaction for sensitive detection of small molecules. Anal. Chem. 83(1):246-253. PMCID: PMC3031424

Kim, Y.A., E.H. Lee, K.O. Kim, Y.T. Lee, B.D. Hammock and H.S. Lee. 2011. Competitive immunochromatographic assay for the detection of the organophosphorus pesticide chlorpyrifos. Anal. Chim. Acta 693(1-2):106-113. PMID: 21504817.

Schebb, N.H., B. Inceoglu, K.C. Ahn, C. Morisseau, S.J. Gee and B.D. Hammock. 2011. Investigation of human exposure to triclocarban after showering and preliminary evaluation of its biological effects. Environ. Sci. Technol. 45(7):3109-3115. NIHMS278856. PMID: 21381656.

Ye, X., X. Zhou, J. Furr, K.C. Ahn, B. Hammock, E.L. Gray and A.M. Calafat. 2011. Biomarkers of exposure to triclocarban in urine and serum. Toxicology 286(1-30):69-74. PMID: 21635932

E. Project-Generated Resources

We have generated antibodies and antigens for fipronil and are in the process of generating reagents for imidacloprid metabolite assays. As with all of our antibodies, they are available gratis to universities for research purposes. Commercial entities may request to evaluate antibodies and antigens through a Materials Transfer Agreement or to license their use for commercial purposes through the campus Technology Transfer Office, Innovation Access. Researc presented at two conferences.

Ki Chang Ahn, Shirley J. Gee, Arlene Blum, Hyun-Min Hwang, and Bruce D. Hammock. Immunoassay for Flame Retardant PBDEs Residues in the Indoor Environment. 31st SETAC North American SETAC Annual Meeting, November 10th, 2010.

Hee Joo Kim. Heavy Chain Single Domain Antibodies Derived from a Phage-Displayed Alpaca Antibody Library for Sensitive Detection of a Small Hapten. Superfund Annual Meeting, Lexington, KY, October 23-26, 2011.

Zuzana Majkova, H.J. Kim,. M.R. McCoy, K.C. Ahn, A. Ranganathan, S. Lakshmana, S. Tabares-da Rosa, G. Gonzalez-Sapienza, I.M. Kennedy, S.J. Gee, B.D. Hammock. Novel immunoanalytical methods for monitoring levels of environmental pollutants.Superfund Annual Mtg, Lexington, KY, Oct 23-26, 2011.